The Farmer's Guide

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The Farmer's Guide

Revised and Enlarged Edition

JAS

To

THE PREMIER OF JAMAICA

HON. NORMAN WASHINGTON MANLEY

Q.C., M.M.

In appreciation of his long years of service to the cause of Jamaica's agriculture and for his constant devotion to the welfare of our farming community – this Guide is respectfully dedicated

DECEMBER 1961

Foreword

THE REVISION of the *Farmer's Guide* has come about at a most appropriate time. We have just launched a new Agricultural Development Programme which embodies all that was good in our former development schemes and is shorn of all that was unworkable or impracticable for our local situation.

In the new era into which our agriculture has entered it will take the best that there is in every farm family to earn from the land, a living comparable to that which other families in industry enjoy.

Our Agricultural Extension Services stand ready at all times to give guidance to the farmer. But it is impossible for any Government to employ a staff big enough to give individual attention to the 200,000 farm families who make up the Extension clientele.

A book such as the *Farmer's Guide* should go a far way in providing the alert farm family with valuable information on the day-to-day problems encountered on the farm.

The *Guide* has earned worldwide acceptance throughout the tropical world, being used as a Text book in many schools.

I wish to commend most heartily the Jamaica Agricultural Society for publishing this revised edition, the technical officers in my own Ministry for their assistance, as well as those experts in the Commodity Organisations and the field of Commerce for their valuable help.

May this *Farmer's Guide* be a constant companion to the farmers of our land and be used by them for future prosperity.

Minister of Agriculture & Lands
DECEMBER 1961

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Introduction

A function of the Jamaica Agricultural Society since its inception in 1895 has been to disseminate information on agriculture, and in 1951 increased emphasis was given to this role at the instance of the Government.

The Society in May 1952 published a *Farmer's Handbook* (revised and brought up to date in 1960), the purpose of which was to provide a compendium covering the various fields of assistance available through Government services and programmes, and other matters of interest to all farmers.

We now publish a *Farmer's Guide* in an endeavour to meet the constant demand for pamphlets and the like on agricultural subjects.

In compiling the book, we have drawn on material from many sources and on the advice, experience and editorial contributions of a number of people and organisations, both here and abroad. (The list of acknowledgments will indicate the extent of our contacts, but it is hoped that the resulting publication has justified the effort.) Among those to whom we are indebted is the Jamaican Ministry of Agriculture and Lands, from whose officials we have had constant and most valuable help, and of whose extension circulars we have made the fullest possible use. Among the officials and others, special mention must be made of Mr C. D. Hutchings, Director of Extension Services and Mr E. V. Clarke, whose contributions throughout have been of the highest importance; also Mr Douglas Mollison, Pest Control Officer; Dr Cleve Allen for valuable contribution on Cattle Rearing; Mr E. W. Winckley and Mr W. T. Domville; Mr A. M. Pratt and Mr R. I. Moss; Mr J. F. Ward, Minstry Horticulturist; Mr Louis Bell, Citrus Agronomist; Mr David Edwards, B.Sc. (Econ.); Mr R. W. Leach, Banana Industry Board; Mr E. Tai; Dr J. Steele and Mr Ted Hebel, United Nations Specialists on Soil Conservation (land classification, coloured illustrations and notes on soil conservation); the Extra-Mural Department of the University College of the West Indies; Mr T. F. Finch, Soil Surveyor, Yallahs Valley Survey; Mr P. A. Bovell, Mr H. L. Archer and Mr H. A. Thompson of West Indies Sugar Co Ltd; Mr H. C. Cahusac, General Manager, West Indies Sugar Co, Frome Division; the University of Puerto Rico (illustrations of weeds and noxious plants); Forest Department; Professor G. F. Asprey of the University College of South Wales; Dr R. G. Robbins, Land Research Section of the Commonwealth Scientific Research Organization (Australia); Mr W. Hinz, I.C.A. Advisor in Hydraulics and Mr Horace Payne; Mr

Cecil Chin Loy, Sugar Research Division of the Sugar Manufacturers' Association; All-Island Banana Growers' Association; the Citrus Growers' Association; the Institute of Jamaica; also authors, contributors and publishers of *The Gardener's Bug Book*; *Tropical Planting and Gardening; Farming in South Africa*; *Species* (Hy N. Ridley, Macmillan); the *Journal of the Agricultural Department, West Australia*; the Department of Agriculture, Canada; *Organic Gardening*; The Institute of Inter-American Affairs, Haiti; Eerste Nederlandsche Kunstmestfabreik; Service Co-operatif Inter-American de Production Agricole, Haiti; the *New Zealand Journal of Agriculture*; the *Journal of the Canadian Department of Agriculture*; the *New South Wales Agricultural Gazette*; the *Journal of the Ministry of Agriculture*; the Sidney Technical College, Department of Technical Education; the *Journal of the Trinidad and Tobago Agricultural Society*; *Trade Magazines Inc., Ohio*; Massey-Ferguson Company Ltd; The United States Department of Agriculture; members of the Information Services of our Society: to all of whom acknowledgment is here gratefully made.

In an effort of this kind so much depends on the co-operation of others who are specialists in their own departments, that without their interest and help but little progress can ever be made. And the more ambitious the work, the greater will be found the necessity for that co-operative help.

My colleague, Mr Wyatt Bryce who as our Information and Publications Officer, is principally responsible for our publications, joins me in expressing our warm personal thanks to all those who have been associated with this great effort.

We wish to add a special word of thanks to our printers. It has been a pleasure to deal with them and if this somewhat ambitious effort does have a good reception, part of the credit must surely be theirs for a contribution of assistance greater than is ordinarily expected of, or given by, printers.

C. Y. Atkinson *Secretary.*

JAMAICA AGRICULTURAL SOCIETY, KINGSTON, JAMAICA, W.I.

PART ONE

CHAPTER 1

Introduction to Farming in Jamaica

At the outset it will be well to introduce the persons who are to be responsible for farming the land—the farmers.

In most countries the term 'farmer' implies an agriculturist, skilled in his particular line, occupying and profitably farming a considerable area of productive land. In England the farms vary between one hundred and five hundred acres. In Jamaica, however, nine-tenths of the people called farmers are very poor and occupy very small holdings varying from five acres to one acre or less.

Having regard to the foregoing and the certainty that larger holdings will not be obtained, the policy of Government has been to teach the 'farmers' not to look for larger holdings but to make better use of what they have, building up fertility, avoiding wasteful methods of cultivation, and aiming at greater productivity. And, above all, to refrain from further fragmentation of already too-small holdings.

In order to foster the development of this new aspect of farming on Jamaica's farms, Government has inaugurated a Farm Development Programme, which will follow along the same lines as the old Farm Improvement and Farm Recovery Schemes, but on a much greater and far-reaching scale, with alterations in detail made in the light of experience gained in operating the former Schemes.

Under this Programme the farmers are substantially assisted with loans on easy terms for providing water supplies, dairy sheds and farm buildings, fencing, fertilizing fields for growing grass, clearing land, establishing soil conservation barriers, and planting crops.

The Programme is worked out by trained men of the Ministry of Agriculture in co-operation with the farmers themselves.

The foundation stone on which the entire structure is to be built, and the most essential factor of the scheme, will be the self-help and co-operation of the farmer himself.

The field of agricultural development in Jamaica is so extensive, and the details of the work so complex, that the mind of the practical farmer is often worried when he contemplates the efforts he must make. The fruits of full development, however, are within reach if we reach out for them, and full and adequate rewards will be received for the work which must be done.

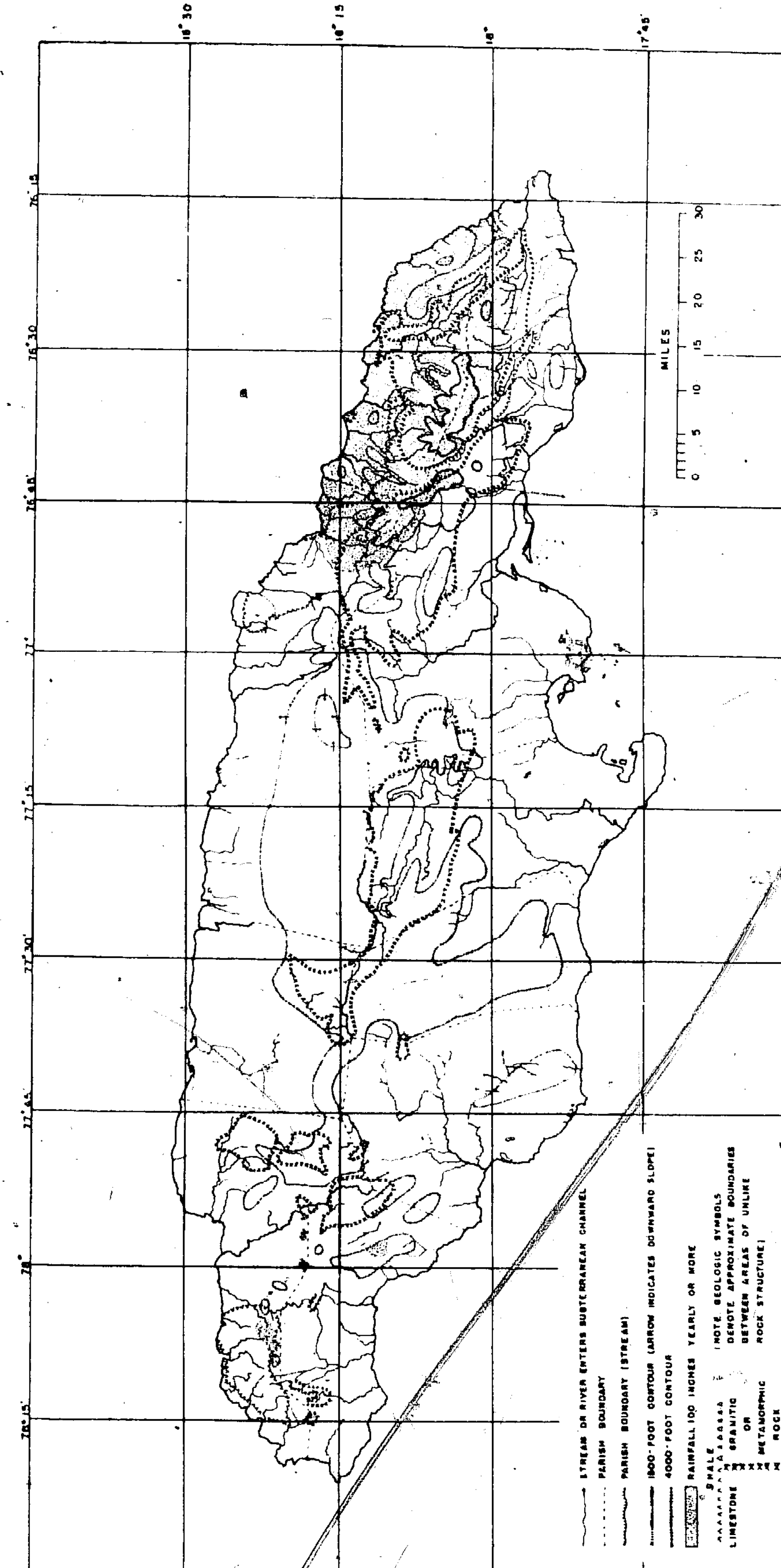
In further aid of farming, extensive soil surveys have been carried out. They were started in 1951 under direction of Professor Hardy of the Imperial College of Tropical Agriculture. These surveys involve study and mapping of our soils, classifying them according to type, steepness of slopes on which they occur, and the severity of erosion which they have suffered. Accurate knowledge of these factors plus information about the climate provide a sound basis for classifying land according to its capability.

This survey will produce practical results in the shape of land-capability maps, which in turn when correlated with the factors of climate, elevation, size of holding, etc., will give rise to the production of land-use plans, the blue-prints of development.

The land-use plans will provide factual details of the farming possibilities on any and all farm land, but the conversion of 'possibilities' into actual 'production' will depend upon the human element, the will and strength of individual farmers, the standard of legislation, the quality of guidance provided by Agricultural Officers, and the effectiveness of the farmers' information and marketing organizations. Of all these human element factors, by far the most important is the character of the farmer, for upon his strength and determination will depend the others.

The full development planned by Government under the Farm Development Programme needs the utmost exertions of farmers, the Agricultural Services, and the Legislators, if it is to be successful. The programme can be gloriously successful, but to ensure success farmers must accept that burning is destructive of land and cease the practice; they must establish and maintain soil conservation measures on *all* the land; they must care for and manage livestock, kindly and efficiently, in ever-increasing numbers, on every single farm; they must apply fertilizers in greater and greater quantities on every single farm; they must control pests and diseases, plant crops and breed animals in the most expert manner, and harvest, process, store, and sell the farm products with the very best techniques; in a word, the land must be farmed well, or it and its people will not survive.

The Farmer's Guide attempts to provide the information or to show the source of information in relation to all the approved techniques of agriculture known in Jamaica, and has been compiled from the results of the thought and practice of over half a century, and now attempts to provide in concise but authoritative form the information needed by farmers for the work of further development ahead.



Map of Jamaica

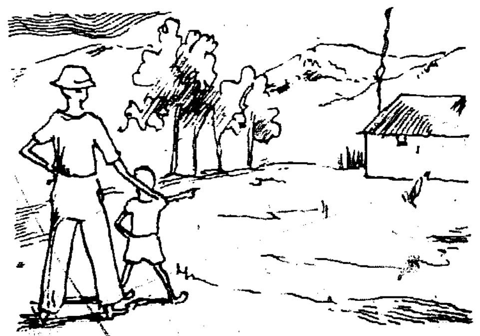
By courtesy The Institute of Jamaica

CHAPTER 2

The Farmer's Log

JANUARY

What to do this month



Weather mild and dry. Begin to prepare land for planting. Avoid burning: it destroys the life of the soil.

The Soil. Prepare the land for planting crops. Avoid burning—it destroys the life of the soil.

Bee Farming. Make final check on colonies to see that they are queen right and that brood rearing is progressing satisfactorily.

Coffee. Prune. Open holes for spring planting. Circle weed seedlings.

Irish Potatoes. Plant seed; mould and spray growing crop.

Vegetables. Plant all types.

Cocoa. Prune trees lightly and repeat every two months.

Citrus. Continue reaping. Remove all dead wood. Spray for clean fruit if necessary. Prepare

FEBRUARY

What to do this month

Coolest and driest month of the year. Cover soil with as much mulch as possible.

The Soil. Complete cleaning up and preparing generally for planting if early rains in March. Continue soil conservation work on newly prepared land.

Bee Farming. Provide colonies with adequate storing facilities. Do not disturb the bees more often than is necessary. Extract honey when the heavy flow is off and the honey is ripe.

Coffee. Prune. Open holes for spring planting.

Irish Potatoes. Plant the main crop and continue spraying and mulching any earlier crop.

Cocoa. Circle-weed plants and if weather is dry, mulch young plants. Extend weeding to drip-circle of tree.

JANUARY—*Continued*

land for Spring planting. Apply chemicals to soil for control of Fiddler Beetle.

Miscellaneous Crops. Plant negro yam. Prepare for drying ginger. Commence harvesting tobacco. Plant corn, cow peas and caroline peas if rains are falling.

Sugar Cane. Have cane tested for sucrose content.

Rice. Harvest rice planted in August.

Timber. Bush out September Tree plantings.

Poultry. Make preparations for receiving day-old chicks.

Livestock. Fertilize pangola pastures. Make sure water is available for your cows.

FEBRUARY—*Continued*

Citrus. Continue reaping. Remove dead wood. Spray if necessary. Prepare land for spring planting. Treat for Fiddler Beetle and Slugs if necessary. Put on first dressing of fertilizer for the year.

Miscellaneous Crops. Cure ginger. Continue planting of negro yams. Reap arrowroot and prepare starch. Continue harvesting tobacco. Prune and fertilize grape vines in latter two weeks of month. Set cuttings of grape vine in sand to grow.

Sugar Cane. Reaping season. Check on juice quality and replanting.

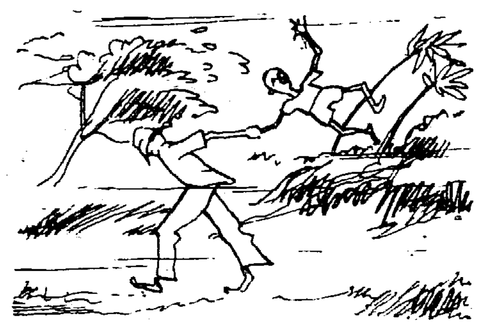
Rice. Plough and harrow land. Plant legume or grass for rotation.

Timber. Prepare holes for planting about 9 ins. in diameter and 1 ft. deep for forest plants. Clear vegetation from around each plant.

Poultry. Make preparation for receiving day-old chicks.

Livestock. Be careful not to overgraze. Remember to make water available for your cows.

MARCH
What to do this month



Strong winds. Protect against loss of moisture by mulching. Generally dry, but light showers in more favoured districts towards end of month.

The Soil. Complete land preparation for early planting. Obtain seed and other planting material for sowing when rains come. Make sure that newly cleared land on hillsides is provided with soil conservation barriers and trenches.

Bee Farming. Continue to provide storing space for the bees and extract ripe honey. Handle honey carefully in the apiary so as not to encourage robbing among the bees.

Coffee. Clean fields. Fill holes for May planting—(those opened in January). *Add fertilizer.*

Irish Potatoes. Continue planting. Continue spraying earlier crops.

Cocoa. Treat trees with Dieldrin against Fiddler Beetle. Make sure area to be treated is free from weeds. Remember to light prune and remove diseased pods.

Citrus. Continue reaping. Clean groves. Apply fertilizers, mulch and organic manures. Remove

APRIL
What to do this month

Light showers may be expected during the month. Mulched plot can be opened up to receive the full benefit of the early rains, then levelled again.

The Soil. Carry on tillage for destruction of weeds among young crops.

Bee Farming. Continue reaping honey which may be available. Look out for colonies that may be showing early signs of swarming and provide more room inside or make increase for such colonies as need it.

Coffee. Mulch. Remove gormandizers. Fill holes for late May or June planting.

Irish Potatoes. Continue spraying.

Cocoa. Planting season. Temporary shade should be adequate and permanent shade planted.

Citrus. Continue Fiddler Beetle control. Replace dead or unthrifty trees with new trees. Apply slug bait. Clean trenches and outlet drains in preparation for May rains.

Miscellaneous Crops. Follow potato crop with cow peas or red peas. Mould, and control weeds.

MARCH—*Continued*

dead wood from all trees before blossoming starts. Look out for and destroy Fiddler Beetle as soon as the Spring Rains start.

Vegetables. Plant all types in the highlands, but only lettuce, radish and cucumbers on the lowlands.

Miscellaneous Crops. Plant all types of roots and tubers. Transplant seedlings. Plough tobacco field and destroy old trees, then plant corn and all types of peas and beans for rotation.

Sugar Cane. Check on juice quality, fertilizer requirements.

Timber. If rains, plant. Clear away vegetation from holes before planting. On steep slopes, plant along the contour.

Livestock. At first sign of rain plant Pangola, if lands are available. Watch for the first sign of heat and breed cows as promptly as possible.

Bananas. Destroy old stools to control the borer pest. Commence intensive spraying.

APRIL—*Continued*

Sugar Cane. Reaping season (continued). Apply fertilizer on acreage already reaped or in Spring plants. Prepare intervals, etc. for rainy season.

Timber. Order seedlings to replace dead and missing forest tree plants.

Poultry. Protect from rain.

Livestock. Continue preparing lands for Pangola. Look about subdivision of pastures.

Bananas. Fork plants not yet in bearing. Continue with intensive spraying.

MAY
What to do this month

The regular May rains may be expected. The soluble nutrients of applied fertilizers will now be released.

The Soil. Continue with weed control and check on soil conservation barriers.

Bee Farming. Take off remaining portion of honey crop. Pay special attention to swarm control measures. Make increases if desired to increase the size of apiary. Very good queens can be reared at this time—either for replacement or for new hives.

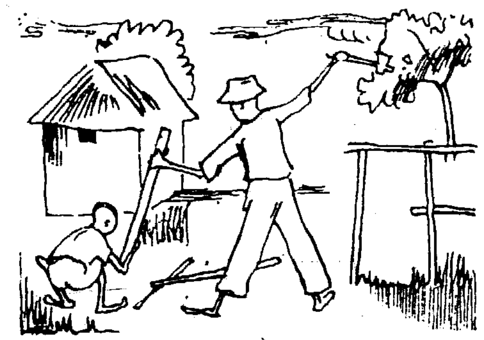
Coffee. Plant seedlings. Remove gormandizers.

Cocoa. Plant cocoa under good shade, established last Fall.

Citrus. Continue Fiddler Beetle control. Continue Slug control. Continue with replacements if not completed in April.

Miscellaneous Crops. Plant white and yellow yams. Young seedlings of any orchard crop may be transplanted into permanent field position. Pumpkins, chochoes may now be planted. Continue moulding and weeding corn. Reap peas planted in February.

JUNE
What to do this month



Good showers may still be expected to complete the May season.

The Soil. Continue with tillage for weed control; begin preparation of land for August planting.

Bee Farming. Check new hives to make sure they are queen right and that the stores are adequate. Feed if necessary. Render cappings. Render combs discarded during extraction.

Coffee. Circle-weed May seedlings. Plant seedlings. Remove gormandizers. *Add fertilizer.*

Cocoa. Prune after harvesting of Spring Crop. Prepare holes for September planting so that they may weather.

Citrus. Clean groves. Check for Rust and treat if necessary. Treat for Fiddler Beetle and Slug. Apply fertilizers.

Miscellaneous Crops. Continue to plant white and yellow yams. Prepare to plant Sweet Potatoes in July. Begin selecting seed corn for August and September planting.

MAY—*Continued*

Sugar Cane. Reaping season (continued). Avoid over-cutting in wet season. This creates stale cane problem.

Timber. Replace dead and missing forest tree plants. Remember to plant on the contours when planting on steep slopes.

Livestock. Continue planting Pangola. If season is wet watch out for sore feet and treat. Cows which are due to calve should be brought in near the compound.

Bananas. Carry on with tillage for weed control. Spray for control of pests and diseases.

JUNE—*Continued*

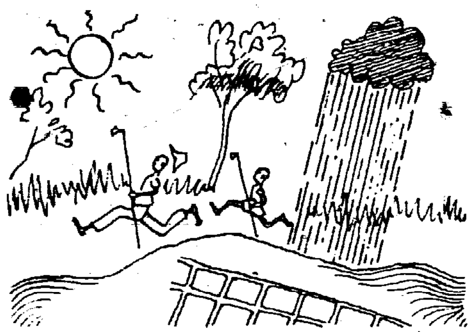
Sugar Cane. Reaping season (continued). Weeding necessary. Check on juice quality. If taking over 10 tons of cane to a ton of sugar check with Chemist for advice.

Timber. Bush out October plantings. Remember when planting on steep slopes to plant on the contours.

Livestock. Start cutting back Pangola. Begin to prepare animals for Denbigh Show.

Bananas. Very intensive spraying needed.

JULY
What to do this month



Fair weather and occasional showers, but absence of showers in the 'dry' areas. Hurricane season begins.

The Soil. Continue tillage work; establish soil conservation measures on land prepared for August planting. Make compost heaps for use on Winter vegetables.

Bee Farming. Check stores in colonies. Feed if necessary. Look out for pests like red ants, etc. Replace queens not suitable for next year's crop.

Coffee. Circle-weed May and June seedlings. Last month for Spring planting. Open holes for Fall planting.

Irish Potatoes. Begin preparing land for planting.

Cocoa. Prepare land for Fall planting. Plant good temporary shade in well prepared land also permanent shade.

Citrus. Clean groves. Continue slug control.

Miscellaneous Crops. Harvest seed of pulses and select seed for planting; commence harvesting corn. Plant sweet potatoes.

AUGUST
What to do this month

Weather warm and dry with occasional showers. Hurricane season.

The Soil. See to soil conservation measures. Bill down weeds but guard against erosion on sloping land.

Bee Farming. Feed bees if necessary. Redistribute frames in supers so that weak colonies will not have more frames than they can adequately protect.

Coffee. Clean fields. Open holes for October/November planting.

Cocoa. Complete preparation for Fall planting. Make sure contour drains are sufficient to take away October rainwater.

Citrus. Prepare new mounds for September planting. Continue Slug control.

Miscellaneous Crops. Plant corn and pulses. Start reaping negro yams. Plant pineapples, pumpkins, melons, tomatoes and sweet potatoes. Make arrangements for curing and storing pimento.

Sugar Cane. Final plant care for Fall rains. Clear drains. Begin Fall planting.

JULY—*Continued*

Sugar Cane. Reaping season (continued). Check on juice quality.

Rice. Prepare land for planting. Plough and harrow.

Timber. Order forest tree seedlings for delivery in September or early October.

Livestock. Continue mowing. Apply fertilizer. Control flies. Treat animals for cuts and bruises where necessary.

Bananas. Continue with spraying for leafspot control.

AUGUST—*Continued*

Rice. Plant rice. Select good healthy seed. See that they are free from grass seeds.

Timber. Bush out March plantings. See that the plants get as much sunlight as possible.

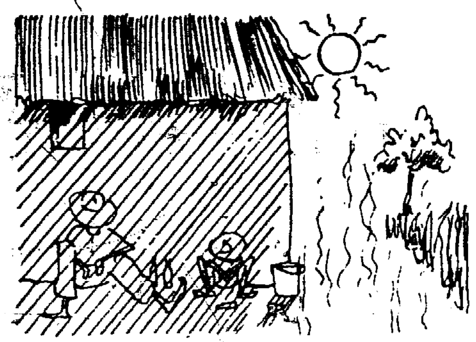
Poultry. Make preparation for receiving day-old chicks.

Livestock. Feed and mow or brush Pangola. Prepare land for Fall planting of Pangola. Look out for milk fever in cows that are calving.

Bananas. Continue with intensive spraying. (Prepare props for bearing plantains.)

SEPTEMBER

What to do this month



Hot weather generally. Hurricane season. Some rains may be expected in last week.

The Soil. Make sure that soil conservation works are adequate to cope with the October and November rains.

Bee Farming. Feed bees if necessary. Redistribute frames so that weak colonies will not have more frames than they can adequately protect. Provide good covers for the hives.

Coffee. Clean fields. Mulch. Fill holes for October plantings. Begin reaping.

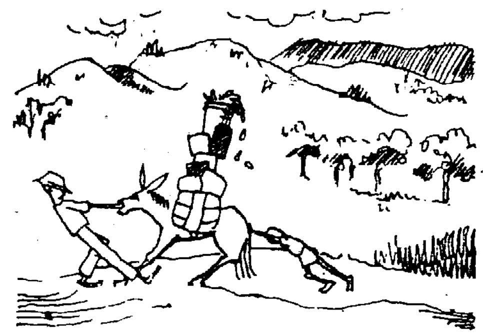
Cocoa. Plant cocoa under shade established in the Spring.

Citrus. Continue planting. Prepare for reaping early fruit. Make or repair boxes or reaping bags for receiving fruit which you will clip from trees in the reaping process. A suitable box is one half the size of a Field Box (internal dimensions of half field box 15½″ long by 12″ wide by 13″ deep).

Miscellaneous Crops. Last month for planting corn. Pulses generally, except Congo peas, may be planted. Continue reaping negro

OCTOBER

What to do this month



End of hurricane season. Regular rains and cooler weather.

The Soil. Prepare for planting of peas on the uplands in November and December.

Bee Farming. Check stores in colonies. Prepare to feed bees during heavy rainfall. Contract hive entrances to assist the bees to conserve heat. Prepare frames, hive stands, hive bodies, etc.

Coffee. Clean fields. Reduce heavy shade. Plant seedlings. Continue reaping. *Add fertilizer.*

Vegetables. Plant seed—all types.

Cocoa. Begin reaping of Fall crop. Spray against Blackpod every two weeks. Continue planting.

Citrus. Apply final dressing of fertilizer for the year. Reap carefully fruit which is ready. Complete Fall planting.

Miscellaneous Crops. Control weeds by tillage. Continue planting pumpkins, melons, pineapples and fruit trees. Water tobacco seed beds. Weed. If necessary treat for 'damping off'. Look out for any other diseases.

SEPTEMBER—*Continued*

yams. Continue planting sweet potatoes, pineapples, pumpkins, melons and fruit. Sow tobacco seed from the middle to the end of this month.

Sugar Cane. Fall planting.

Rice. Maintain irrigation water in rice fields.

Timber. If rains, plant trees. When planting on steep slopes, plant on the contours.

Poultry. Protect from high winds and rains.

Livestock. Plant Pangola roots or cuttings. Make preparation for rainy month ahead so that cows can calve in dry quarters. Deworm calves.

OCTOBER—*Continued*

Sugar Cane. Fall planting.

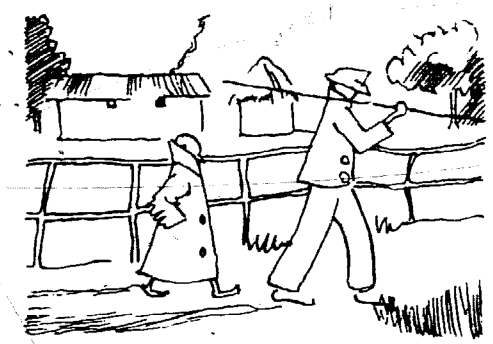
Rice. Maintain irrigation water in rice fields.

Timber. Plant trees. Clear away vegetation from holes before planting. Remember when planting on steep slopes to plant on the contours.

Livestock. Continue planting Pangola. Make sure that salt lick is available. Look out for foot rot and mastitis and treat.

Poultry. Protect from high winds and rain.

NOVEMBER
What to do this month



Cool weather with some rains. Cold winds ('Northers') from the north.

The Soil. Mulch before the end of the rainy season.

Bee Farming. Feed to prevent starvation if there is prolonged rainfall. Continue repairing equipment.

Coffee. Circle-weed seedlings. Last month for Fall planting. Continue reaping. Start pruning if reaping completed.

Vegetables. Continue the planting of all types of vegetables.

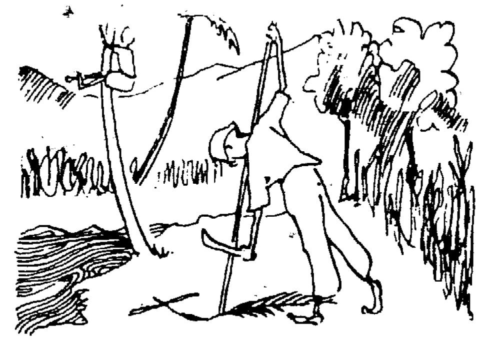
Cocoa. Continue reaping Fall crop. Set traps with poison bait to kill rats. Make sure all planting is finished by the end of the month.

Citrus. Continue reaping. Apply mulch around young trees.

Miscellaneous Crops. Continue weed control. Plant red peas in the uplands. Continue planting pumpkins, melons and sweet potatoes. Plant negro yams. Plant tobacco seedlings in fields.

Sugar Cane. Recondition transportation units.

DECEMBER
What to do this month



Cool weather. Bright sunny days. A touch of cold at nights in the more elevated areas.

The Soil. Mulch extensively—dry weather is at hand.

Bee Farming. Examine brood nests to see that combs are in good condition. Replace inferior queens and those from badly starved colonies. If necessary, feed to stimulate brood rearing. Prepare extracting equipment. Unite weak colonies. Clip the wings of queens if it is desired. They can be easily found at this time.

Coffee. Prune.

Vegetables. Continue the planting of vegetables, where water is available.

Cocoa. Clean up trees after final reaping. Make sure your shade is satisfactory before the onset of the dry season.

Citrus. Continue reaping. Remember to handle fruit carefully. Start cleaning groves after the November rains.

Miscellaneous Crops. Continue planting red peas in the uplands. Mulch extensively—dry weather

NOVEMBER—*Continued*

Rice. Maintain irrigation water in fields.

Timber. Plant trees. Remember to clear away vegetation from holes before planting and to plant on the contours when planting on steep slopes.

Livestock. Give extra feed to cows that are undergoing rest before calving.

Bananas. Remove and bury or heap all trash in banana fields.

DECEMBER—*Continued*

is at hand. Weed and mould and cultivate tobacco.

Sugar Cane. Check on transportation equipment, etc. Prepare for reaping season.

Rice. Remove water from field when 20% of the paddy on the rice plants starts to yellow. This should take place about the middle of the month.

Timber. Replace dead or missing forest tree plants. Clear away vegetation from holes before planting.

Livestock. Fertilize Pangola for dry period. Watch out for calving trouble in cows that are ready to calve. Remember to give special care to the new born calf.

Bananas. Remove and bury or heap all trash in banana fields.

Vegetable Time-Table and Cultivation Notes

Kind of Vegetables	*Ideal time for sowing, Highland*	*Ideal time for sowing on Lowlands where rainfall is limited*	*Seed rate per square*	*Seed Sowing*	*Spacing in beds*	*Days to germinate*	*Miscellaneous*	*Crop ready in about*
Root Crops:								
Irish Potatoes	Jan.–May	Sept.–Nov.	100–150 lb.	Make sure one good or two medium sprouts on each set piece	3′ × 1′	7–14	Fertilize and spray	4 months
Yams:								
Negro	Dec.–Apr.			Tuber heads 4-oz. pieces in ridges	4′ × 1½′	7–14	Provide stakes	12–15 months
Yellow	Feb.–June	March–May	220 lb.					
White	Apr.–June							
Sweet Potatoes	July–Dec.	March–May and Sept.–Nov.	Cuttings used	Cuttings on ridges	3′ × 1′		When weeding prevent trailers rooting on ridge	4–5 months
Cocoes	Feb.–June, Sept.–Nov.	March–May and Sept.–Nov.	120 lb.	Heads of old plants	4′ × 4′	14–30	Earth up at each weeding	5–6 months
Cassava	Feb.–Sept.	March–May and Sept.–Nov.	50 × 3′ sticks	8″ cuttings in open ground	4′ × 4′	14–21	Plant Congo Peas between	9–18 months
Cereals:								
Corn	Mid. Feb. Mid. April	Feb.–May and Aug.–Oct.	1 lb.	In furrows	2′ × 2′	4	2 seeds per hole	10 weeks for green corn
Guinea Corn	Fodder all season	Fodder: Mar.–May and Aug.–Sept.	1¼ lb.	In furrows	Fodder: 2′ 6″ × 4″	7		3 months
	Grain none	Grain: Aug.–Sept.	⅛ lb.	In furrows	Grain: 2′ 6″ × 1′	7		8 months
Legumes:								
Soya Beans	Feb.–Apr., July–Sept., and Nov.	Feb.–Apr. and July–Oct.	10 lb.	In beds	1½′ × 1′	3–4	Inoculate seed	2½–4 months

THE FARMER'S LOG

Vegetable Time-Table and Cultivation Notes—(Continued)

Kind of Vegetables	*Ideal time for sowing, Highland*	*Ideal time for sowing on Lowlands where rainfall is limited*	*Seed rate per square*	*Seed Sowing*	*Spacing in beds*	*Days to germinate*	*Miscellaneous*	*Crop ready in about*
Legumes, contd.								
Red Peas	Mid. Nov.–Dec. Feb.–Apr. and Aug.	Feb.–Apr. and Sept.	10 lb.	In beds	2′ 6″ × 8″	3–4	Succession sowing	String beans 8 weeks Dry pods 10–12 weeks
Caroline Peas, Cow Pea and Black Eye	Feb.–Apr. and July–Sept.	Feb.–Apr. and July–Sept.	10 lb.	In beds	2′ × 1′	3–4	Cow pea pods: reap as they ripen	12–14 weeks
Congo Peas	Mar.–June and Sept.	March–Aug.	1½–2½ lb.	Open ground, 4 seeds per hole, thin to 2 plants	4′ × 4′	7–10	Interplant with red peas	5 months on
Old Homestead	Feb.–Apr. and July–Sept.	March–April and Sept.–Nov.	3 lb.	In beds	2′ × 1′	4–7	Place stake for twining	2–3 months
Bountiful	Feb.–Apr., July–Sept.	March–Apr. and Sept.–Nov.	3 lb.	In beds	2′ × 1′	4–7	Place stake for twining	2–3 months
Peanuts	Do not do well	March–Apr. Aug.–Oct.	2–4 lb.	In beds	2′ 6″ × 1′ 6″	3–6	Earth up pods when they begin to turn down	3½–6 months
Salads:								
Lettuce	Every month	Every month	¼ lb.	In boxes	1′ × [illegible]	3–10	Water frequently	2½–3 months
Beetroot	Every month	Oct. and March	½ lb.	In drills in beds	1¼′ × 6″	7–9	Soak seeds before planting. Thin out to 6″	2–3 months
Carrots	Every month	Oct.–Feb.	6 oz.	In drills in beds	1¼′ × 3″	10–15	Seeds slow to germinate, so firm in soil. Thin out to 3″	2–3 months

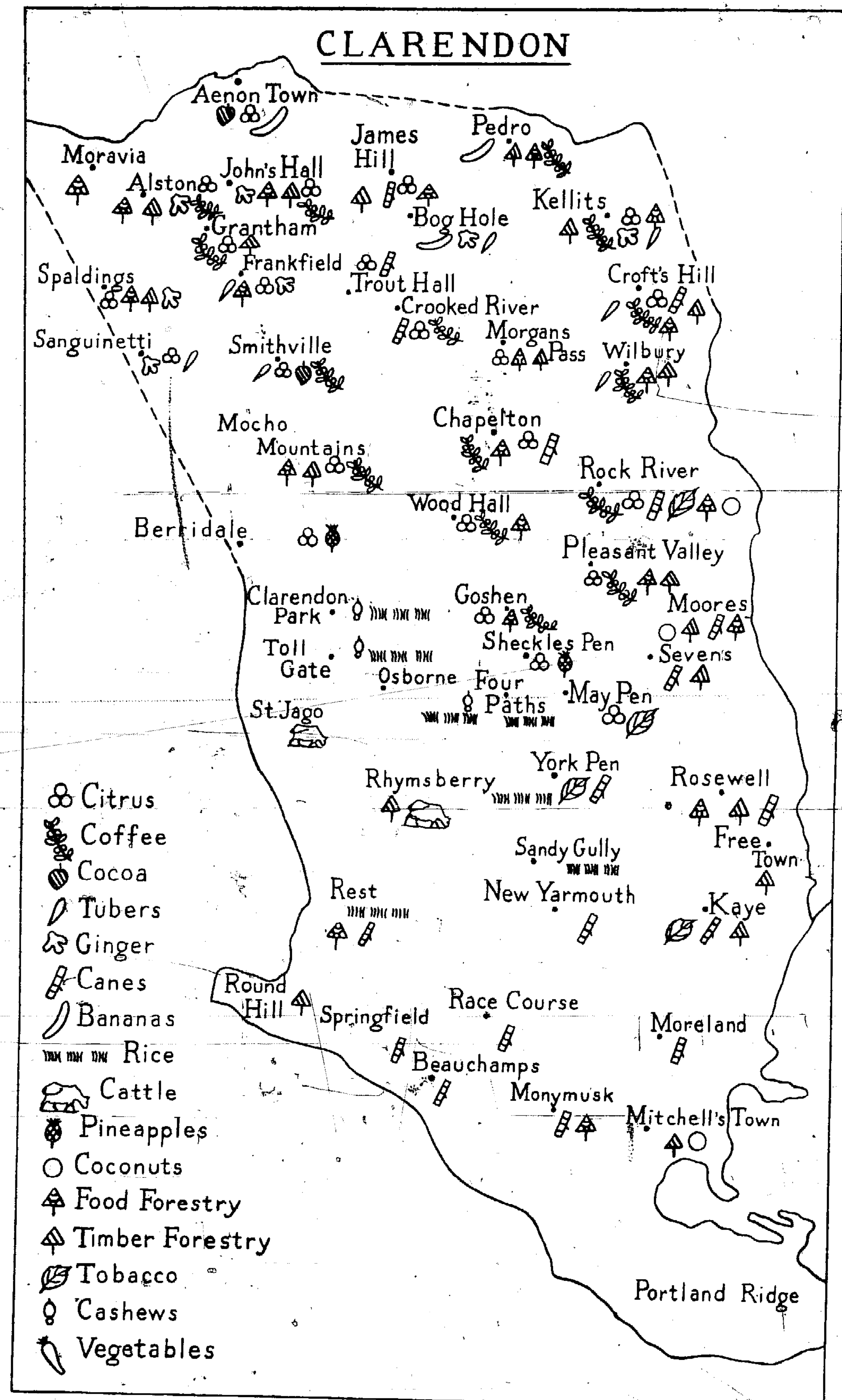
Vegetable Time-Table and Cultivation Notes—(Continued)

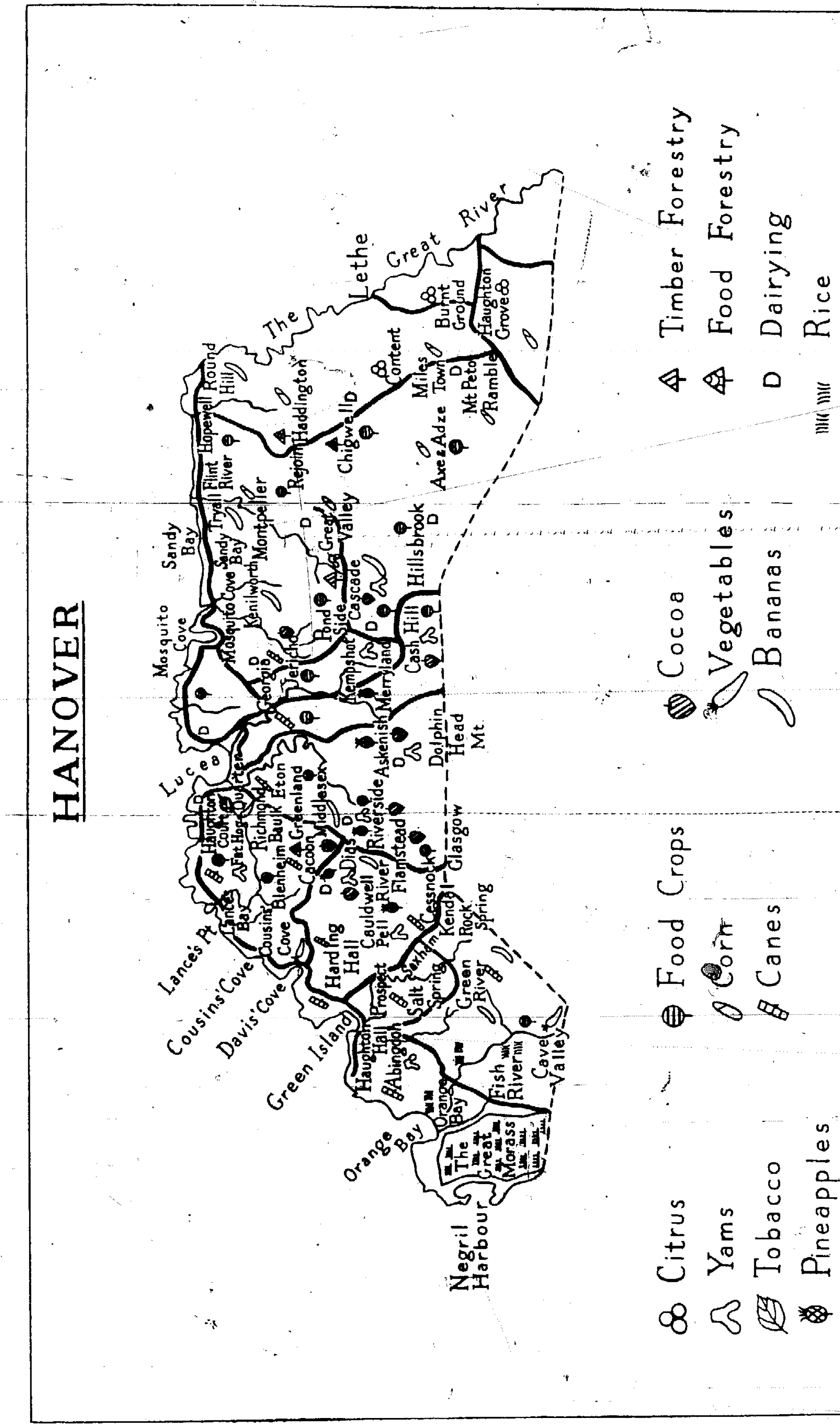
Kind of Vegetables	*Ideal time for sowing, Highland*	*Ideal time for sowing on Lowlands where rainfall is limited*	*Seed rate per square*	*Seed Sowing*	*Spacing in beds*	*Days to germinate*	*Miscellaneous*	*Crop ready in about*
Salads, contd.								
Celery	Every month	Oct.–Feb.	½ oz.	In boxes	3′ × 6″	12–20		4½–5 months
Turnips	Every month	Oct.–Feb.	¼ lb.	In drills in beds	1½′ × 6″	3–7	Thin out to 6″	2–2½ months
Radishes	Every month	Every month	¾ lb.	In garden bed and drills	1½′ × 2″	3–6	Thin out to 3″	1–1½ months
Tomatoes	Jan.–Apr.	Sept.–Feb.	½ oz.	Sow every week in boxes	3½′ × 2′	4–10	Stake, tie and prune side shoots	4–5 months
Sweet Pepper	Every month	Every month	¼ oz.	Sow every week in boxes	2½′ × 2′	4–10	Protect from sun scald by nitrogen fertilizers at blossom time	4–5 months
Egg Plant	Feb.–Mar.	Oct.–Feb.	½ oz.	Sow every week in boxes	2½′ × 2′	10–14	Water as often as soil appears dry	3–5 months
Okra	Every month	Every month	¾ lb.	In beds	4′ × 4′	6–12		1½ months and on
Cucumber	Feb.–May and Aug.–Oct.	Oct.–Feb.	¼ oz.	In boxes or on ridges	4′ × 2′	6–8	Branches or low arbour is advantageous	2–2½ months
Cabbage Group:								
Cabbage	Every month	Sept.–Jan.	1 oz.	In boxes	2′ × 2′	4–10	Hand pick caterpillars	3½–5 months
Cauliflower	Every month	Sept.–Jan.	1 oz.	In boxes	2′ × 2′	4–10		3½–5 months
Kohl Rabi	Every month	Oct.–Jan.	¼ lb.	In boxes	9″ × 6″	6–8		3–4 months
Broccoli	Every month	Oct.–Jan.	1 oz.	In boxes	2′ × 2′	4–10		4–5 months

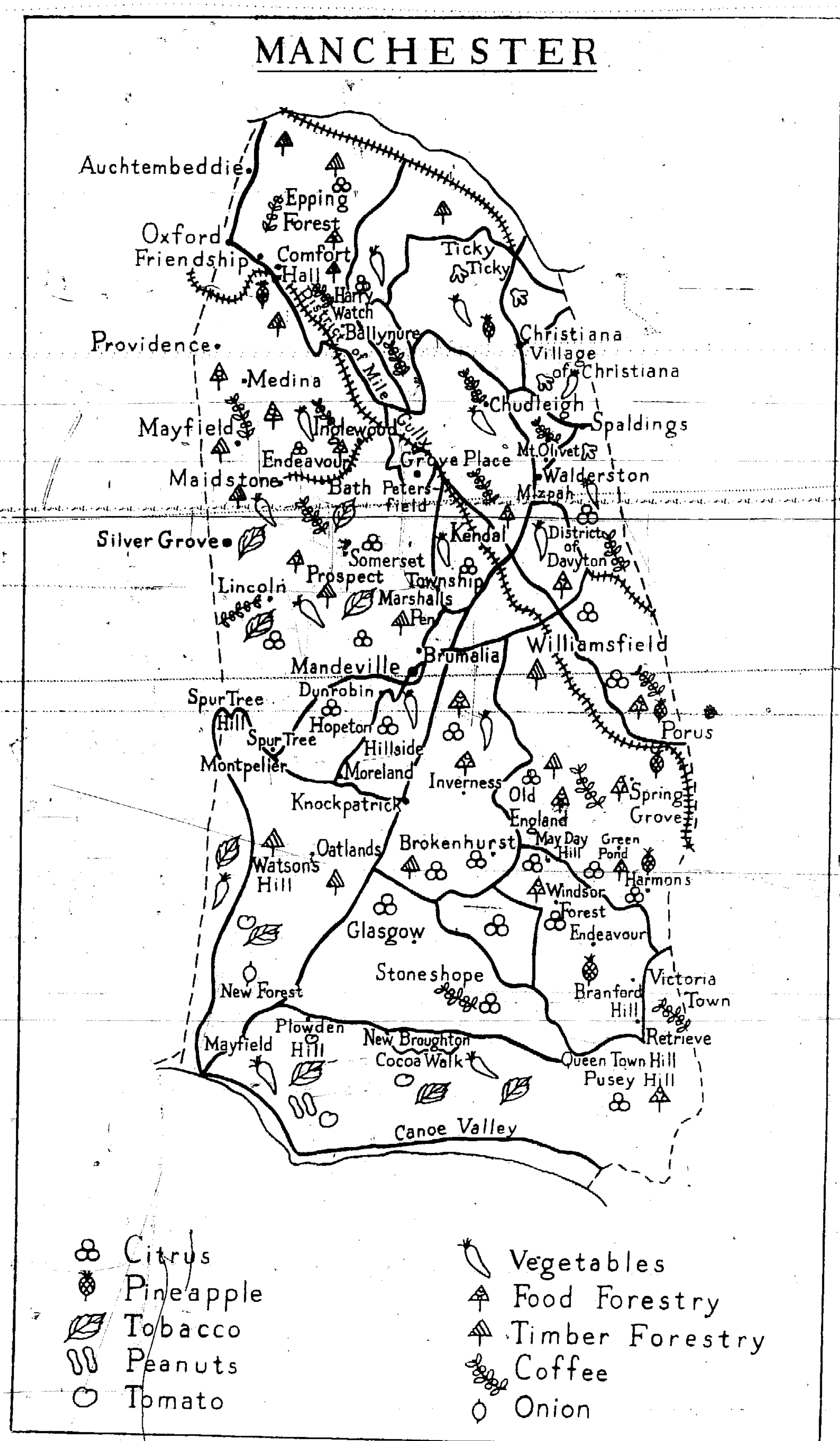
Vegetable Time-Table and Cultivation Notes—(Continued)

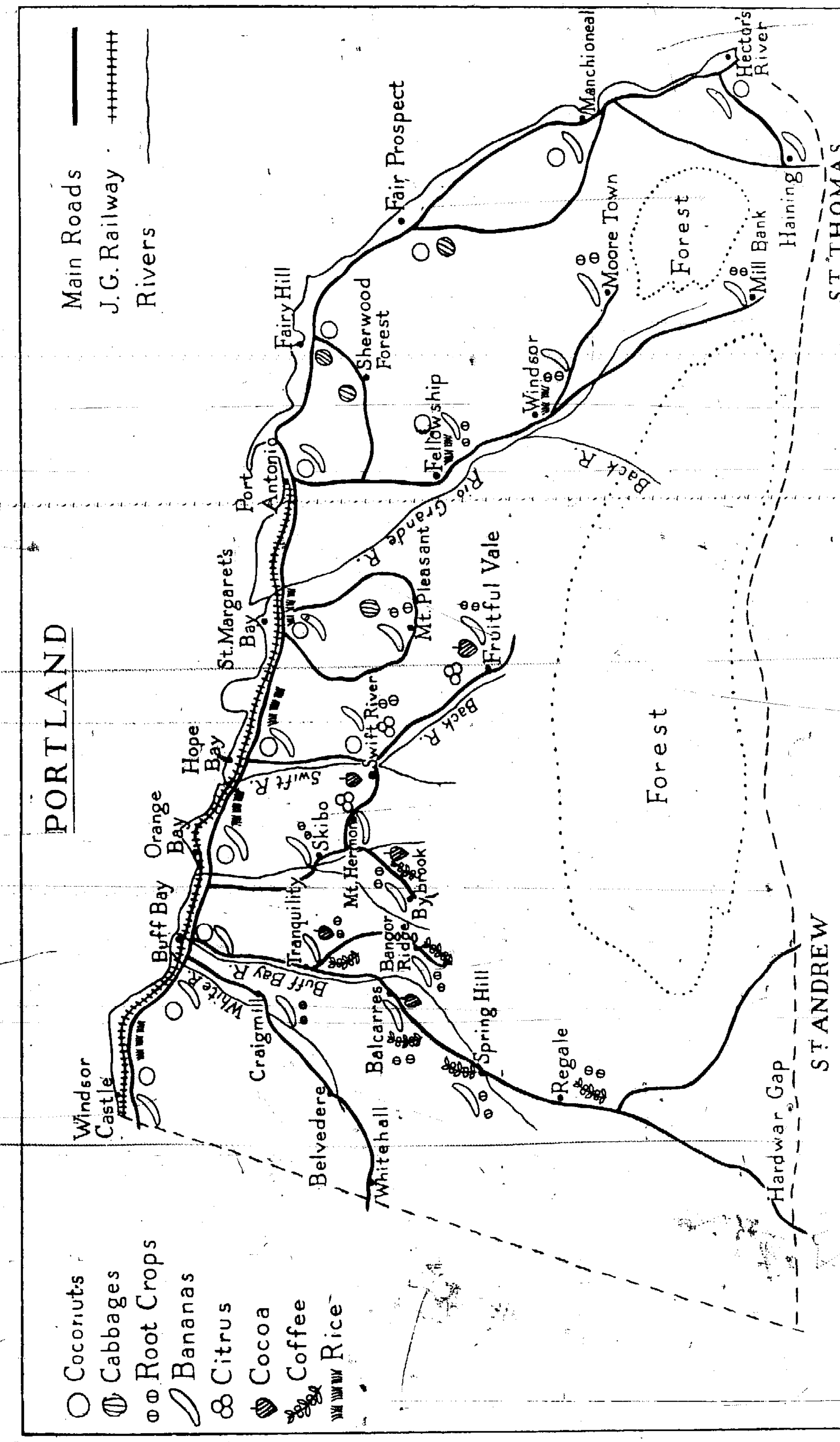
Kind of Vegetables	*Ideal time for sowing, Highland*	*Ideal time for sowing on Lowlands where rainfall is limited*	*Seed rate per square*	*Seed Sowing*	*Spacing in beds*	*Days to germinate*	*Miscellaneous*	*Crop ready in about*
Salads, contd.								
Spinach Group:								
Callaloo	Mar.–Sept.	Every month	1 lb.	Seeds in ground	1½′ × 1′	6–12	Remove flower head for best results	3–3½ months
New Zealand Spinach	Mar.–Sept.	Every month	1 lb.	Seeds in ground	3′ × 1½′	6–12	Soak seed in hot water to hasten germination	2 months and on
English Spinach	Mar.–Sept.	Every month	2 lb.	Seeds in ground	3′ × 2′ 6″	5–10	Provide arbour for plants to climb	3–4 months
Mustard	Every month	Aug.–Feb.	½ lb.	In boxes	2′ × 1′	3–8		1 month and on
Chinese Cabbage (Packchoi)	March	Every month		In boxes	1½′ × 1′			1½–2 months
Squash Group:								
Pumpkins	March	Aug.–March	6 oz.	In beds or on well-prepared mounds	8′ × 8′	6–10	Allow to trail on ground	3½–4 months
Melons	March	Aug.–March	6 oz.		8′ × 8′	8–12	Allow to trail on ground	3½–4 months
Cho-Cho	Every month	Aug.–March		Plant germinating fruit in bed 4″–6″ deep	8′ × 8′	8–12	Provide arbour for plants to climb	4–5 months
Onion Group:								
Onions	Sept.–Mar.	Sept.–March	½ lb.	In boxes	9″ × 6″	6–10	Weed carefully	3–4 months
Escallion	Every month	Every month		Green off-shoots	9″ × 9″			9 months
Shallots	Sept.–Mar.	Sept.–March	4–6 lb.	Dried bulbils in bed	2′ × 1′			3–4 months

Production Maps


CLARENDON
Citrus
Coffee
Cocoa
Tubers
Ginger
Canes
Bananas
Rice
Cattle
Pineapples
Coconuts
Food Forestry
Timber Forestry
Tobacco
Cashews
Vegetables


HANOVER
Timber Forestry
Food Forestry
Dairying
Rice
Cocoa
Vegetables
Bananas
Food Crops
Corn
Canes
Citrus
Yams
Tobacco
Pineapples


MANCHESTER
Auchtembeddie
Epping Forest
Oxford Friendship
Comfort Hall
Harry Watch
Ballynure
Ticky Ticky
Christiana
Village of Christiana
Providence
Medina
Mayfield
Inglewood
Chudleigh
Spaldings
Endeavour
Grove Place
Mt. Olivet
Maidstone
Bath
Peters Field
Walderston
Mizpah
Silver Grove
Kendal
District of Davyton
Somerset
Prospect
Township
Lincoln
Marshalls Pen
Williamsfield
Mandeville
Brumalia
Dunrobin
Spur Tree Hill
Spur Tree
Hopeton
Porus
Montpelier
Hillside
Moreland
Inverness
Old England
Spring Grove
Knockpatrick
Oatlands
Brokenhurst
May Day Hill
Green Pond
Watson's Hill
Harmons
Windsor Forest
Endeavour
Glasgow
Stoneshope
New Forest
Branford Hill
Victoria Town
Plowden Hill
Retrieve
Mayfield
New Broughton
Cocoa Walk
Queen Town Hill
Pusey Hill
Canoe Valley
Citrus
Pineapple
Tobacco
Peanuts
Tomato
Vegetables
Food Forestry
Timber Forestry
Coffee
Onion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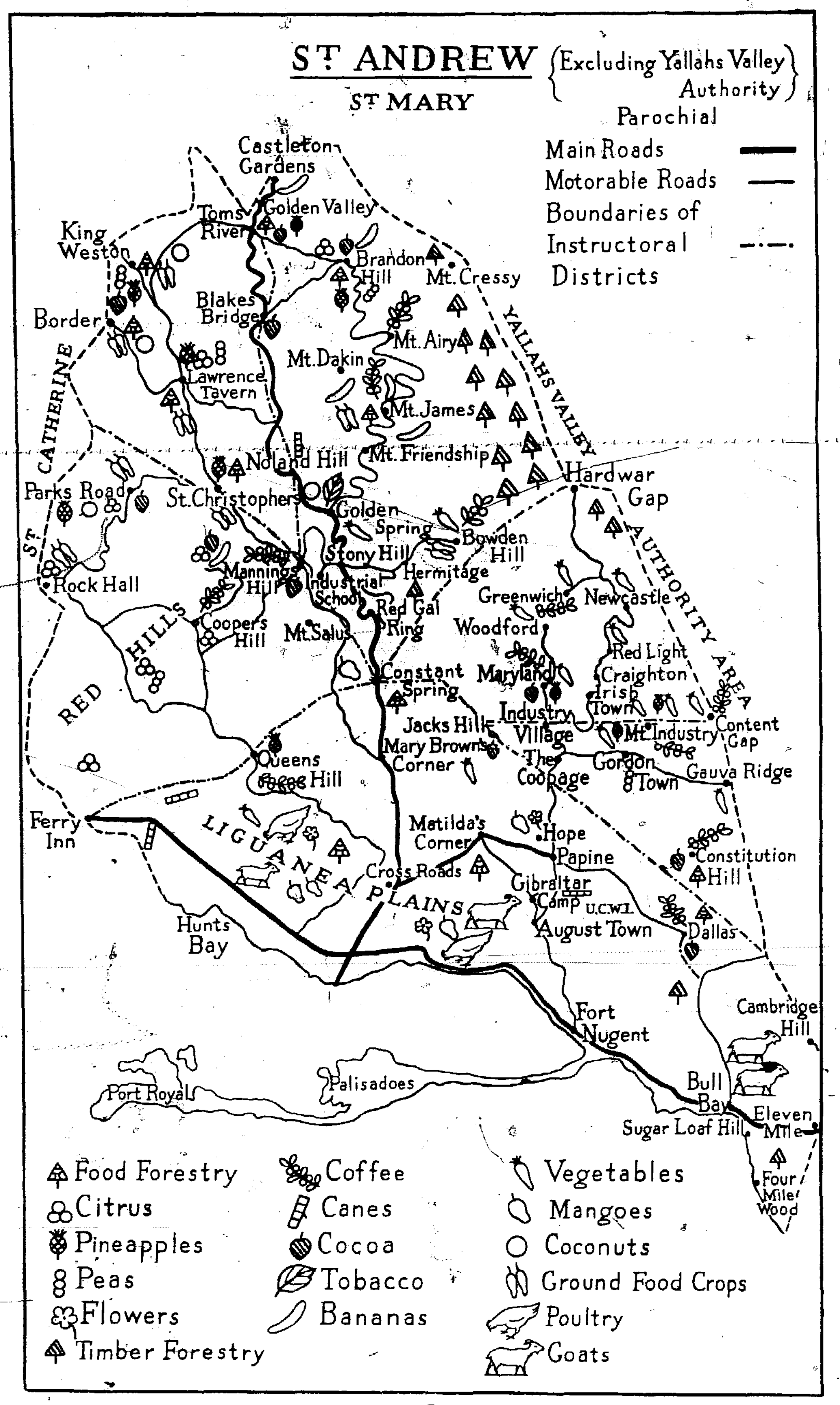
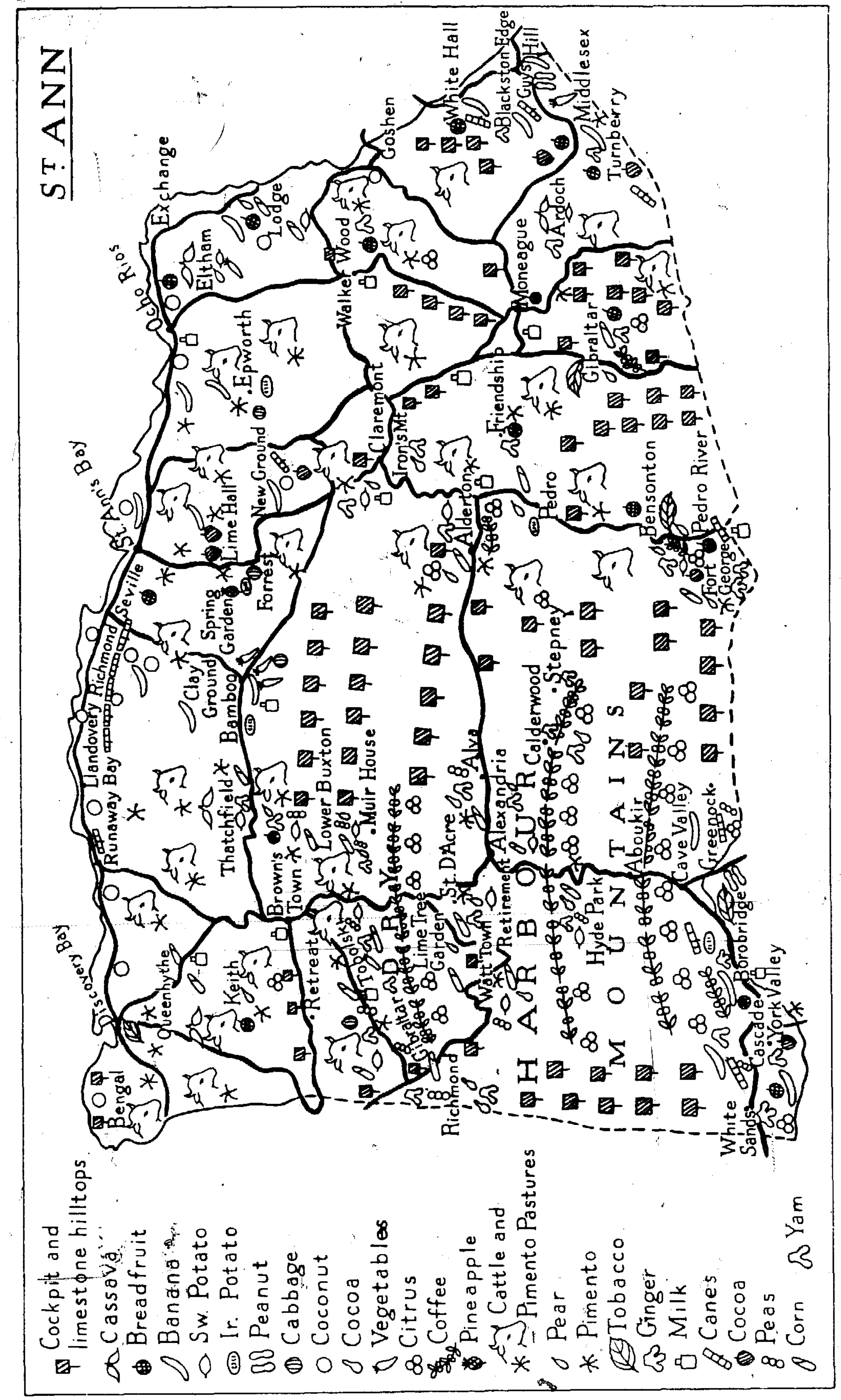
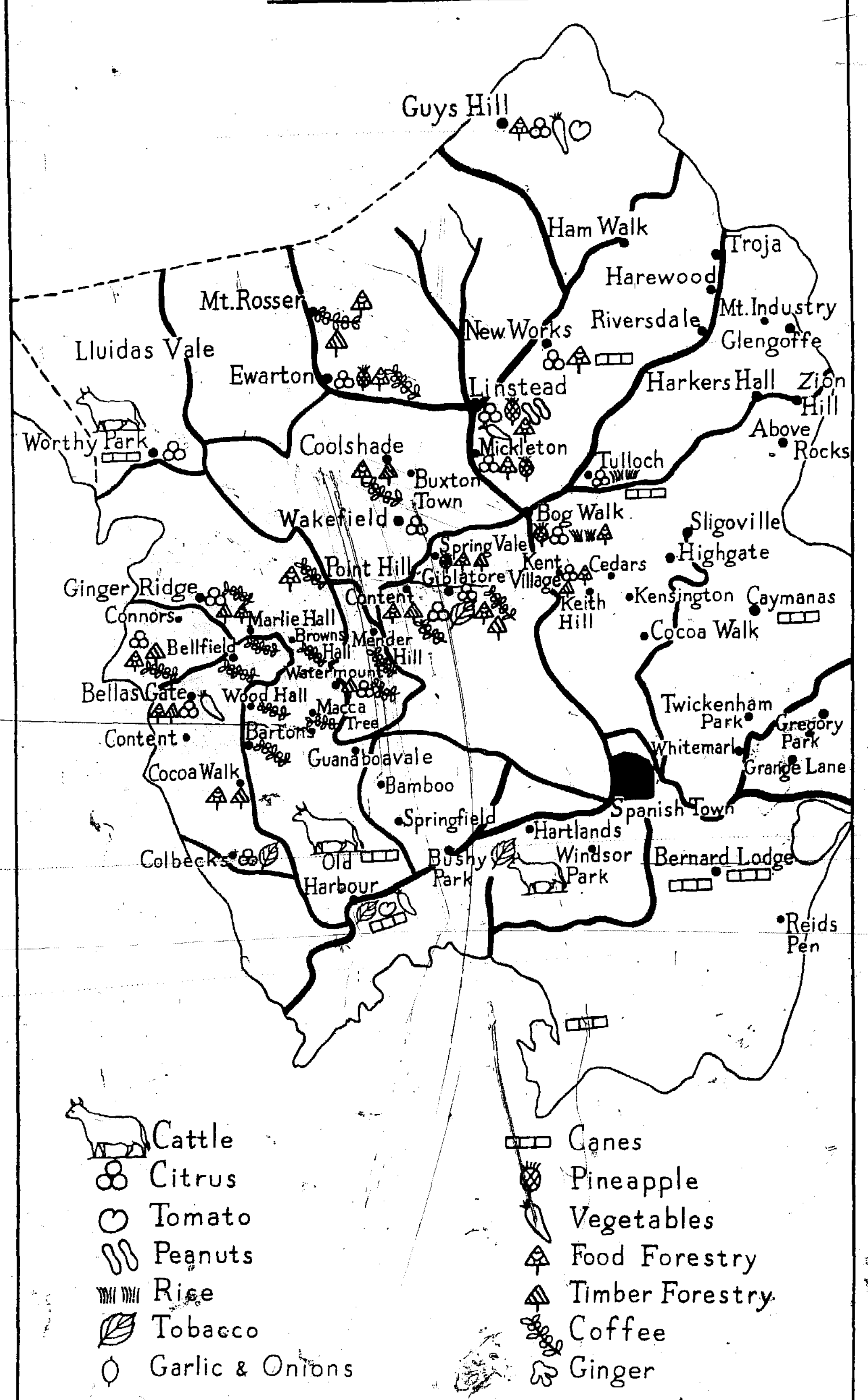
Main Roads
J. G. Railway
Rivers
Fair Prospect
Manchioneal
Hector's River
Forest
Moore Town
Mill Bank
Haining
ST THOMAS
Fairy Hill
Sherwood Forest
Windsor
Fellowship
Port Antonio
Rio Grande R.
Back R.
St. Margaret's Bay
Mt. Pleasant
Fruitful Vale
Swift River
Back R.
Hope Bay
Swift R.
Forest
Orange Bay
Skibo
Mt. Hermon
Bybrook
Buff Bay
Tranquility
Bangor Ridge
Buff Bay R.
White R.
Craigmill
Balcarres
Spring Hill
Windsor Castle
Belvedere
Whitehall
Regale
Hardwar Gap
ST ANDREW
Coconuts
Cabbages
Root Crops
Bananas
Citrus
Cocoa
Coffee
Rice

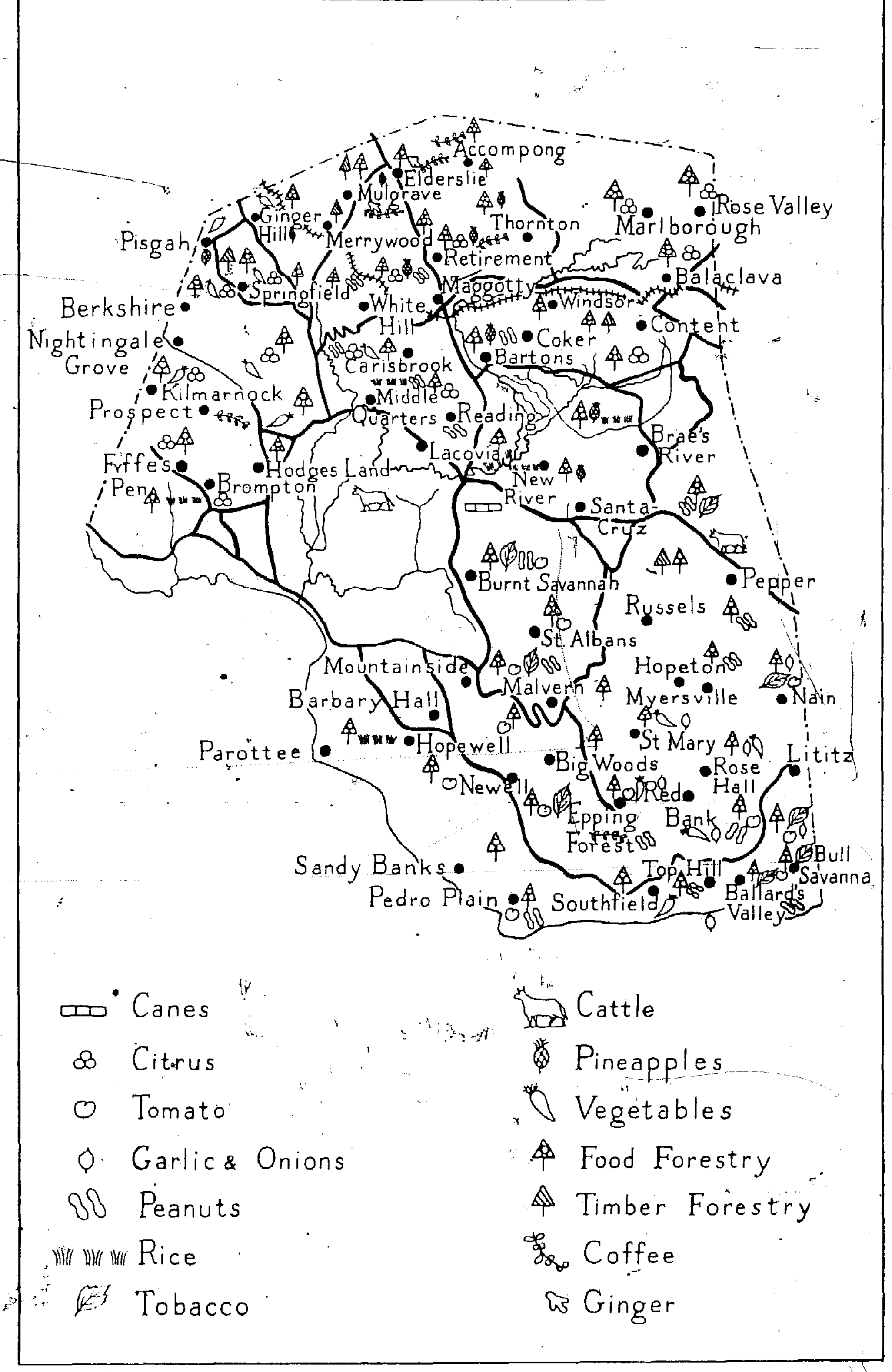

ST ANDREW
(Excluding Yallahs Valley Authority)
Parochial
ST MARY
Main Roads
Motorable Roads
Boundaries of Instructoral Districts
YALLAHS VALLEY AUTHORITY AREA
ST CATHERINE
RED HILLS
LIGUANEA PLAINS
Castleton Gardens
Golden Valley
Toms River
King Weston
Brandon Hill
Mt. Cressy
Border
Blakes Bridge
Mt. Airy
Mt. Dakin
Lawrence Tavern
Mt. James
Noland Hill
Mt. Friendship
Hardwar Gap
Parks Road
St. Christophers
Golden Spring
Bowden Hill
Stony Hill
Hermitage
Mannings Hill
Rock Hall
Industrial School
Red Gal Ring
Greenwich
Newcastle
Coopers Hill
Mt. Salus
Woodford
Red Light
Craighton
Constant Spring
Maryland
Irish Town
Jacks Hill
Industry Village
Mt. Industry
Content Gap
Mary Browns Corner
Queens Hill
The Cooperage
Gordon Town
Gauva Ridge
Ferry Inn
Matilda's Corner
Hope
Papine
Constitution Hill
Cross Roads
Gibraltar Camp
U.C.W.I.
August Town
Dallas
Hunts Bay
Fort Nugent
Cambridge Hill
Port Royal
Palisadoes
Bull Bay
Eleven Mile
Sugar Loaf Hill
Four Mile Wood
Food Forestry
Citrus
Pineapples
Peas
Flowers
Timber Forestry
Coffee
Canes
Cocoa
Tobacco
Bananas
Vegetables
Mangoes
Coconuts
Ground Food Crops
Poultry
Goats

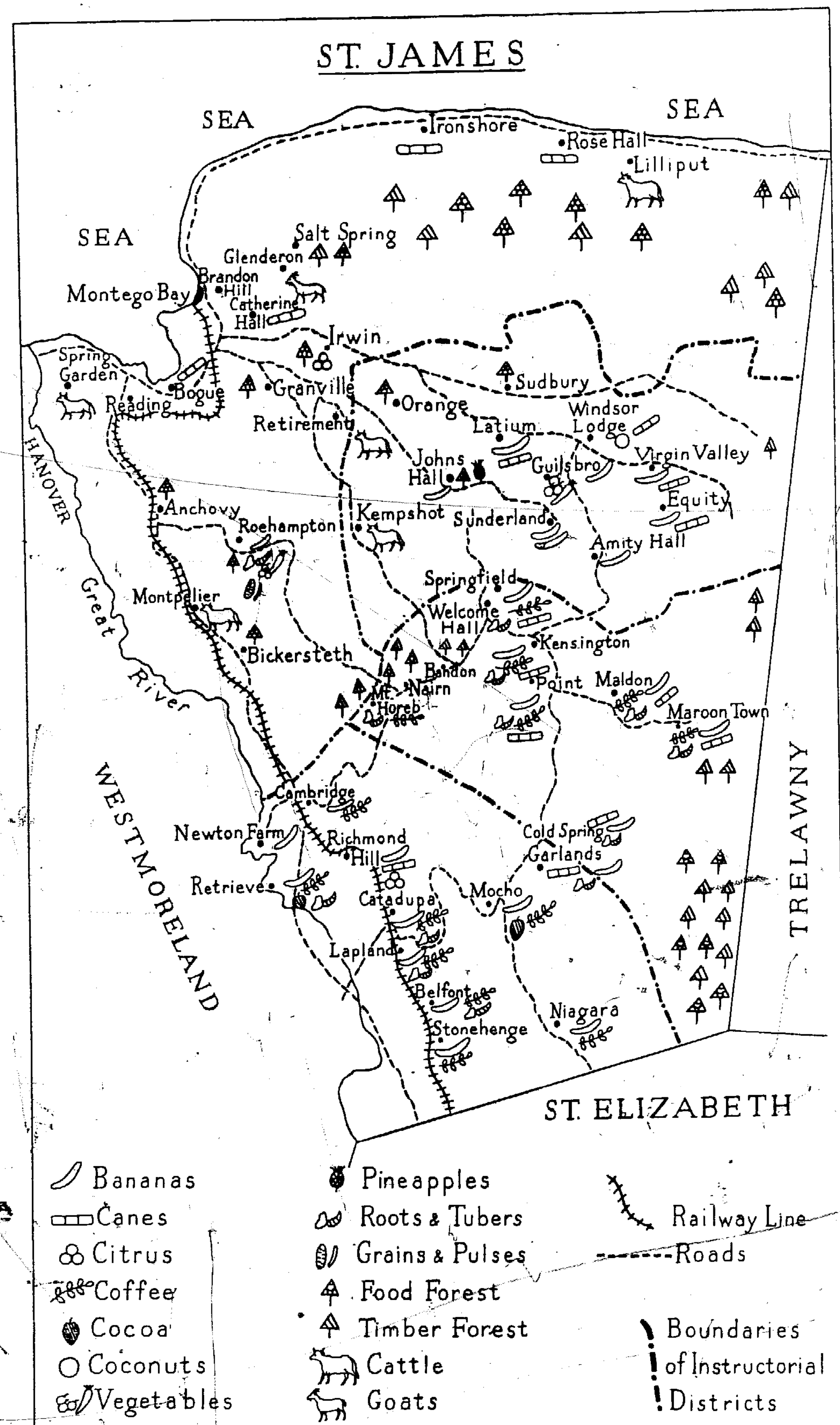

ST ANN
MONTAGUE
Ocho Rios
St. Ann's Bay
Discovery Bay
Runaway Bay
Exchange
Eltham
Lodge
Epworth
Goshen
White Hall
Blackstonedge
Middlesex
Turnberry
Moneague
Walkers Wood
Claremont
Friendship
Gibraltar
Pedro River
Bensonton
Lime Hall
New Ground
Forrest
Spring Garden
Clay Ground
Bamboo
Saville
Richmond
Llandovery
Thatchfield
Brown's Town
Lower Buxton
Muir House
Alderton
Alexandria
Calderwood
Stepney
Aboukir
Cave Valley
Greenock
Hyde Park
Retreat
Keith
Queenhythe
Bengal
Retirement
Watt Town
Richmond
Cascade
York Valley
Borobridge
White Sands
Cockpit and limestone hilltops
Cassava
Breadfruit
Banana
Sw. Potato
Ir. Potato
Peanut
Cabbage
Coconut
Cocoa
Vegetables
Citrus
Coffee
Pineapple
Cattle and Pimento Pastures
Pear
Pimento
Tobacco
Ginger
Milk
Canes
Cocoa
Peas
Corn
Yam

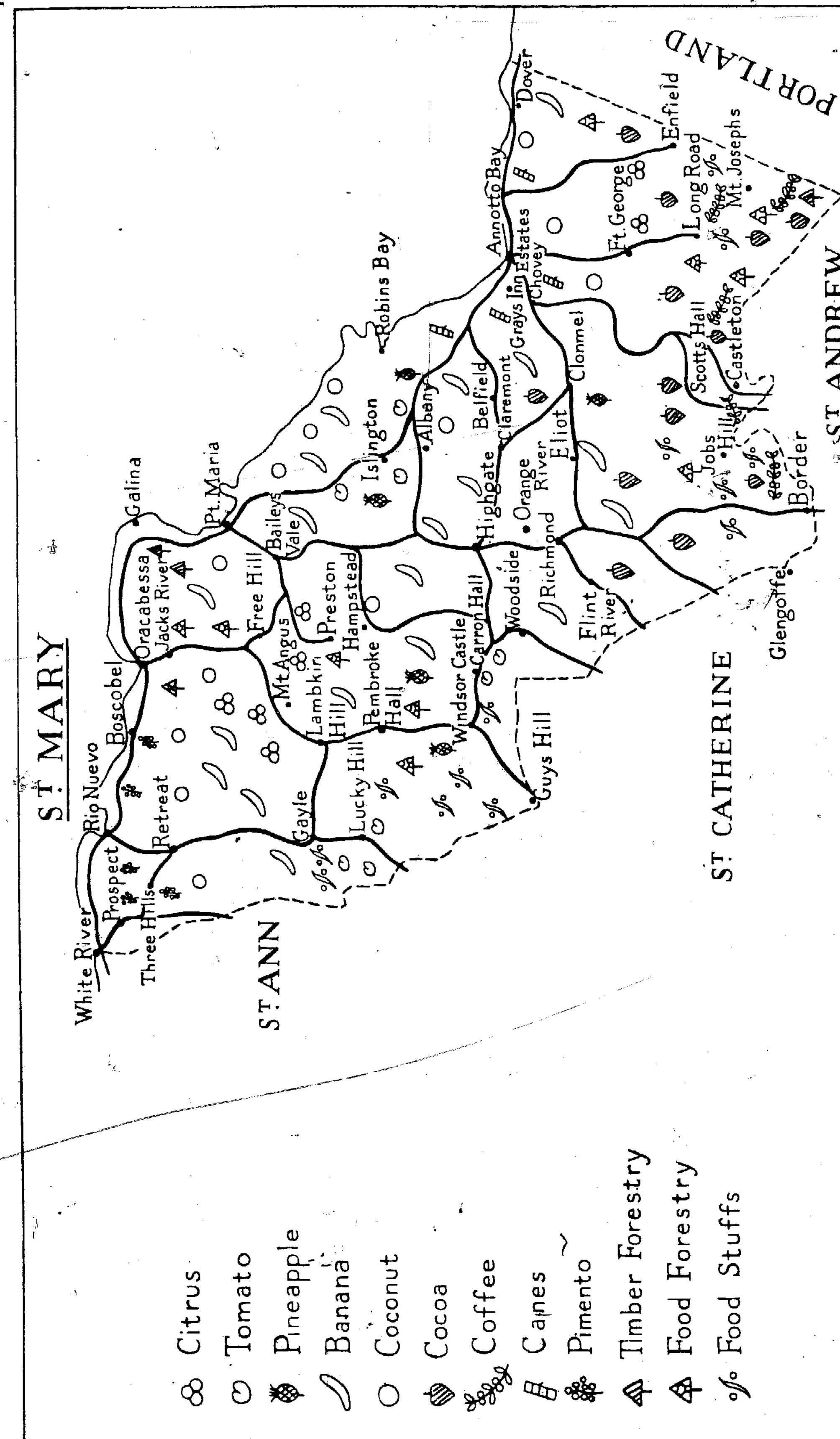
ST CATHERINE

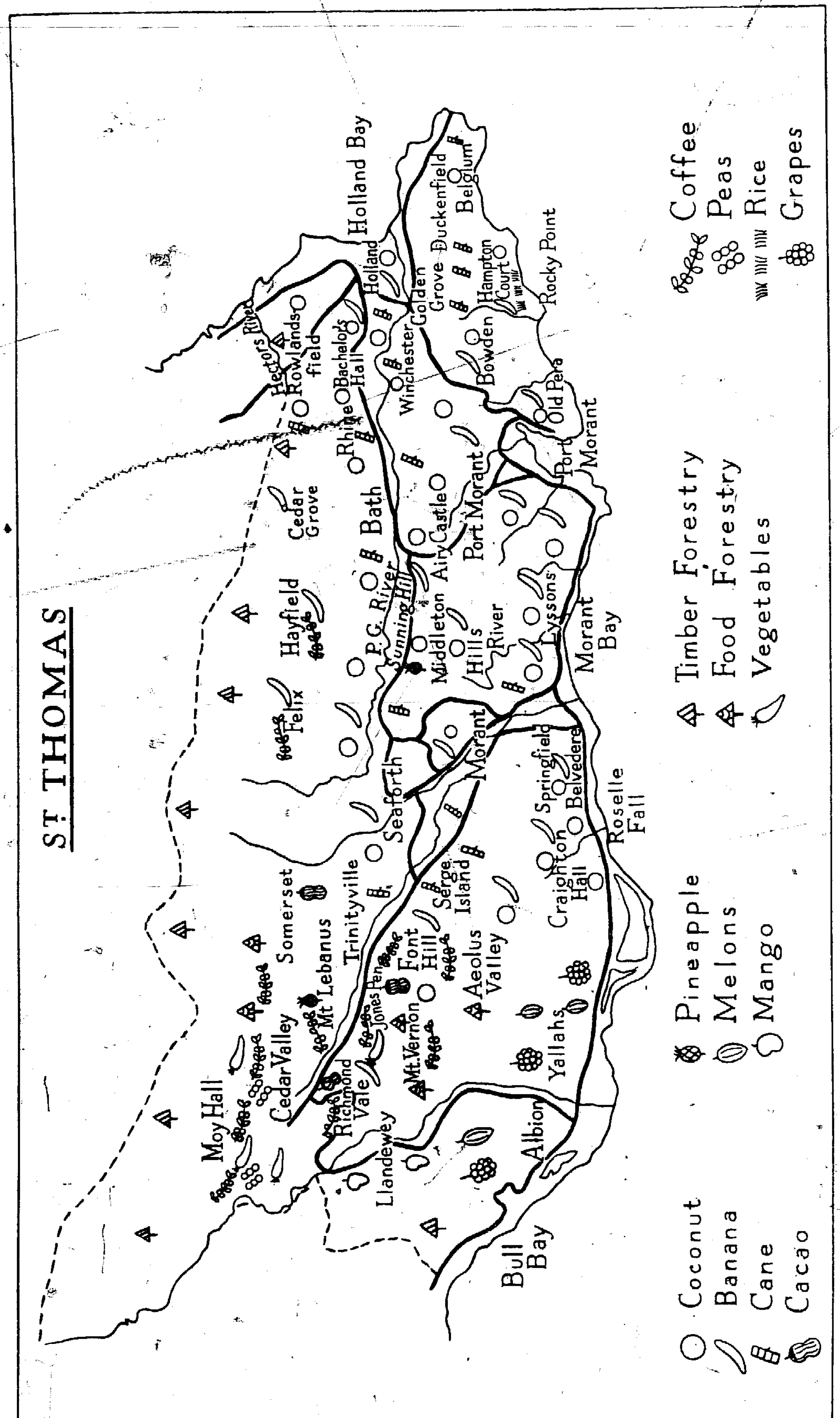


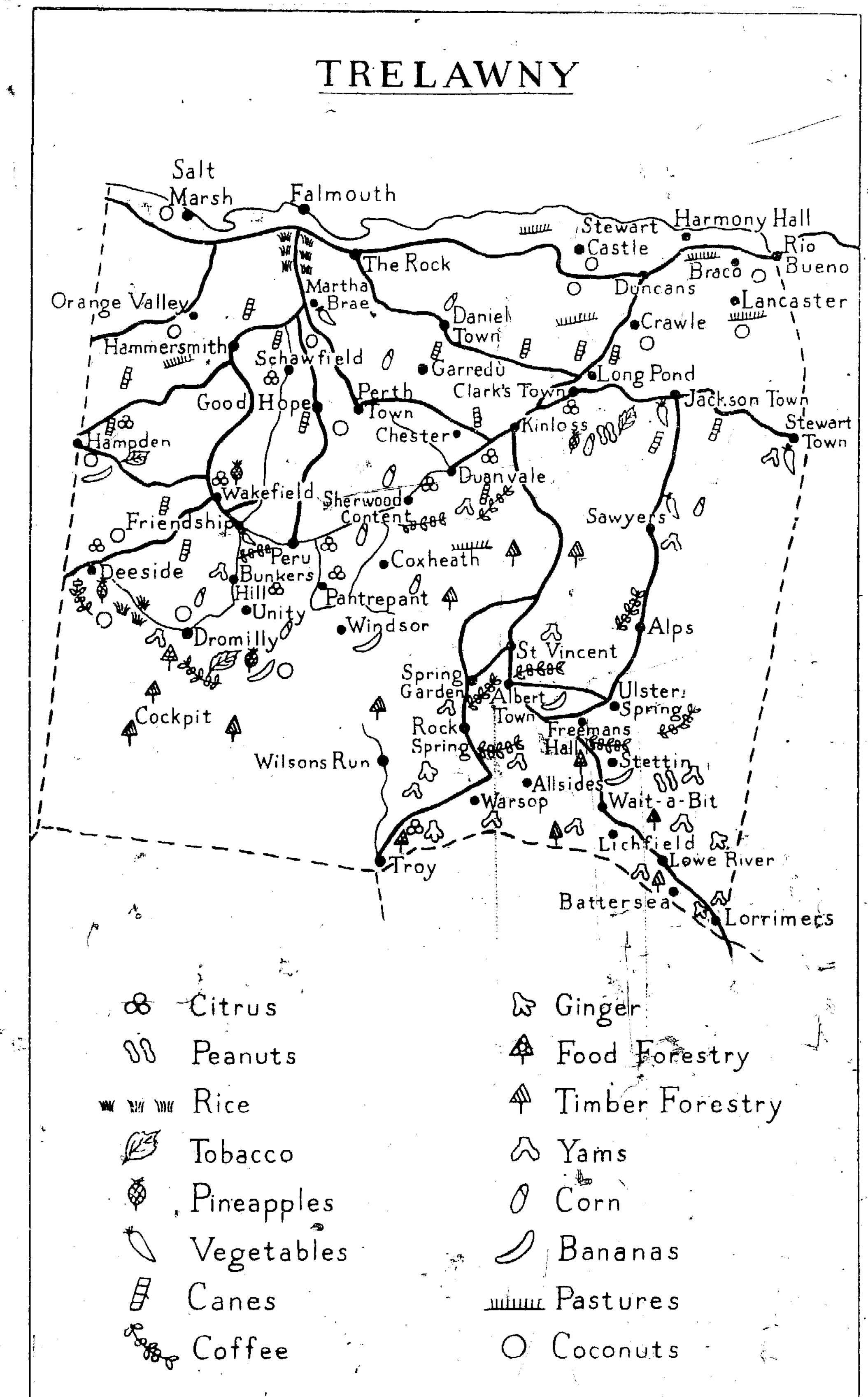
ST ELIZABETH

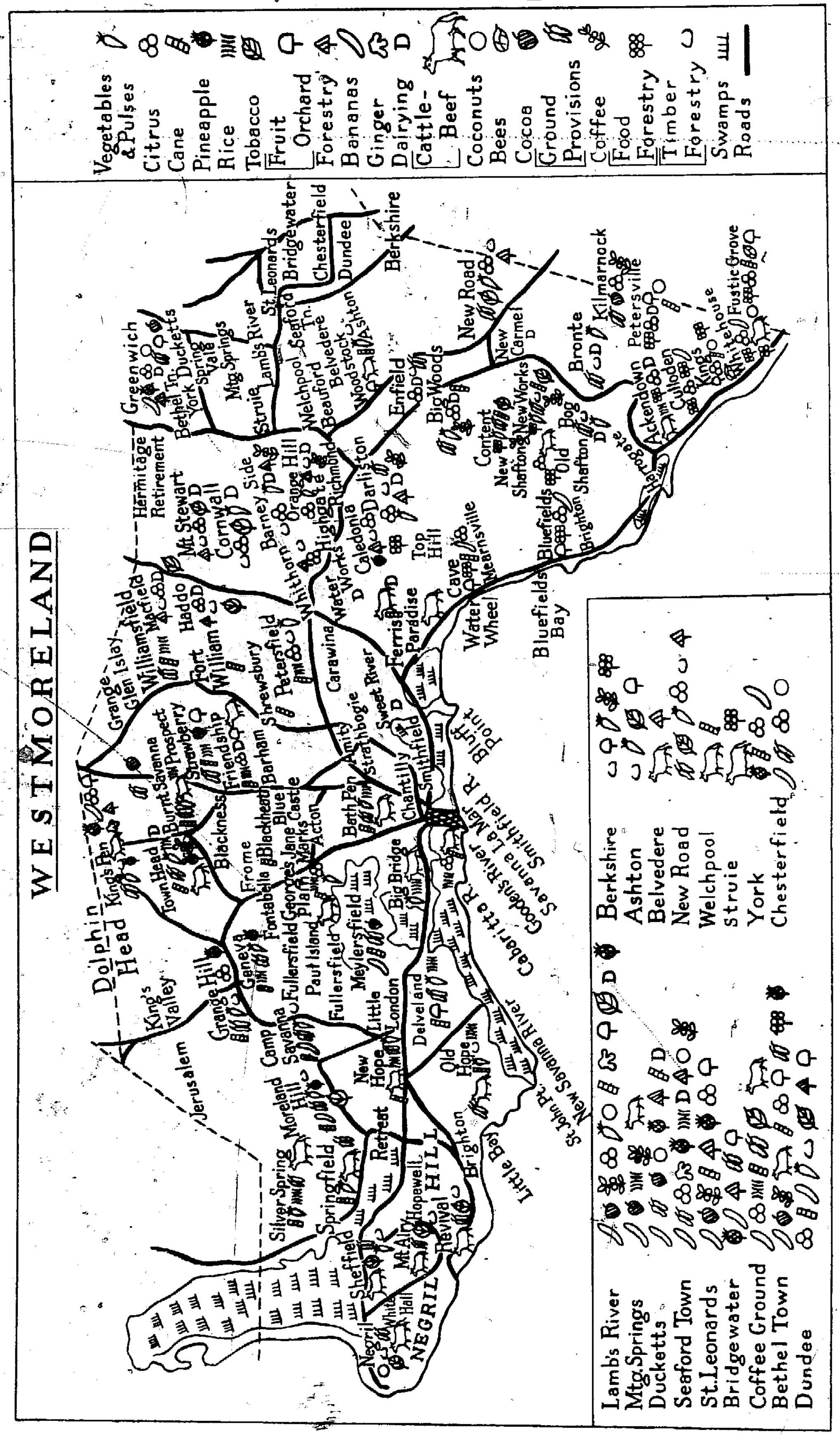



ST. JAMES
SEA
SEA
SEA
Ironshore
Rose Hall
Lilliput
Salt Spring
Glenderon
Montego Bay
Brandon Hill
Catherine Hall
Irwin
Spring Garden
Bogue
Reading
Granville
Orange
Sudbury
Retirement
Latium
Windsor Lodge
Virgin Valley
Johns Hall
Guilsbro
Equity
HANOVER
Anchovy
Roehampton
Kempshot
Sunderland
Amity Hall
Springfield
Welcome Hall
Montpelier
Great River
Bickersteth
Kensington
Bandon
Nairn
Mt. Horeb
Point
Maldon
Maroon Town
WESTMORELAND
Cambridge
Newton Farm
Richmond Hill
Cold Spring
Garlands
Retrieve
Catadupa
Mocho
TRELAWNY
Lapland
Belfont
Stonehenge
Niagara
ST. ELIZABETH
Bananas
Canes
Citrus
Coffee
Cocoa
Coconuts
Vegetables
Pineapples
Roots & Tubers
Grains & Pulses
Food Forest
Timber Forest
Cattle
Goats
Railway Line
Roads
Boundaries of Instructorial Districts


ST. MARY
PORTLAND
ST. ANDREW
ST. CATHERINE
ST. ANN
Dover
Enfield
Annotto Bay
Ft. George
Long Road
Mt. Josephs
Grays Inn Estates
Chovey
Robins Bay
Scotts Hall
Castleton
Islington
Albany
Belfield
Claremont
Clonmel
Highgate
Orange River
Eliot
Jobs Hill
Border
Galina
Pt. Maria
Baileys Vale
Free Hill
Preston
Hampstead
Richmond
Woodside
Flint River
Glengoffe
Oracabessa
Jacks River
Mt. Angus
Lambkin Hill
Pembroke Hall
Windsor Castle
Carron Hall
Boscobel
Rio Nuevo
Retreat
Gayle
Lucky Hill
Guys Hill
Prospect
Three Hills
White River
Citrus
Tomato
Pineapple
Banana
Coconut
Cocoa
Coffee
Canes
Pimento
Timber Forestry
Food Forestry
Food Stuffs


ST THOMAS
Holland Bay
Duckenfield
Belgium
Golden Grove
Hampton Court
Rocky Point
Holland
Winchester
Bowden
Old Pera
Port Morant
Hectors River
Rowlandsfield
Bachelors Hall
Rhine
Bath
Cedar Grove
Airy Castle
Port Morant
P.G. River
Running Hill
Middleton
Hills River
Lyssons
Morant Bay
Hayfield
Felix
Seaforth
Morant
Springfield
Belvedere
Roselle Fall
Somerset
Trinityville
Serge Island
Craighton Hall
Mt Lebanus
Jones Pen
Font Hill
Aeolus Valley
Cedar Valley
Mt Vernon
Yallahs
Moy Hall
Richmond Vale
Llandewey
Albion
Bull Bay
Coconut
Banana
Cane
Cacao
Pineapple
Melons
Mango
Timber Forestry
Food Forestry
Vegetables
Coffee
Peas
Rice
Grapes


TRELAWNY
Salt Marsh
Falmouth
Stewart Castle
Harmony Hall
Rio Bueno
Braco
Duncans
Lancaster
The Rock
Martha Brae
Orange Valley
Daniel Town
Crawle
Hammersmith
Schawfield
Garredu
Long Pond
Clark's Town
Jackson Town
Good Hope
Perth Town
Chester
Kinloss
Stewart Town
Hampden
Duanvale
Wakefield
Sherwood Content
Friendship
Sawyers
Peru
Coxheath
Deeside
Bunkers Hill
Unity
Pantrepant
Windsor
Alps
Dromilly
St Vincent
Spring Garden
Albert Town
Ulster Spring
Cockpit
Rock Spring
Freemans Hall
Wilsons Run
Stettin
Allsides
Warsop
Wait-a-Bit
Lichfield
Lowe River
Troy
Battersea
Lorrimers
Citrus
Peanuts
Rice
Tobacco
Pineapples
Vegetables
Canes
Coffee
Ginger
Food Forestry
Timber Forestry
Yams
Corn
Bananas
Pastures
Coconuts



CHAPTER 3

The Approach to Farming

Is farming an Art or is it a Science? If it is accepted that Art is skill as the result of knowledge and practice, and Science an occupation requiring trained skill, then it may be contended that farming is a combination of both. As indeed it is, when the matter is considered.

In former times, too, it was held that the farmer was somewhat of a philosopher, no doubt a result of the feeling that he accepts with equanimity the vagaries of weather and markets and, living near to the earth, is able to attune himself to the beauty and truths of nature.

Having gone so far, it remains to study the makings of a farmer; to consider the elements that go to the making of a good farmer; and the resultant good farming.

A genuine liking for farming. A very important requirement for successful farming is that the prospective farmer must have a real liking for a farmer's life. He must prefer it to any other mode of life. He must be equally cheerful in the sun and in the rain, and not be averse to getting out of bed and beginning work long before daylight. If he can do all this, and also enjoy handling and looking after poultry and animals, then he may turn his thoughts to farming with a reasonable hope of making a success of it, although there will still be left a final hurdle to be cleared; for the only thing that settles the question beyond doubt is an initial practical trial of farming, involving an experience of actual farm work, the problems of farming and life on a farm. It is a successful combination of the requisites precedent and the actual trials of the life that helps to make a good farmer.

Farming is a highly skilled occupation, and despite the provision by Government of trained advisory services, nothing is so certain as the fact that new farmers need periods of training and/or apprenticeship before beginning to farm on their own; the length of periods of training will obviously vary with the kind of farming anticipated.

Special abilities required. The prospective farmer will also need special abilities to assist him in running a farm. He should accordingly satisfy himself that he will be skilful in handling farm machinery, erecting less important buildings, effecting repairs, handling tools and motors, rendering first aid to injured animals, and in a dozen other ways proving himself a handyman.

Co-operation of family. Finally, the prospective farmer should make sure that his family will fit comfortably into the pattern of life on a farm. They also must show an aptitude for the life, for their interest and help will very often be in demand, and unless they fit in, the success of the entire scheme will be in jeopardy. The farmer's wife and the rest of the family should be able to manage the poultry yard, look after the milk, grow vegetables, and harvest crops, in addition to looking after the meals and caring for the house.

Copy the successful farmer. Farming is a complicated business, but the inexperienced, willing farmer need not worry over the difficulty of learning it all in quick time. Make haste slowly should be his motto. By the exercise of skill, intelligence, hard work and patience, he will soon learn enough to get along successfully. He should make contact with an experienced and successful neighbour, observe his methods, take the advice that will be readily given, and put them into practice, and he should join the branch of the Jamaica Agricultural Society in his district.

Money or credit needed. The requirements for successful farming include sufficient capital, cash or credit. Ordinarily before a farmer can obtain credit he must be possessed of a sufficiency of cash or valuable assets. It takes a good deal of money to start even a small farm, and unless a sound investment is made, the sum expended may be entirely wasted. Productive soil, good returns from the cattle, proper farm equipment, sure supplies of cattle and poultry feed are all necessary approaches to success. Again, the cost of the land, equipment, livestock, supplies, and operating capital are all related, varying with the type of farming adopted.

It is not possible to state definitely the amount of capital that will be needed by the beginner, but the figure is likely to be in the neighbourhood of £50 per acre. It will vary in proportion to the size of his farm, the stock, the particular type of farming to be followed, and the farmer's training, knowledge and skill.

Size, site and suitability. To be successful in his farming, the beginner must not only be a good man at the job. The soil and climate must be favourable, markets within economic reach, and community facilities like stores, schools, Welfare groups, J. A. S. branches are important. Also the farm must be big enough to grow the crops and raise the livestock necessary to provide the farmer and his family with enough income to maintain for them a fair standard of living. Too small a farm will never provide a satisfactory living. Neither will a large farm if the soil is so poor that good results cannot be obtained. It is the number of *productive* acres that count.

Productivity, however, must not be secured at too high a cost. The farmer should first ascertain what are the yields from other farms in the

same location, and what have been the yields from his prospective farm in past years, and whether those yields were obtained from standard methods of husbandry.

Lastly, the inexperienced farmer should be cautious in approaching where the previous occupier had failed. While the failure may have been due to poor farming methods, it may more likely be due to other causes, and where the experienced have failed the inexperienced should move with caution.

Need for social contacts. Success in farming is not to be measured by financial gains alone. The successful farmer must lead a satisfactory cultural and social life. His farm must be a place to live in and to support others, as well as a means of livelihood. Schools, Churches, Community Meetings, Welfare Activities, all affect and demand interest and contact from the farmer. So also does the branch of the Jamaica Agricultural Society in his district.

CHAPTER 4

Features Affecting Farming

The principal natural factors affecting farming may be divided into six general heads:

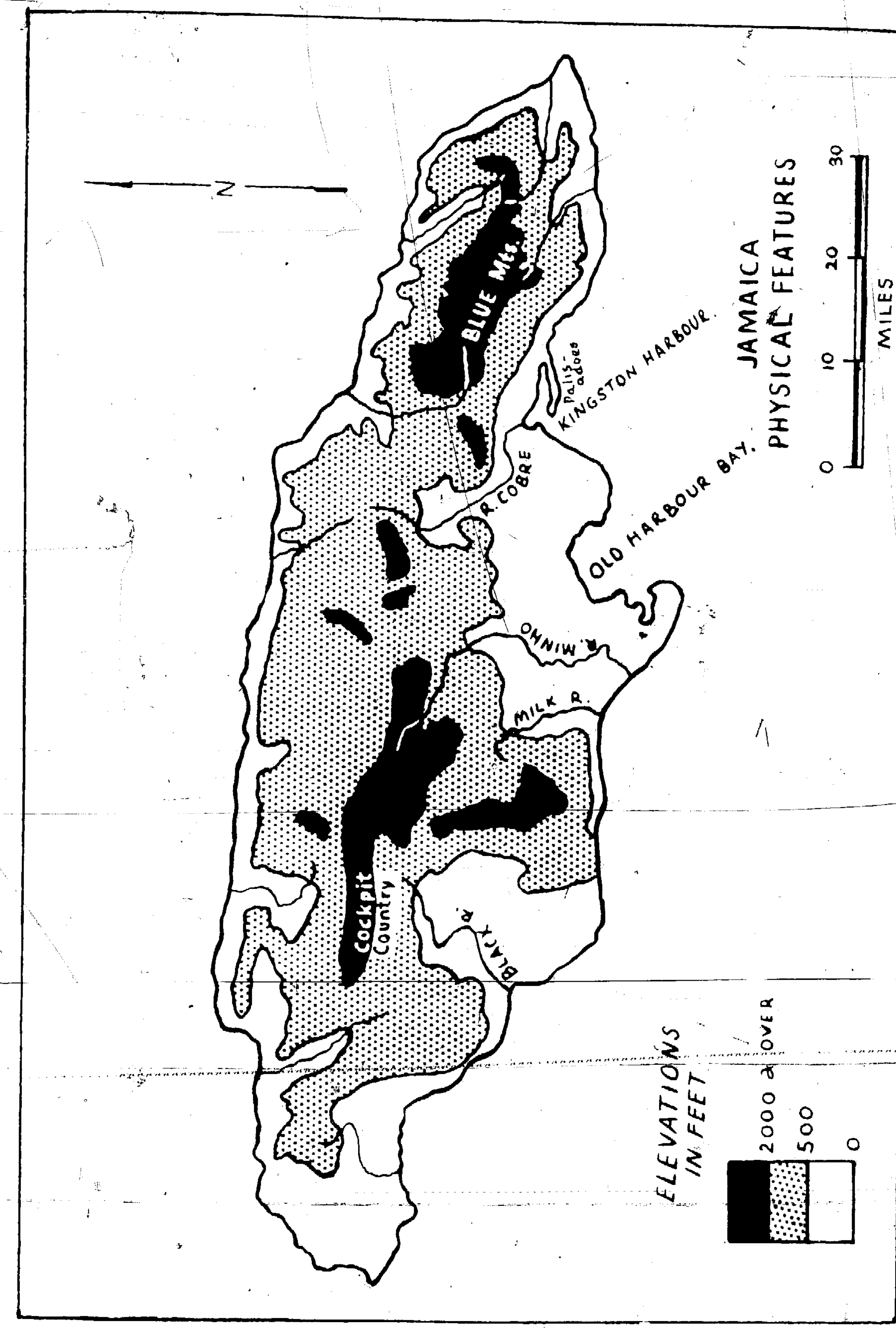
(*a*) Climate.
(*b*) Rainfall.
(*c*) Elevation.
(*d*) Soil Types.
(*e*) Degree of Erosion.
(*f*) Biotic factor.

(**a**) **Climate.** Owing to the varying altitudes of the country between sea level and the highest elevations (a range of 7,000 ft. within a relatively small area) there is a fairly wide difference of mean temperature between the two levels, amounting to about 23° F.

In areas lying between 1,500 ft. and 2,500 ft. above sea level, the average temperature is between 73° F. and 70° F. These areas occur in the parishes of Manchester, St. Ann, Upper St. Andrew, Clarendon and St. Catherine, and Upper St. Mary, St. James, St. Elizabeth and Westmoreland. Many towns and settlements are found in these temperate areas:

Manchester	Mandeville Newport Christiana	*St. Elizabeth*	Malvern Ipswich
		Westmoreland	Darliston
St. Ann	Brown's Town Moneague Claremont Alexandria	*St. James*	Cambridge Montpelier
		St. Mary	Highgate
St. Catherine	Guy's Hill Brown's Hall Lluidas Vale	*Clarendon*	Spaldings Kellits

(**b**) **Rainfall.** There are two well-defined recurring wet seasons during the year, the May season and the October season, occurring in those months. The May rains give an average monthly fall of 8·7 inches and the October 10·2 inches. The lowest rainfall is in February, with an average of 3·3 inches. July comes next with an average of 4·7 inches.



Average Annual Temperature at Different Elevations

Altitude above sea level	*Mean temperature*	*Mean maximum*	*Mean minimum*
0	78·7	87·6	71
500	77·1	85·1	69·8
1,000	75·3	82·8	68·6
1,500	73·6	80·6	67·4
2,000	72·0	78·6	66·1
2,500	70·3	76·7	64·7
3,000	68·7	74·9	63·3
3,500	67·1	73·2	61·7
4,000	65·5	71·6	60·1
4,500	64·0	70·1	58·5
5,000	62·4	68·8	56·8
5,500	61·0	67·5	55·0
6,000	59·5	66·3	53·1
6,500	58·0	65·2	51·2
7,000	56·5	64·3	49·3

The mean annual rainfall computed on a sixty-year data is 74 inches.

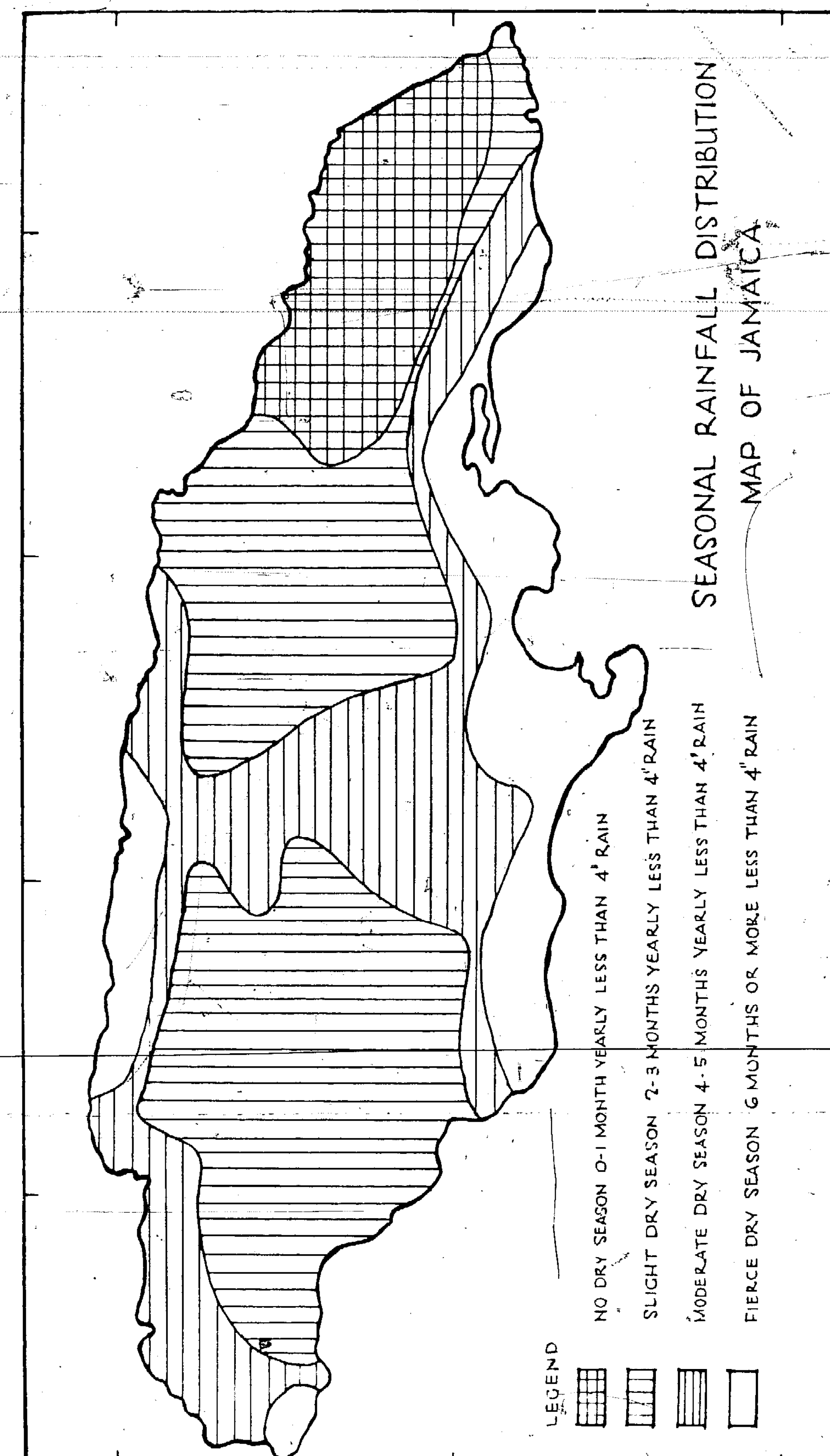
Rainfall is least on the low-lying coast areas, the mean annual fall along the southern coast from Morant Bay to Black River varying between 30 and 60 inches. The highest rainfall occurs on the northern slopes of the Blue Mountain Range in Portland.

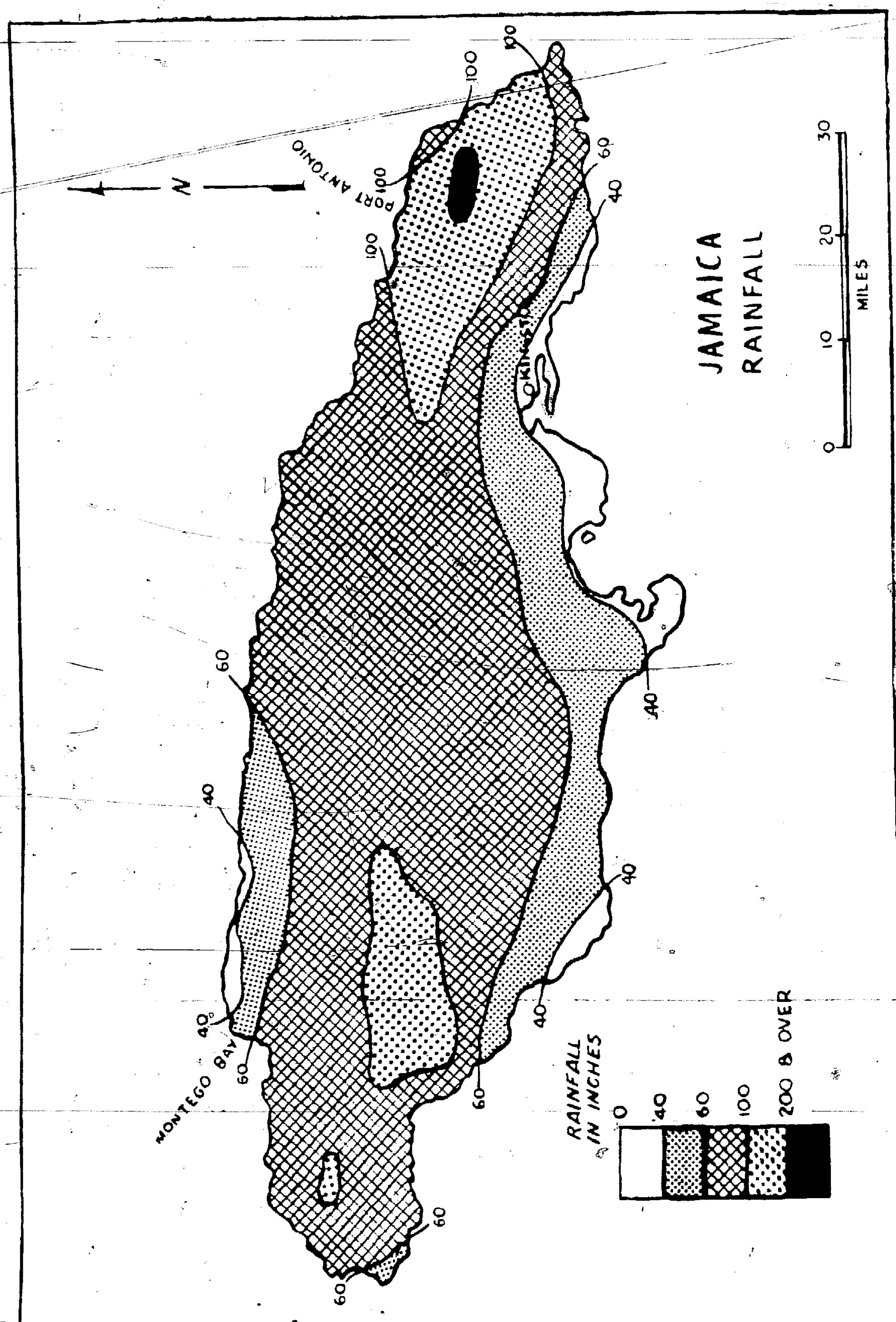
A ten-year table shows the following distribution annually:

Parish	*Inches*	*Parish*	*Inches*
Kingston	30	St. Andrew	68
Clarendon	60	Manchester	71
Trelawny	62	St. Thomas	80
St. James	64	Hanover	81
St. Catherine	65	St. Mary	84
St. Elizabeth	66	Westmoreland	84
St. Ann	66	Portland	136

In connection with the usual data of inches of rainfall a year, the farmer is at a disadvantage. It is not of much use to him. What more interests him is the *seasonal* distribution of rain, and not the annual. The farmer is accordingly referred to the map showing seasonal rainfall. It will be observed that in the wet eastern area there is no significant difference in the rainfall distribution. On the lowlying coast areas on normal well-drained soils a monthly rainfall of 4 inches is necessary. If less, the deficiency must be supplied by irrigation. This applies especially to the area extending on the south coast from Kingston to Negril.

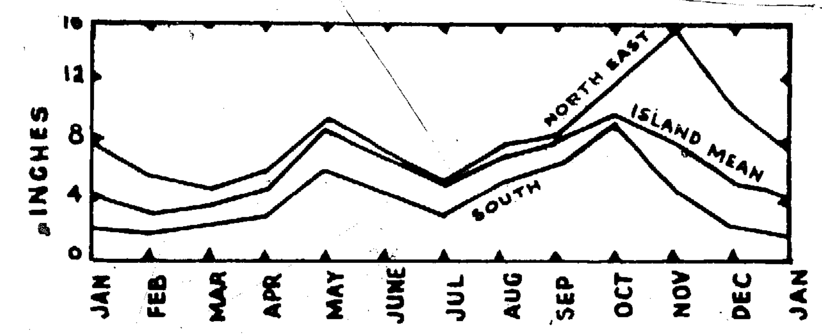
(c) **Elevation.** A feature affecting farming, and linked with soil types, is elevation. Rainfall and temperature being influenced by elevation, it follows that there will be differences of variety between lowland and





upland crops. Thus it will be found that crops like cane, cocoa, coconuts, cassava, breadfruit, mangoes, Guinea corn, peanuts and many fruits thrive best on the lowlands, while citrus, avocado pears, coffee, vegetables, yams, potatoes and ginger do better in the more elevated regions.

(d) **Soil Types.** The range of many crops is limited by soil types, and by soil types with other factors closely correlated, for example, cane, cocoa and bananas are not grown extensively on red dirt (terra rossa) soils, but flourish on alluvial soils and on carbonaceous shales as well as certain soils of limestone origin. Ginger grows successfully only on a very limited range of soil types with definite rainfall and elevation correlations, while on the other hand the citrus plant is so ubiquitous that its range is limited only by elevation and certain highly alkaline soils.



MEAN MONTHLY RAINFALL

Graph showing seasonal periodicity of the rainfall resulting in maximum in May and October and a major dry period from January to March.

(e) **Degree of Erosion.** Soil erosion on a vast scale has accompanied man's farming activities all over the world, and in Jamaica the degree of erosion reached after one hundred and fifty years or more of cultivation is very serious indeed. Land capability surveys now being started in Jamaica reveal that much if not most of the top soil has gone from sloping lands, and that in many large areas the sub-soil too is going fast. Eroded soils are lacking in organic matter and in mineral nutrients available to plants, and in addition are lacking in microbes which to a large extent make soil minerals into available nutrients. Where organic matter is lacking, microbes cannot flourish and soil does not retain moisture readily, with the result that plants cannot thrive. The greater the degree of erosion, the less fertile a soil, *and the more difficult it is to restore fertility.*

(f) **Biotic Factor.** Another important factor affecting farming is the *Biotic Factor* which relates to the accumulation of humus in the soil. Man and his animals are closely connected with this. With the clearing of the forest on hill and mountain slopes, the top-soil, not very deep originally, was gradually removed by the action of water and deposited on the alluvial plains. It then became necessary to stop erosion and to grow such crops as would put back more humus into the earth.

CHAPTER 5

The Soil

Soil and Food. It is now widely recognized that there are grounds for grave anxiety about the future world-supply of food. The United Nations Organisation admit that the greatest problem for the next generation will be to produce enough to eat. The main grounds for this admission are:

(1) World population is increasing at a rate which, if projected, implies a doubling and re-doubling of the number of consumers at intervals of less than 100 years.

(2) Expansion of food output is failing to keep pace with growth of population, so that the average level of nutrition is falling.

(3) The continual loss of farm land through diversion to other uses and through soil erosion.

While food production may be increased by such means as the improvement of food plants and domestic animals, and by better control of plant and animal diseases and insect pests, the greatest contribution towards the solution of the problem can come only from the fuller and more efficient use of the soil by the world.

What is Soil? Soil is the natural medium in which plants grow, and is composed of mixtures of rocks, rock minerals, organic matter, air and water. There are in soils various layers formed under the influence of the various factors which go to make up climate, and living organisms. Soils are constantly undergoing changes, but after a long number of years they reach a state in which there is but little change and a soil is then formed which is characteristic of the environment.

Soil is not just dirt and inert substance, but is a factory in which raw materials are converted into other products. It is the repository of all life and the laboratory within which most of the changes which enable life to continue are carried out. It is to this factory that all dead bodies of plants and animals are returned and converted from the forms in which they existed to other products, which are again used by other plants and animals as sources of further life.

This factory, like any other, must be understood, and must be serviced and cared for like any other factory if the best results are to be obtained.

Experience and practice count for a lot in the operation of this factory

—the soil—but that is not all. The farmer who is to operate the soil must learn how it is formed, and must appreciate that without proper care it will deteriorate and eventually fail to manufacture products for him.

Crops are the joint efforts of man and the soil, and man being the intelligent factor in the partnership must be held responsible for failure to maintain economic production from the land.

Soils generally are of two main types:

(*a*) Sedentary.
(*b*) Transported.

(*a*) When soils have been formed without removal from the site of the original rock they are termed *sedentary* or *in place*. These soils bear most of the characteristics of the parent rock, and on the composition of the latter will partly depend whether a soil is fertile or not. They are most commonly found on rock plateaux and on gentle slopes and plains where the run-off of rain water is insufficient to carry the soil away.

(*b*) *Transported Soils* are those that have been moved to their present position by water, wind or gravity, and laid down under new conditions, developing properties entirely different from the sedentary soil. When soils are the result of deposition by streams, the material having been gathered along the course of the stream from various sources and carried to a distance before being deposited, the soil is designated as *alluvial*. These are the soils of the valleys and flood plains. As a rule they are of a very fine and uniform texture, as they represent the finer portions of the soils of the regions drained by the water courses. As representing the most advanced decomposed products of the parent rock, they are very fertile.

Composition of Soils

Soils are composed of five principal constituents:

Sand, principally composed of quartz, flint, or silica, imparting a loose, porous nature to the soil and so assisting water and air to penetrate it more easily, and helping the roots of plants to find their way through more easily in all directions. In agricultural practice, sand, if available, is often added to the stiffer soils to render them more porous.

Clay, composed of *Silica* and *Alumina* in combination with water. When wet, it is sticky and plastic, and when burnt the plastic property is lost and it becomes brittle. When *lime* is mixed into a clay soil, it also has a similar effect, depriving it of its sticky nature and rendering it more fit for supporting plant life.

Some varieties of clay are white (used for making pottery), others are yellow and red (used for making bricks, tiles, and coarse pottery).

From its nature, a clay soil is more retentive of water, hence a proportion of clay is necessary in all cultivated land to secure a necessary amount of moisture for the development of plant life.

Lime occurs in soils in the form of limestone in its various forms (limestone proper, chalk, marl, coral). Tropical soils are usually lacking in lime, although this cannot be said to apply to Jamaica, where the 'backbone' of the Island is limestone mountain.

Humus or vegetable mould is formed by decayed vegetable matter (leaves, stems, roots, branches, etc.), and exists to some extent in all cultivated lands, formerly forest or bush-covered. It is spongy in texture and of a dark brown colour, and occurs abundantly on the surface of forest land.

Gravel or Stones are particles of the original rock from which the surrounding soil was derived. When not too abundant in the soil they serve to drain it and render it lighter, and also to assist in conserving moisture.

Hence Soils may be classed in accordance with their physical composition.

Classification of Soils

Clay or Argillaceous Soils. These contain over 50% of clay, are heavy and dense and very retentive of water. They are cold, stiff and difficult to work, requiring to be well drained and limed, manured and sanded. Owing to the stiff nature of the pure clay soil, rootlets are impeded from finding their way to moisture or plant-food. Clay soils of moderate texture, however, have the important advantage of storing moisture and soluble manures for plants when the season is dry.

Loamy Soils are composed of 30% to 50% of clay, and the rest of vegetable mould, sand, and a little lime.

Sandy Soils contain not less than 60% of sand, have but little cohesion, are very porous, and contain little nourishment for plants. Such soils have to be improved by the addition of clay, marl or lime, and manure.

Marl Soils contain from 5% to 20% of lime, and may partake of the same characteristics as sandy or gravelly soils.

Calcerous Soils contain over 20% lime, and may partake of the nature of loamy or sandy soils.

Gravelly Soils may also partake of the nature of sandy, clay or calcerous soils.

Volcanic Soils. Not present in Jamaica.

Coral Soil. Not present in Jamaica.

Humus Soil or *Vegetable Mould* contains not less than 5% of *humus* or vegetable matter. These soils may partake of the nature of loamy or sandy soils, or may be composed entirely of vegetable matter.

Humus is the most important constituent of the soil for the farmer or gardener, and has great influence on the capacity of soils for retaining moisture and for encouraging soil bacteria. Soils deficient in humus tend to cake and become very hard in dry weather and quickly lose heat in cool weather.

Soil Conservation

Until recently the term 'Soil Conservation' to most people in Jamaica had a very restricted application, and referred to the mechanical structures used for the prevention of erosion. To-day, more and more farmers are accepting the term as comprising not only those mechanical devices such as stone and live barriers, drains, bunds, etc., but the whole range of agronomic practices such as mulching, crop rotation, etc., as well as fertilizing, drainage, irrigation and other techniques which assist in maintaining the fertility of the soil. Soil conservation must therefore cover not only the preserving of the soil, but preserving water for the crops.

In short, a good conservation programme is one which provides for the proper utilizing of a given area so that the maximum returns may be obtained without deterioration of the land. It is with this concept in mind that Extension Officers of the Department of Agriculture with the assistance of organizers of the Agricultural Society and the co-operation of Farming Groups in various sections of the Island have set about operating what are now known as 'Watershed Schemes', which involve communal effort within common watersheds, designed to develop the proper use of land based on its capability, and to establish adequate soil and water conservation practices.

Soil Conservation may be regarded as having two main divisions:

(1) Erosion Control.
(2) Maintenance or Restoration and Maintenance of Soil Fertility.

What is Erosion? It is the process by which particles of soil-forming materials are dislodged and moved downward by wind, water and/or gravity. There are two types of erosion—Geologic Erosion and man-made or Accelerated Erosion.

Geologic Erosion. This type of erosion goes on continuously in nature, and is responsible for the wearing down of land masses to provide material for the formation of soils on which farmers produce their crops. This type of erosion is greatest in geologically young countries, where the ridges are sharp and steep and slope down as the ridges round off, and a smooth and rolling topography develops.

It is well nigh impossible to stop geologic erosion, and even if it were possible it would be wrong to stop it, as it is responsible for the deposition on cultivated lands of freshly weathered soil which rejuvenates the soil, and prevents the development of a 'dead layer' on which little or no crop production would be possible.

Man-made or Accelerated Erosion. This is the type of erosion brought about by man, when in his prolonged attempt to produce crops from the land he exposes the soil to the two great eroding agents—wind and water.

There are many things that can be done to prevent soil from eroding. One is to keep the soil covered with grass, bush, trees, or with a good mulch. These break the force of the raindrops which would otherwise dislodge small particles of soil, block up air and water passages in the soil and wash the surface soil away. Another is to make barrier walls, terraces or drains across the slope. Sometimes these structures should be on the contour, but often they should be on carefully laid out grades. These structures check the flow of water, let as much as possible soak into the soil, and lead the rest into protective channels which take care of the disposal of excess water. Still another method is to work plenty of organic matter into the top soil, so that the surface layer will remain porous and crumbly and not dry out into blocks or slabs like a concrete floor. A crumbly top soil will soak up plenty of moisture, and will not break up as will a soil with poor structure.

Maintenance or Restoration of Soil Fertility

It is possible to control the erosion on a bit of land so that there is absolutely no loss of soil taking place and yet not increase the productivity if you started with very poor soil. It is important, therefore, that a Soil Conservation programme contains, in addition to erosion control measures, provision for improving and maintaining the fertility of the soil in order that the production may be increased. These measures include addition of plant nutrients in the form of Artificial Fertilizers or Organic Manure, Rotation of Crops, Mulching, Drainage and Irrigation.

Drainage. This involves measures for the removal of run-off, and also of surplus water held in the soil. In porous soil with good internal drainage, it is not as a rule necessary to provide for removal of excess water held in the soil except in swamps, but in all soil in heavy rainfall belts and in clay or clayey soils in medium and in some cases even in low rainfall areas provision should be made for the collection and safe disposal of surplus run-off water wherever there is a water disposal problem. Two types of drains are required—those built across the slope to collect the water which would otherwise run down over the land surface taking particles of soil with it, and those which receive water from the cross drains and lead it away. These latter drains are commonly referred to in Jamaica as run-off trenches.

The drains built across the slope may be dug on the contour on the free draining soils, but should be on a carefully laid out grade of, say, 1 ft.–100 ft., or a 1% grade on soils which do not absorb water readily, like the clay soils found all over the Island. It may even be necessary to put a slight grade on soils which take water fairly easily and quickly if they are in areas subject to very heavy downpours of rain.

In constructing these drains the size will be dependent on the amount

of water they will be called upon to carry, which will be determined by a number of factors like the type of soil, the width between drains, the length of drain, the rainfall of the area and the heaviest precipitations.

The earth removed from the drain should be placed on the lower edge of the drain to increase its carrying capacity. The upper edge of the drain should be sloped back to an angle of 45° or thereabout in order to prevent it from caving in, and to enable grass to grow easily over the surface and down into the drain.

A strip of low-growing vegetation just above the drain should be left unploughed, and flat grasses like Crab, Pimento or Pangola planted with a minimum width of 3–4 ft.

Run-off Trenches. These should be located as far as possible in the natural courses, and should be located and prepared before any of the cross drains or diversion ditches are cut. Preparation does not mean digging. Some shaping or repairing may be necessary, but as far as possible any digging should leave a tray-shaped effect, and in all cases the run-off should be well covered with a creeping grass. Avoid in the run-off any plant or structure which is likely to resist the flow of water, as this will encourage digging. In this connection large roots crossing the drain should in most cases be cut, and it will in a number of instances be necessary to remove some stones.

Irrigation. This is the applying of water to land and is a rather specialized field. There are two ways in which this water may be applied:

(1) In surface drains from which soil is made wet by flooding the entire surface, or by smaller drains or twigs from the large main or secondary drains; and
(2) By sprinkling the surface from an overhead irrigation system, of which there are a number of types.

The frequency of wetting and the amount of water to be applied have got to be worked out for different crops and different localities, and is a field in which much work has yet to be done in Jamaica. It is a common practice to employ a 10 to 14 day cycle for most crops in some irrigation areas, but this rule of thumb method of a set cycle has been found to be wrong by at least one investigator so far.

Much erosion has been caused by both methods of irrigation even on very gently sloping land. It is important that properly controlled grades be used for surface irrigation drains, and that for both methods planting be undertaken on the contour and drains for the disposal of surplus water be properly laid out on grade.

Strip Cropping. The term is self-explanatory, and advocates the cropping of land in strips across the slope rather than the common practice of clearing long strips up and down the slope.

A strip cropping system renders easy the adoption of a crop rotation, which is so vital to maintenance of continued economic production from an area.

Stone Barriers. There has been much discussion about the economics of using stone barriers. The construction of stone barriers is expensive, and is not recommended in areas where stones are not plentiful and where the carting of stones for long distances even on the same holding is involved.

Stone barriers properly constructed make an excellent anti-erosion structure, and though expensive may be well-advised in areas where high-producing cash crops such as flowers and vegetables are produced.

In most areas where stone barriers are now popular it is based on the fact that some place has got to be found to put the stones in order that the farmers may be able to find some soil to cultivate; and placing them as contour barriers not only makes more land available, but reduces erosion and gives an orderly appearance to the holding.

Live Barriers. For many years single or double or even treble rows of some tall grass as Napier, Elephant, Khus-Khus and Lemon have been used along the contour. These tall grasses have in many instances held quite a weight of soil, but because they do not provide a continuous cover on the soil, erosion has still taken place. It is now advocated that belts of the flat grasses as Molasses, Crab, Pimento and Pangola which will strain water through slowly be used to replace or in association with these upright grasses.

Keep the Soil covered. This sounds so simple that little or no importance is attached to it by most farmers in Jamaica, yet there is no single technique which is as effective in the conservation of soil and water as that of keeping the soil covered. The type of cover may vary from tall forest trees to food trees like Breadfruit, Avocado pears, Ackee, Citrus; or shrubs such as are commonly seen on land lying fallow; to grasses as Cane, Elephant, Napier, Guinea, or the low and most effective cover provided by such flat grasses as Crab, Pimento, Wynne and Pangola, and even to dry grass used as mulch.

A good cover not only protects against the beating action of raindrops and prevents movement of the soil, but slows down the movement of water over the surface of the soil, thus enabling the soil to absorb much more and act as a reservoir from which plants and streams can draw during periods of low rainfall. Farmers should therefore see that land not in cultivation is covered with vegetable growth, preferably a legume as Kudzu or Indigophera, and that in cultivated areas practices be undertaken which permit of clean cultivation for as short a period as is possible.

The question of clean cultivation on the scale carried on in Jamaica is one which requires considerable investigation. For conservation of the soil, it would be ideal to have a good leguminous cover over the soil as soon as

preparation for planting is completed and retain this cover continuously. It may be that this would bring about too much competition for nutrients and at seasons for water between the cover and the crop, while on the other hand this competition could probably be taken care of by adequate fertilizing and cutting back of the cover at prescribed seasons.

Farmers must in the interest of their soil effect the best compromise possible.

Rotate Crops. Apart from the dangers of increasing the incidence of pests and diseases and depleting the soil of plant nutrients, continuous cultivation destroys the structure of the soil. Soil structure is of much greater importance than is generally recognized. It has long been known that crops with but a few exceptions must have a constant supply of air and moisture around their roots, and that in the absence of these growth is retarded. Air enters and is held in the soil by channels left by rotting of plant roots and other vegetation, by the space between individual soil particles, and to a greater extent between aggregates of particles.

These soil aggregates are held together largely by organic matter which is in process of being broken down.

The break-down of this organic matter is accelerated by constant stirring of the soil, so that continuous cultivation destroys structure not only by the mechanical damage done to aggregates by the implements used in tillage, and by the constant exposure of soil to the beating and puddling action of rain, but by the rapid breakdown and loss of the soil organic matter.

The maintenance of our soil structure is vital not only because of the crops growing on it, but because soils with a good structure are much less erodable than poor-structured soils. We cannot therefore afford not to rotate or to exclude grass from the rotation, since grasses are the best crops which we have for the restoration of soil structure.

Conclusion. In this chapter an attempt has been made to indicate various conservation measures which may be adopted in an attempt to hold soil in position and maintain fertility. Important as this may be, it is of no use effecting this if the cost is so high as to render production from the area so conserved uneconomic.

In order then that the best programme be prepared for a given farm or portion of a farm, the crops to be produced should be selected in accordance with the capabilities of the land as well as the capability of management of the farm, and then the conservation measures or combination of measures best suited to the land crop, management and finance of the farm adopted.

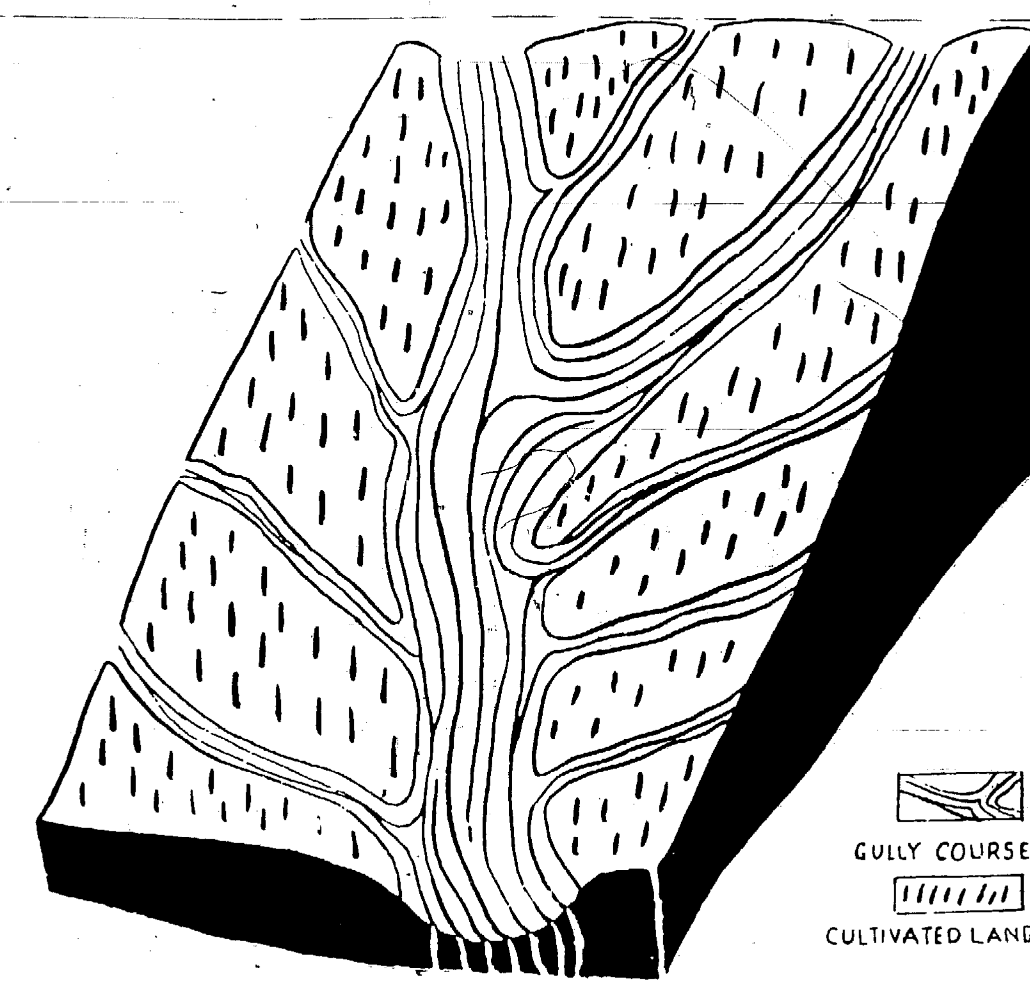
Selection of conservation measures most suited to various areas and cropping systems, involves not only a knowledge of the various techniques advocated for use in Jamaica, but also such information as the soil type, slope, degree of erosion, rainfall and other climatic factors such as prevailing winds and altitude. Different combinations of these factors make it necessary to adopt different measures even where the same crop is being planted. A plot of citrus on a 10% slope on the red limestone soils of Manchester may be adequately conserved with a cover crop and the necessary fertilizer dressing, whereas on the same slope a plot of citrus on clay soils of Portland will require in addition graded drains, due to higher rainfall and the difference in water-holding capacity of both soils.

Having decided on the conservation measures to be adopted, it is important that any structure, being constructed for the prevention of erosion, be properly put down, since these will be expected to be permanent. The service of the local Agricultural Officer should be sought whenever certain lines or more especially grade lines are required, since errors can lead to the breakdown of the entire system.

Burning. In Jamaica the majority of the soils are young, consequently there is no great depth of soil to fall back on when the surface is removed. It is necessary, therefore, to stop erosion and also to grow crops which will put back some humus in the soil. The condition is a familiar one, as it is to be seen daily on the hills, which are producing very little except a thin cover of molasses and guinea grasses. The practice of burning the vegetation is to be condemned throughout the world as a bad agricultural practice. In Ireland and Wales burning has caused the extensive growth of bracken on land depleted of nutrients; once established the bracken is difficult to eradicate. In Jamaica, burning of the Newcastle hills has produced similar conditions, where a fern called Jamaica bracken is presenting the problem. Molasses grass is another product of the burning practice.

HINTS ON CONSERVATION PRACTICE

CARELESS GULLY COURSES, BARED AND UNPROTECTED

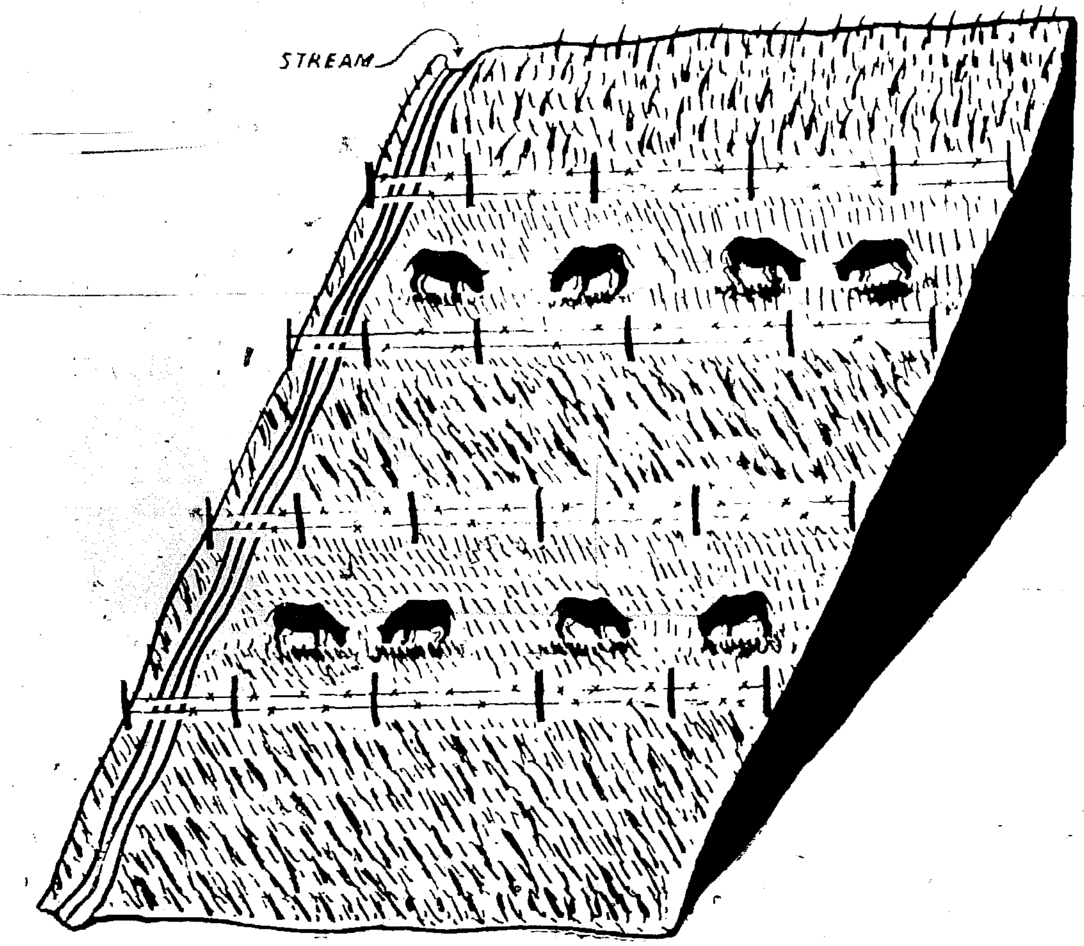


The trouble with little gullies is that they don't stay small, they become big gullies. This is especially true when the land above and around them is farmed badly.

Cultivated crops grown in mounds on a hill like this, allow rain to run off too quickly.

Bare gullies rob both soil and water.

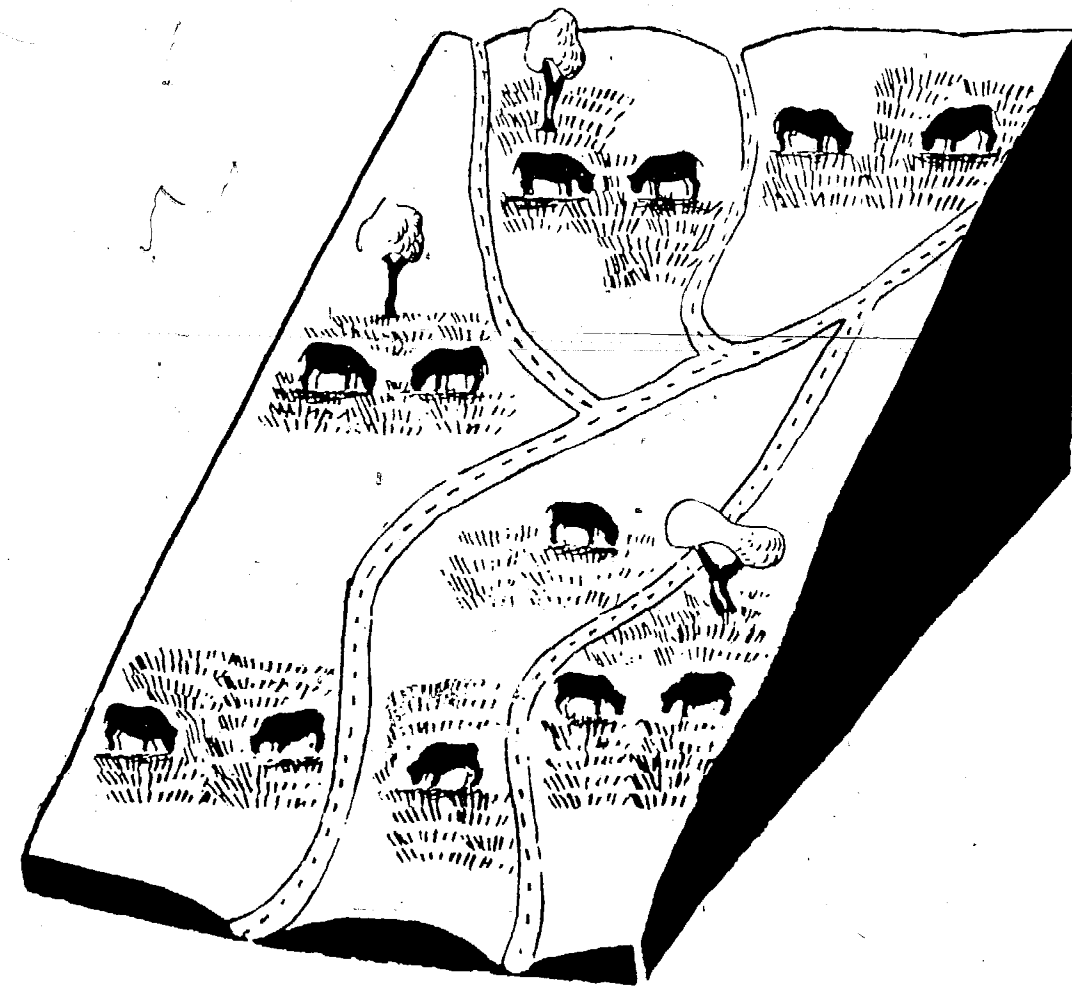
ROTATION GRAZING ON CONTOUR STRIPS



This farmer seeds or plants the kind of grass he wants, fertilizes it according to a soil test, and rotates his livestock so that the grass has a chance to recover.

By building fences on the level, he can farm alternate strips in vegetables too.

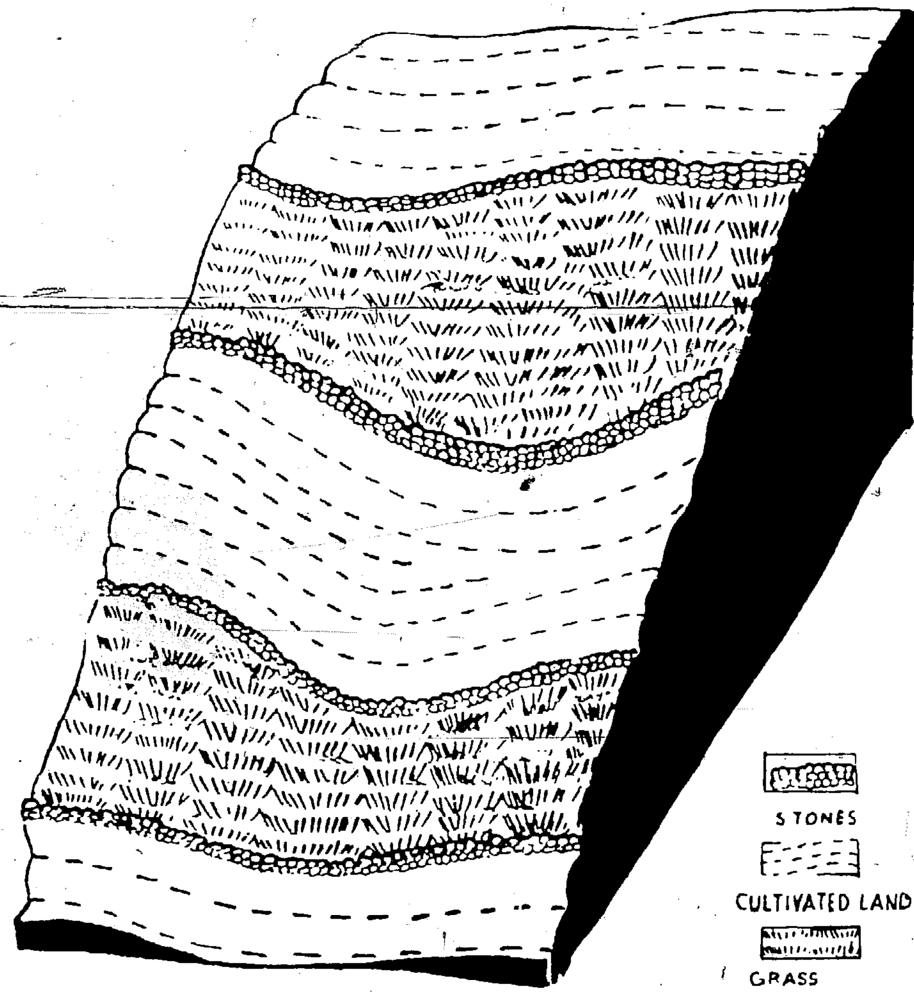
INADEQUATE FERTILITY—OVER-GRAZING—BARE GROUND—EROSION



There is erosion on grass fields too.
This is usually for one or more of several reasons:

(1) The soil is too poor to grow grass, and needs fertilizer.
(2) Too many cows or goats eat the grass too closely—it should be rested.
(3) The farmer did not sow or plant grass, but expected Nature to cover the field after it would not produce any other crop.

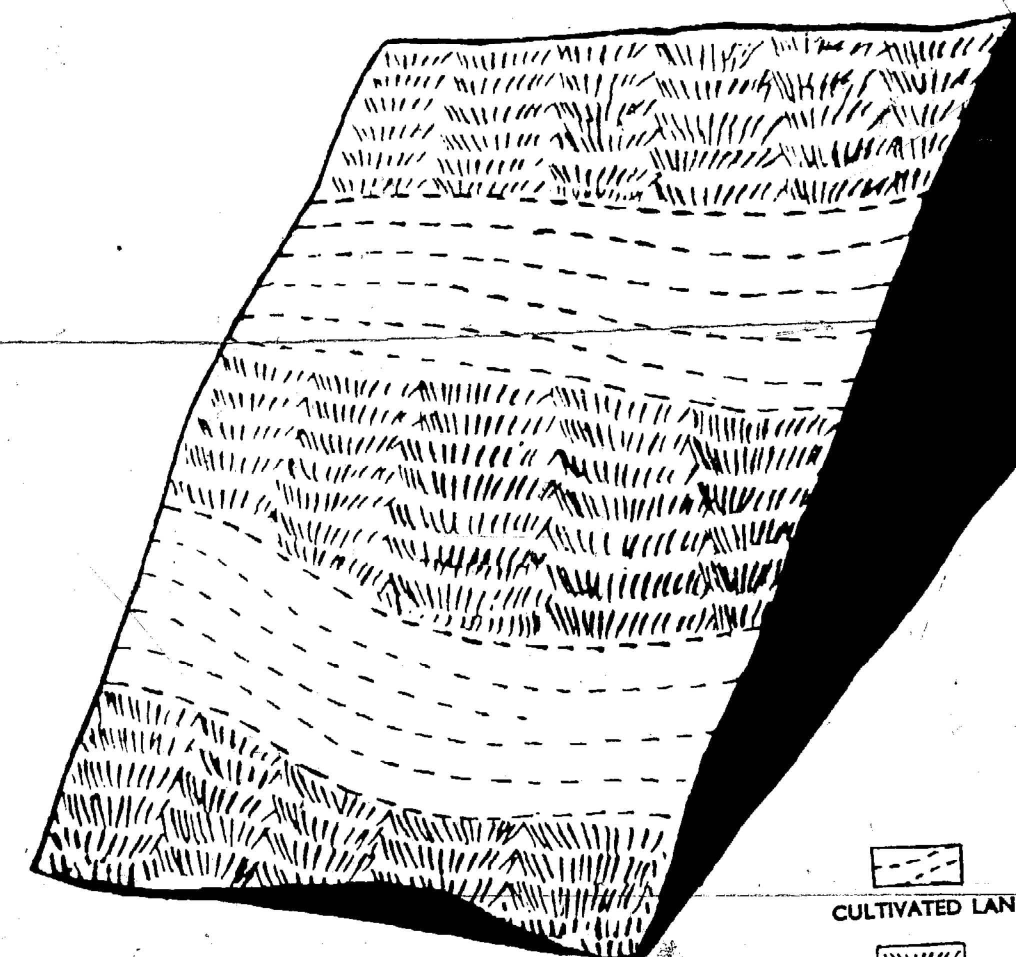
USE STONES ALONG CONTOURS WHERE AVAILABLE



This is the best place to put stones, but be sure the lines are LEVEL. You can't do it if you don't have stones; we don't think that you should carry stones to the field.

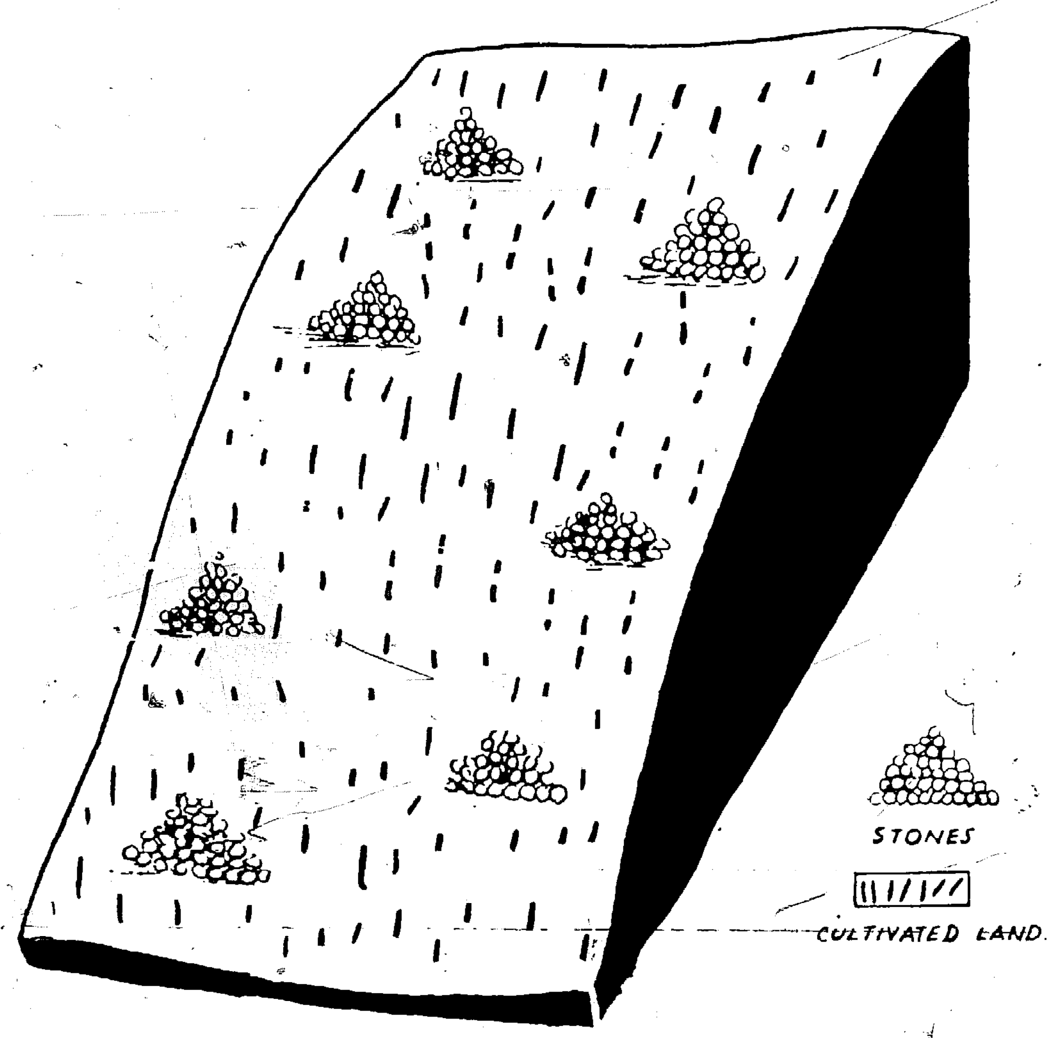
But you can do everything else this picture shows, and possibly other practices too.

STRIP CROPPING ON SLOPING LAND



This is a very simple practice which can be used where land is not too steep. Level lines are laid out across the slope. Between two of them vegetables are planted in level rows. Grass for livestock is grown between the next two lines. Then vegetables come again, and so on. After several years the vegetable strips will be seeded or planted to grass, and the former grass strips will grow good yields of vegetables.

WHAT NOT TO DO!!



What is wrong with this picture?

Don't read any further until you have decided what he should NOT do.

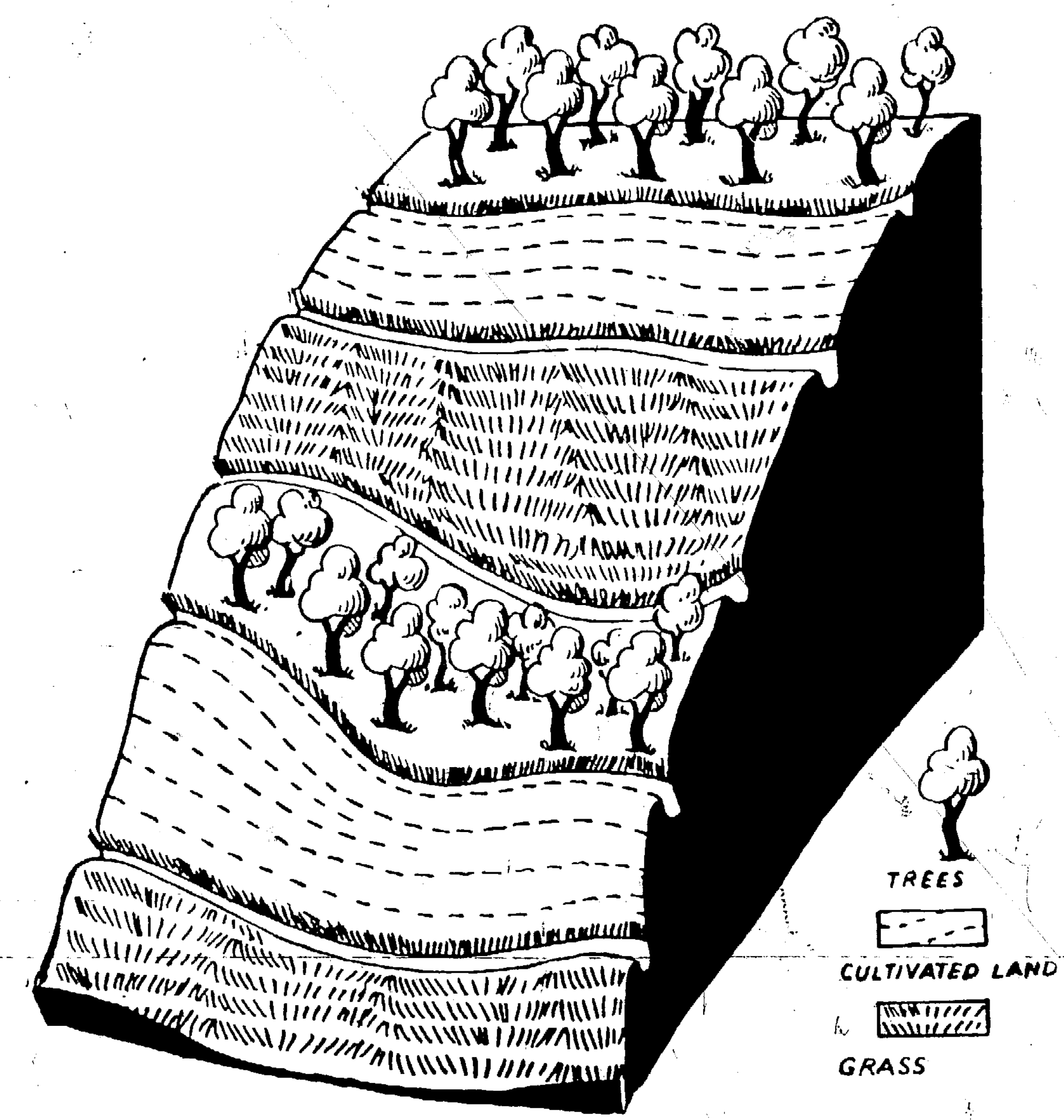
We'll name:

(1) when he clears land, he should not PILE stones, but place them on LEVEL LINES to hold soil;

(2) he should plant his crop in LEVEL ROWS to hold water; and

(3) he should not plant the WHOLE SLOPE to a cultivated crop, but grow STRIPS OF GRASS between strips of vegetables.

STRIP CROPPING ON STEEP LAND



On steeper land, strip cropping with grass alone may not control erosion.

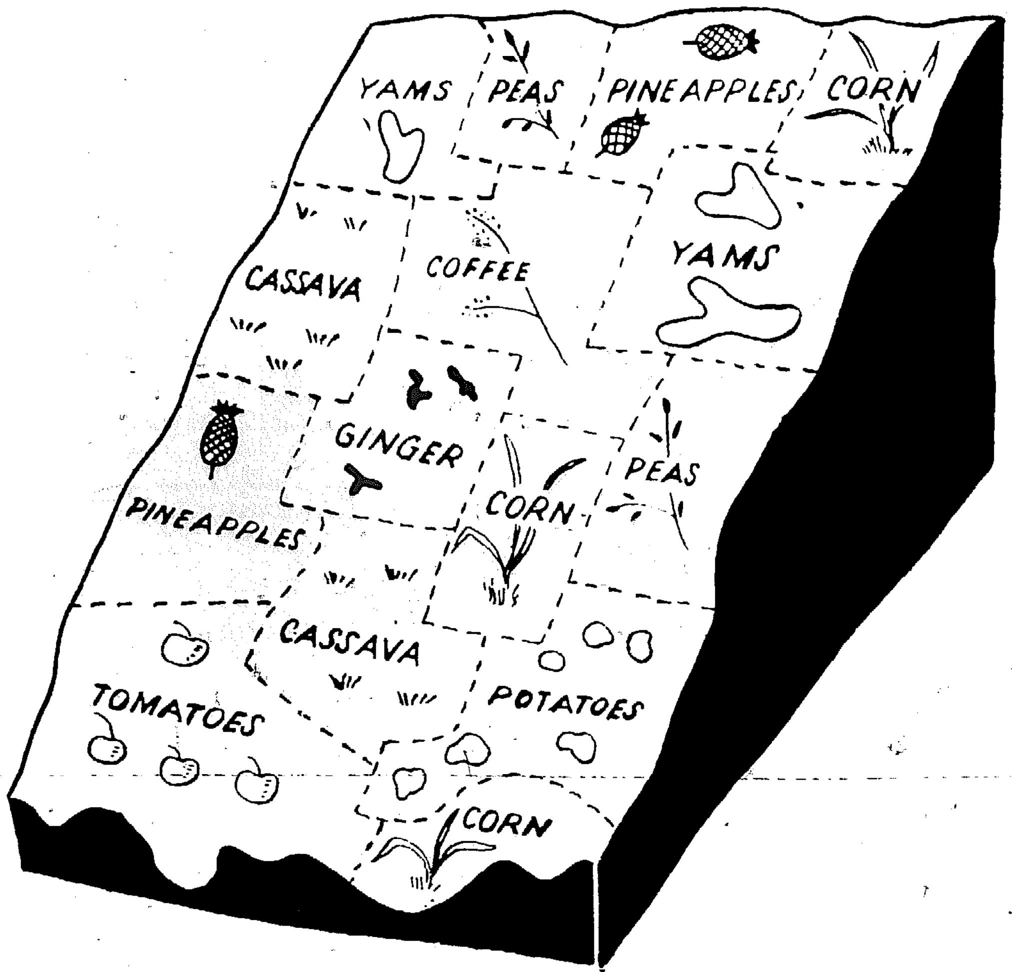
Contour trenches may have to be dug to catch more water, making it soak into the ground or carrying it to grassed drains when there is too much rain.

These trenches need to be protected by barriers of grass above them.

And in addition to strips of grass, which will rotate with the vegetables, there should be strips of trees—all kinds of trees.

Forest trees may be mixed with fruit or 'Food Forest' trees.

HAPHAZARD CULTIVATION DOES NOT PROTECT SLOPING LAND



Block planting like this may be all right for FLAT land, if it is rotated with grass and other good management practices are followed.

But for sloping land, there is too much cultivation here; there is no grass to stop washing; hill cultivation will not make water soak into the ground.

SOIL CONSERVATION

This series of pictures is intended to bring home to the farmer's notice how widespread is the occurrence of the soil erosion and the necessity for soil conservation.*

CAUSES OF EROSION

1. Crops like Corn and Peas which leave the land bare

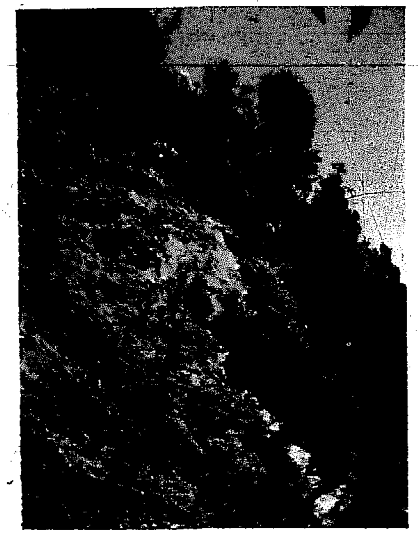
2. Shifting—cultivation, destruction of trees

3. The ruinous burning of land leaving it bare and unprotected

* An arrangement of pictures reproduced by courtesy of Mr. Ted Hebel, Soil Conservation Officer, F.A.O.

4. Clearing land on rock ridges

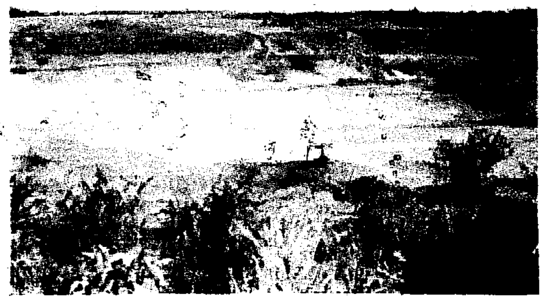
5. Geological erosion. (It is both uneconomical and inadvisable to stop this kind of erosion)



6. Cultivation on steep stony hills quickly exposing the underlying rocks

7. Clearing away the woodland and undergrowth and failure to introduce soil conservation measures. (The trees should be replanted in a planned programme)

8. Over-grazing exposes the top soil and makes it easily eroded. (Even grass needs help)



9. Failure to replace the 'food' which came out of soil leaving the land bare and barren

10. Running water can produce deep gullies, the sides of which always cave in

11. If the top soil is very thin, irrigation erosion can damage the land

12. Cultivation on poor soil in which rock boulders and ledges are plentiful

RESULTS OF EROSION

1. Muddy water meaning that somewhere higher up the topsoil has been washed away. (Good grass barriers would check this

2. Landslide at the head waters of a river, carrying everything to the bottom of a valley

3. Road slides caused by cultivating on too steep a slope and too close to the edge of the road embankment

4. Need for expensive retaining walls. (We pay the cost in taxes)

5. Trickle of water instead of good flow because of water run-offs. Rain water should soak into the soil and be retained for future use

SOIL CONSERVATION PRACTICES

1. Contour cultivation making rain water soak into the soil instead of running off

2. Hilling up contours on the upper side helping to retain the water

3. Terrace of trash, leaves, limbs, held back behind stakes. A temporary measure. (A heavy flood will carry it away)

4. Strip cropping on the contour. Cultivation in grass, etc.

5. Strip cropping alternately with grass and economic trees or forest and fruits

6. Planting 'conservation' grasses like Guinea and Wynne

7. Slow benching is preferable. Terraces benched level too quickly, result in poor crops

8. In case of sugar planting on hillside— break hill into strips when replanting

9. Trenching with modern equipment

10. Sloping bank above trench allows for growth of flat grass to 'brake' flow of water

11. Putting in trenches on slope with instruments. The work must be accurately done

12. 'Trimming' grass. Leave a little to help new growth and to check flow of water

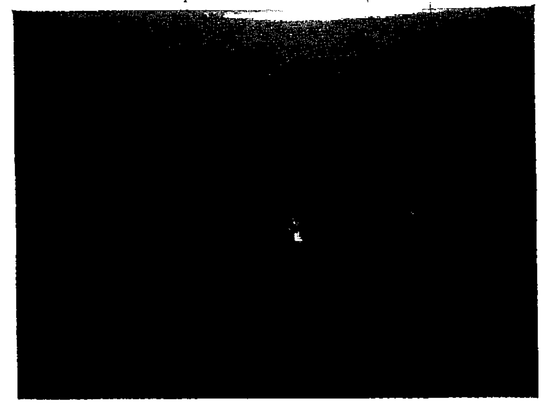
13. Providing drainage on heavier soils. Soil holding water too long is bad for crops

14. Draining on grade with outlet channels. Planting bananas parallel with drains

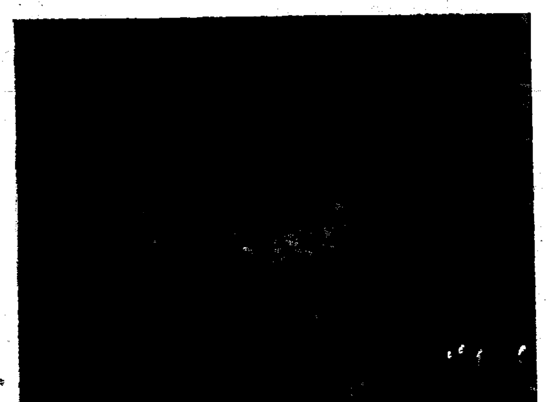
15. Erecting stone barriers. Slope them back into the hill

16. Stone barriers following the contours, *not straight*

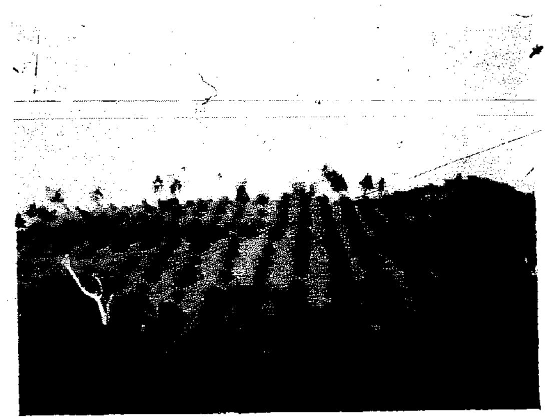
17. Timber crops like mahoe which don't need much cultivation on poorer soils as well as other tree crops as in background



18. Forestry is profitable and can be good business on steep slopes



19. Research for suitable cover crops for bananas is necessary. The land should not be left bare



20. Mulching saves soil from being beaten by rain drops

CHAPTER 6

Types of Soils in Jamaica

Geology and Soils

The geological history of Jamaica began in upper Cretaceous times when volcanic activity occurred. This was probably submarine as the volcanic tuffs and lavas, the Trappean Series (Sawkins 1869) are interbedded with shallow-water, marine shales and reef limestones. At the end of the Cretaceous period, uplift converted Jamaica into land. Pronounced earth-movements with folding, thrusting and faulting, accompanied the uplift and continued into lower Eocene times but had ceased by middle Eocene. During Eocene times, gradual subsidence supervened and, by middle Eocene, large areas of the island were submerged beneath a shallow sea. The sea extended progressively until, by the Oligocene, probably the whole island was submerged. Renewed uplift began in the lower Miocene but probably no land appeared until the middle Miocene when there was considerable uplift so that only the margins of the present island remained beneath the sea. This uplift was accompanied by renewed folding and faulting on a less pronounced scale, with localized exceptions where folding was intense. Later, uplift brought the island to its present form.

Broadly speaking, Jamaica has an igneous and metamorphic core, covered, for the greater part, by a limestone mantle deposited during several marine submergences. The surface consists of approximately two-thirds limestone with the other third of igneous rock, sedimentary shales and alluvium.

Hard white limestone up to 2,000 feet thick forms some three-quarters of the surface rock and may reach an elevation of 3,000 feet. Softer yellow limestone and marl occur in some areas and are often present as a narrow bordering strip around shale areas.

Soil Types of Jamaica

Before proceeding to any detailed description of the soil types in Jamaica, it is necessary for a better understanding of their formation to review briefly the geological history of the Island. This review is important mainly because the recognized series of soils are closely related to the various geological formations making up the Island.

The relief of Jamaica is dominantly mountainous. The coastal plain makes only a narrow fringe around the Island. The configuration of the Island resolves itself into three distinct and easily recognized formations. The chief features of these formations are:

(1) An interior mountain range constituting the nucleus of the Island.
(2) An elevated limestone plateau which surrounds the interior mountains and ends abruptly towards the sea.
(3) A series of low flat coastal plains around the periphery of the Island.

The interior mountains are made up of a fundamental series of stratified shales and conglomerates, tuffs and volcanic debris, all of which

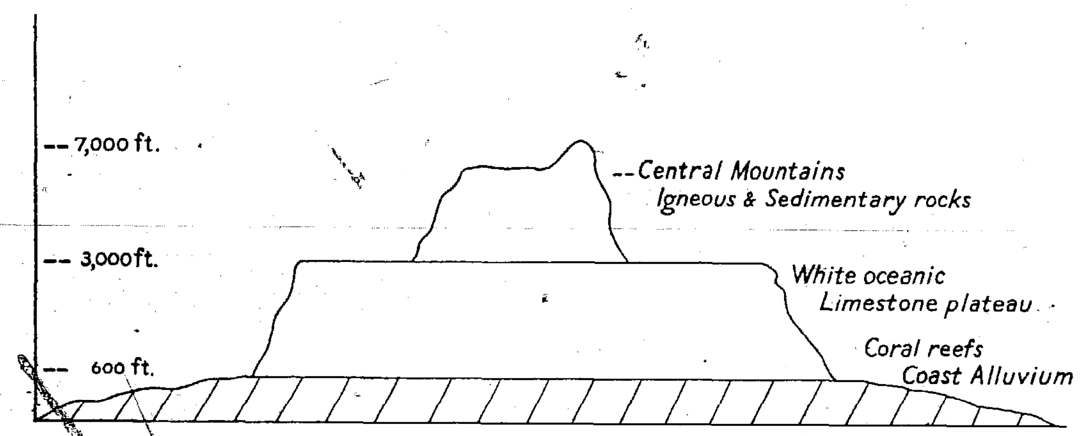


Fig. 1. Diagrammatic representation of the geological formation in Jamaica

have been displaced and deformed. This series characterizes the higher mountains and forms the nucleus of the Island structure upon and around which all subsequent formations have accumulated. The material, except for occasional beds of limestone or clay marl, can be traced to igneous rocks. It was first volcanic ejacta and sedimentation from coarse boulders to finely divided clay shale. These rocks are the materials of the Central Mountains and make up all the land over 3,000 feet such as the Blue Mountain Ridge, the Bull Head Mountains and the Jerusalem Mountains.

The history of events which played their part in the geological history of Jamaica have shown that in the early Cretaceous era the crests of the Island appeared out of the sea and these sediments were derived from the volcanic eruptions centred in the Blue Mountains and Clarendon Ridges. The next event was the degradation of the volcanic heaps by erosion. The nature of the sediments and their uniform alternations indicate that the material was sorted out in shallow water. The presence of pebbles of

foreign origin suggests the existence in the region at that time of larger land areas than the mere nucleal summits of the Blue Mountains and Clarendon Mountains.

Following on to the deposition of these sediments, there was a period of subsidence, during which oceanic limestone deposits encrusted the mountainous core to a height of 3,000 feet. During this period, only the summits of the existing mountains today were dry land.

The next event was the re-elevation of the sea bottom and the restoration of the land area to proportions far beyond its present outline, connecting it with the adjacent Island of Haiti.

This emergence brought up with it the old presubmerged mountainous topography now encrusted with a crating of oceanic limestone. The second geological formation is therefore the series of organically derived oceanic marls and limestone which rests against the more elevated outcrops of the basement series.

This limestone formation forms an upland plateau which includes almost all the Island under 3,000 feet altitude, outside of the Blue Mountain district except its immediate coastal borders. Accompanying this uplift was a great intrusion from below of deep-seated granitoid and dioritic rocks.

The next event in the geological history of Jamaica was a renewal of subsidence, a contraction of land to its present back coast borders. These later movements are represented in the last series of geological formations by deposits of alluvium, oceanic marls and coral reef rock which are adjacent to the present coasts and represents fringing reefs and other accretion around the Island's border. The soils which are derived over these formations may be classified for easy reference therefore into three series:

(1) Soils of the Basement and Intrusive Series
(2) Soils of the Limestone Series
(3) Soils of the Alluvial Series

(i) Soils of the Basement and Intrusive Series

These soil types have been derived over the geological formations which make up the interior mountain masses, and as has been stated above, this series of sedimentary and igneous formations are the oldest rocks in the geological history of the Island.

The soils may be conveniently classified into the following types:

(a) Soil types formed from the mixed sediments of the Cambridge Beds (including Trappean Shale of Sawkins).
(b) Soils derived over the sedimentary Richmond Beds.

(**c**) Soils derived over purple conglomerates and sediments of andesitic origin.
(**d**) Granite and Granodiorite soils.
(**e**) Soils derived over the intrusive porphyry of the Newcastle Sill.

(a) Soil types formed over the mixed sediments of the Cambridge Beds (including the Trappean Shale of Sawkins)

The Cambridge Beds constitute the highest subdivision of the Blue Mountain Series and are mainly composed of impure yellow limestones and limestone shales.

The more important soil types which have been found associated with these formations are as follows:

No. 94. Carron Hall Clay
No. 91. Killancholly Clay
No. 92. Nonsuch Clay
No. 95. Waitabit Clay
No. 96. Wild Cane Sandy Loam
No. 32. Wirefence Clay Loam
No. ~~98. Deepdene~~ Clay
No. 99. Boghole Clay

94. Carron Hall Clay. This is a dark grey brown soil overlying yellow brown clay with a weak coarse blocky structure. The soil type is found in St. Mary in the Guys Hill-Highgate area, in upper St. James, around Welcome Hall and Cambridge and is one of the most important soils in the area of the Christiana Land Authority.

The main variation in this soil is in depth. The depth of soil varies from 12 to 24 inches before the soft yellow limestone is reached. The drainage is good and this soil type is resistant to erosion chiefly due to the structure of the topsoil and because it is situated on moderate slopes. The reaction of Carron Hall Clay is generally slightly alkaline to very alkaline depending on the depth of soil overlying the soft limestone. Available phosphate is low but the potash status is generally medium to high. Because of this strong structure, and resistance to erosion this soil type may be regarded as one of the more important soils of the Island for crops such as bananas, coffee and food crops.

Generally, stone ~~barriers, which~~ are easy to make from the abundance of stones found on this soil type, is the main soil conservation measure that may be recommended for this soil type.

91. Killancholly Clay. This is a shallow rendzina developed over rubbly limestone and in many areas it is found closely associated with Carron Hall Clay. The topsoil is a very dark grey brown to black clay

which is friable and alkaline in reaction. Below 6 inches is dark grey clay becoming light yellowish brown in colour with a weak subangular blocky structure, until at from 12 to 18 inches loose chalky limestone is encountered. Due to the fact that this soil occurs on steep slopes there has been moderate to severe erosion in most areas. Often there is so very little surface soil remaining that any cultivation carried out on steep slopes will turn up the soft limestone and mix it with the topsoil.

The presence of excess lime in the soil frequently induces chlorosis in plants and intense yellowing of foliage due to deficiencies of Iron Manganese and Zinc occurs in crops of citrus and bananas. The nitrogen status is high, the phosphate and potash content is usually low. Killancholly Clay is a major soil type of the Carron Hall area in St. Mary, and the coastal areas of St. Thomas, St. Ann and St. James where it is developed over marl. Where it occurs on steep slopes, this soil should not be cultivated and pasture, tree crops and forest trees should be the chief use to which the land be put.

92. Nonsuch Clay. On gently sloping land or on wide hillside benches over soft limestone this heavy clay soil develops. It is always in association with Killancholly Clay which occupies the neighbouring steeper slopes. Generally, it is a black or dark brown clay which overlies pale brown and brownish yellow mottled; plastic, acid clay. The depth of soil before the soft marly limestone is reached is usually 3 to 4 feet. Poor internal drainage is the greatest limiting factor on Nonsuch Clay. Graded drains which lead into well protected run-off channels are necessary on this soil type.

The fertility of the topsoil is medium low, and phosphate and potash are the most important nutrients for crops growing on this soil. The area of this soil is not very great and banana is the chief crop grown.

95. Waitabit Clay. Over the limestone shales which are associated with the yellow limestone formation a red to brown acid clay develops, chiefly on gentle slopes in association with Carron Hall Clay. A typical profile shows a brownish red clay to 12 inches over a pale, mottled, red, silty clay with very weak structure. The soil type is chiefly found in the Christiana Land Authority area, and in St. Mary, in the Guys Hill-Decoy area. Erosion takes place rapidly in the soil when it is cultivated, and once the topsoil has gone, gullies readily form at any sudden increase in the slope. The growing of yams in particular on this soil type has resulted in severe erosion and there is great need for soil conservation on Waitabit Clay. The nutrient status of the topsoil may be fairly high, but as soon as this has been removed by erosion the subsoil which is poorly supplied with plant nutrients is exposed. Graded drains to remove water slowly from the land may be found particularly useful in stopping erosion on the soil. Nitrogen and phosphate fertilizers are very necessary for the growing of crops on the Waitabit Clay.

96. Wild Cane Sandy Loam. The presence of sandstone in the yellow limestone formation results in a shallow soil developing over these materials. It is generally a dark brown sandy loam with a very fine weak granular structure which changes to grey brown on drying out. The subsoil is a brown to yellowish brown sandy loam with little or no structure and is friable and highly acid. The nutrient status is low except for potash, and nitrogen and phosphate fertilizers are very necessary on this soil type.

It is usually found on steep slopes in the Christiana area and because of its ease of handling it is everywhere cultivated. Strip cropping with a cultivation of one (1) strip in every three (3) is the soil conservation measure recommended for the soil.

32. Wirefence Clay Loam (Trappean Shale). Over the tuffs and conglomerates of the Trappean series the soil type formed is Wirefence Clay Loam. It is derived from sedimentary beds mainly of volcanic origin and may be seen in the Guys Hill area of St. Mary and in the Christiana-Lorrimers-Albert Town areas of Trelawny, and other areas such as Kellitts, Point Hill in St. Catherine, and between Cambridge and Catadupa in St. James. Typically, this soil is a dark reddish brown clay loam with a very fine strong blocky structure which overlies reddish brown plastic clay. At about 3 to 4 feet soft, porous, light parent shale occurs which usually weathers quickly into soil. The soil is extremely erodible and some of the worst soil erosion in Jamaica may be seen in the above areas.

Gullying due to tracks leading up steep slopes is frequently seen and is mainly due to the fact that the red subsoil weathers into fine particles which are readily washed away by water. Erosion is generally very marked because of the growing of clean cultivated crops on this soil type. Yams, Irish Potatoes, Ginger are grown intensively and the system of shifting cultivation is gradually leaving most of these areas a barren waste. This soil is one of the most important in the problem areas of the Christiana Land Authority and its rehabilitation will be an important step in the agriculture of the area. The soil has a high potash status, but otherwise it is poorly supplied with plant nutrients.

Wirefence Clay Loam is acid and liming is essential for crops of the grass family such as cane. Strip cropping is the chief soil conservation measure which may be recommended for Wirefence Clay Loam. Where the soil is found on slopes of more than 20 degrees tree crops should be established.

98. Deepdene Clay. In areas of poor drainage over shales of the Yellow Limestone formation, this soil exists associated with Boghole Clay and Carron Hall. Typically it is a reddish brown clay overlying red and grey mottled clay at about one foot and the use of proper drainage systems is necessary for the growing of crops on this soil. The soil is acid, very

deficient in phosphate, and the use of fertilizers together with graded drains is the only method of getting good crops from this soil type.

99. Boghole Clay. This soil develops over shales of the Yellow Limestone formation in badly drained hollows and it is closely associated with Deepdene Clay.

The topsoil is 4 to 9 inches of dark brown clay with fine weak structure which is plastic when moist and sticky when wet. The subsoil is very acid and has many coarse mottles of pale brown and reddish yellow.

The nitrogen status is high but other nutrients are low and graded drains are necessary to lead off water on this soil type.

(b) Soils Derived over the Sedimentary Richmond Beds

The Richmond shales make up most of the parishes of St. Mary, Hanover, the western half of Portland and occur in the Yallahs Valley area of St. Thomas. The parent Richmond Shale is made up of well bedded layers of sandstones and claystones which are greyish brown to blue in colour. The sandstones are formed from cemented grains of water-borne hornblende andesite and the shaley material represents the more finely divided particles of these minerals. These soils have suffered severe erosion in the past due to the cultivation of bananas in St. Mary, yams in Hanover and coffee in the Yallahs Valley area. Weathering, however, takes place rapidly on the shales and soil is quickly formed. But for this fact, the parishes of Hanover, St. Mary and most of the Blue Mountain area would have been left barren of all vegetation through soil erosion, and it is a conservative estimate that 90 per cent of the cultivation today in these areas is being done on subsoil or soil of parent material.

The soil types which have been differentiated on the Richmond shales are as follows:

No. 41. Belfield Clay
No. 42. Salt Bay Gravelly Loam
No. 43. Highgate Clay
No. 44. Haldane Sandy Loam
No. 45. Marymount Clay
No. 46. Hall's Delight Channery Clay Loam
No. 47. Llandewey Clay Loam
No. 48. Clifton Mount Clay Loam
No. 49. Silver Hill Clay Loam.

41. Belfield Clay. This is a soil which occurs on the steeply sloping hill slopes in St. Mary, in association with Highgate and Marymount soils which occur on the less steep slopes. Typically, this soil is a dark yellow brown clay with crumby structure which overlies brown silty clay which occurs at from 6 to 18 inches in the soil profile. The rotten shale is often found at from 18 to 36 inches depending on the degree of slope—the shallower soil naturally appearing on the steeper slopes. The dominant slope range in which the Belfield Clay is found is from 10 to 20 degrees and this soil is susceptible to severe erosion under clean cultivation on these slopes. Gullies do not form easily, but when the silty clay subsoil is wet it tends to slip and slump over the parent shale. Bananas are the most important crop in this soil and the minimum cultivation is recommended for this crop when planted on the less severe slopes.

The slopes of over 20 degrees should not be cultivated and should be in timber, food trees, forest, cocoa or coffee. The nitrogen status of these soils is usually low and bears a direct relation to the degree of erosion that has taken place in any area. Phosphate is also deficient but the potash status is generally good. These soils, if erosion can be checked, are very suitable for intensive agricultural pursuits.

42. Salt Bay Gravelly Loam. This is a brown to pale brown very shallow excessively drained soil that occurs on steep slopes over some areas of conglomerates within the Richmond shales. This soil is of fairly small extent and little agricultural importance. It is mainly in bush and very poor pasture.

43. Highgate Clay. On the gently sloping areas over the Richmond shales in St. Mary a heavy dark grey brown clay is found in association with Belfield and Marymount soils. This is a much deeper soil than Belfield Clay and below the topsoil there occurs pale brown silty clay with mottling which is indicative of poor drainage. The parent shale is usually encountered at from 4 to 6 feet in the soil profile. The dominant slope range of which Highgate Clay is found is from 3 to 10 degrees and the slow internal drainage is the main problem in the management of the soil. Bananas are the chief crop and do well, provided that graded drains into well-protected outlets are established.

The soil is acid in reaction and suitable for cocoa planting. The fertilizer requirements are similar to those of Belfield Clay and applications of nitrogen and phosphate fertilizers are important on this soil type.

44. Haldane Sandy Loam. Haldane Sandy Loam is derived over massive sandstones within the Richmond Beds and is chiefly encountered on moderate to steep slopes as a pale brown sandy loam passing at 6 to 12 inches into rotten sandstones. This soil type is of small extent and importance.

45. Marymount Clay. On the very gentle slopes of hilltops and benches over the Richmond shales, poorly drained Marymount Clay is found. It is a reddish brown clay which overlies a pale brown intensely mottled silty clay subsoil. An older soil than the others with which it is associated (Belfield and Highgate Clays), it is highly acidic and of very low natural fertility. The intense mottling is indicative of poor internal

drainage and this together with its high acidity and low fertility make it a soil with many drawbacks. The addition of nitrogen and local phosphate fertilizers and a provision of adequate graded drains is recommended for any cultivation of crops carried out on Marymount Clay.

46. Hall's Delight Channery Clay Loam. This is the most important soil of the Yallahs Valley area, sections of eastern St. Mary and Western Portland and of the parish of Hanover. It is a very erodible soil type and because of its position on very steep mountain slopes it should be cultivated as little as possible. Typically, the topsoil is a dark grey brown clay loam with abundance of loose channery material from the partly weathered shale. Most of the area occupied by this soil is useless, mountainous topography with slopes of from 25 to 40 degrees, or steeper. The surface drainage and internal drainage of the soil is excessive and soil erosion over most of this area is a serious problem. Much of this land on which Hall's Delight Channery Clay Loam is found should be retired to forestry or coffee under the shade of suitable trees. The reaction of the shale varies from slightly acidic to slightly alkaline in relation to the amount of free calcium carbonate in the parent material. Associated with this soil is Silver Hill Clay Loam which is a deeper soil developed on bench situations.

47. Llandewey Clay Loam. This soil occurs in the lower valley of the Yallahs Valley particularly in the Llandewey-Cedar Valley area on slopes of 15 to 30 degrees. The soil varies from 1 to 4 feet in thickness depending on the degree of slope and the degree of erosion which has occurred. It is typically a dark brown clay loam over yellowish brown loam in which numerous small pieces of shattered shale appear, until the soil grades into a parent shale material. Similar to the other Richmond shale soils nitrogen and phosphate fertilizers are the most important for this Llandewey Clay Loam and strip cropping is recommended as being the best method of soil conservation.

48. Clifton Mount Clay Loam. Associated with Hall's Delight Channery Clay Loam this soil develops on the ridgetops in the shale of the Yallahs Valley area. It is typically a dark brown clay loam over red clay and the depth ranges from 6 to 7 feet over the shales. The recommended fertilizers and soil conservation measures are similar to those of Llandewey Clay Loam.

49. Silver Hill Clay Loam. This soil is of very limited extent and is typically a dark grey brown clay loam over a yellowish red sandy clay. It is unimportant because of its small extent.

(c) Soils Derived Over Purple Conglomerates and Sediments of Andesitic Origin

The purple colour of these geological formations makes them easy to recognise and they are found in the Frankfield-Trout Hall area of Clarendon, the Mount James-Mount Airy-Newcastle areas of St. Andrew and in a section of south-eastern St. Mary. These soils are generally found on steep slopes and the greater part of the areas listed above have suffered severely from soil erosion. The most important soils which have been described on purple conglomerates are No. 38—Cuffy Gully Gravelly Sandy Loam, No. 39—Konigsberg Clay and No. 36—Donnington Gravelly Loam.

38. Cuffy Gully Gravelly Sandy Loam. This is a dark brown gravelly sandy loam which overlies the parent conglomerate at depths of from 6 to 14 inches and which occurs on steeply sloping land. Clean cultivation on these steep slopes has caused severe erosion and gullying, and most of these areas are best used for tree crops and for food forests. Drainage of the soils is good to excessive and its fertility is medium to high. Soil reaction varies from acid to markedly acid and cocoa would be a suitable crop for most of the land on which this soil type is found. If cultivation is unavoidable, then great precautions are necessary to prevent soil erosion. Cultivation should be on contour strips between strips with tree cover.

39. Konigsberg Clay. This is a reddish brown to red deep soil that occurs on gentler slopes on ridgetops over deeply weathered purple conglomerates. It is not of very great extent and its chief drawbacks are its high acidity and low nutrient status. Drainage is poor and graded drains are necessary together with the application of nitrogen and phosphate fertilizers in order to ensure the good growth of plants.

36. Donnington Gravelly Loam. This is a dark brown gravelly loam with fine structure which overlies a dark reddish grey loam which is developed over Trappean conglomerates in parts of the Christiana Area and St. Mary. Generally, the soil occurs on steep slopes of the E and F classes, and soil erosion is widespread and active in the form of sheet erosion. The soil has, normally, a medium nutrient status with a high phosphate content, but its limitation is its shallowness and the steep slopes on which it is found. Strip-cropping with one strip in three being cultivated is recommended for the less steep slopes. The very steep slopes may be planted up to cocoa and food trees.

30. Sunbury Clay, and 33. Pennants Clay Loam. On hilltops and benches in the conglomerate country, these two soils are found.

Below a brown clay topsoil there is grey or brown structureless clay with red mottling. These soils are very poorly drained and of low nutrient status.

(d) Granite and Granodiorite Soils

Most of eastern St. Catherine is made up of a granite formation which stretches over into the Richmond-Flint River area of St. Mary and the

Golden Spring—Lawrence Tavern area of St. Andrew. No. 50 soil—Flint River Sandy Loam—is the main soil of the area.

50. Flint River Sandy Loam. This is a brownish grey sandy loam overlying light yellow sand which varies in depth from 6 inches to 2 feet over the rotten granodiorite rock. The chief weathering products of the minerals in the granodiorite are granite sand, kaolin clay and these are two of the most inert materials which any soil could be made up of. The nutrient level of the soil is therefore extremely low and its acid reaction and high erodibility makes its use for intensive agriculture very difficult. Most of the Flint River Sandy Loam soil is found on steep slopes and severe erosion has removed the topsoil in the majority of the areas in which it is found. The soil dries out easily and liberal additions of organic fertilizers are necessary for any cultivation. Most of the steep slopes should be planted out in tree crops, and cocoa is a very suitable crop for this area. Cultivation on the less steep slopes should be carried out in strips and a rotation with some form of cover crop is recommended.

The content of nitrogen varies with the amount of erosion that is taking place and phosphates are generally very low in the soil. The potash content is medium to high.

51. Harkers Hall Sandy Loam. On the foot of slopes and on shelves in the granodiorite country very small extents of a colluvial soil is found. Harkers Hall Sandy Loam is a dark brown sandy loam with good to very good internal drainage and fair to low nutrient status. This soil is very limited in extent.

59. Williamsfield Clay. On small hilltops and on bench positions, the oldest residual soil derived from the granodin is found. This soil is a dark red clay to clay loam which overlies a mottled and speckled clay loam. At 4 to 8 feet the rotten granodiorite rock is found.

This soil is very erodible, acid and poor in nutrients—drainage is essential on this soil type, and the use of fertilizers particularly Nitrogen and Phosphate is recommended.

(e) Soils Derived over the Intrusive Porphyry of the Newcastle Sill

The Newcastle porphyry which varies between a quartz porphyry and the felspar porphyry is well developed in the western half of the Yallahs Valley Land Authority area, and in sections of eastern St. Andrew. Due to the fine-grained texture of this rock weathering takes place very slowly and over most of the area soils are very shallow, hardly ever exceeding 2 feet in depth. The soil types which have been differentiated on this porphyry are No. 52—Valda Gravelly Sandy Loam—and No. 58—Irish Town Loam.

52. Valda Gravelly Sandy Loam. This soil is a dark brown gravelly sandy loam mixed with gravel which increases in depth until the parent material is reached. It is found on very steep slopes none of which are generally under 30 degrees, and the surface and internal drainage are both excessive which makes this soil very liable to drought. Although this soils is sometimes high in available potash, it is generally infertile and together with the disadvantage of excessive drainage and severe droughty nature of the soil it is obvious that most of this land should be immediately removed from cultivation and planted with such trees that may be able to survive under these extreme conditions of infertility.

The comparison of the rate of weathering of the Richmond shales and the Newcastle porphyry should be noted. Richmond shales weather rapidly into soil and after erosion has removed the topsoil it is quickly reformed from the porphyry material. The reclamation of land is difficult due to the slow formation of soil from the parent material.

53. **Irish Town Loam.** This is a pale grey soil which covers a small part of the Yallahs Valley area and which is associated with Valda Gravelly Sandy Loam. Except for a high content of potash, this soil is deficient in plant nutrients and it should never be cultivated on slopes of over 20 degrees due to its erodibility.

(ii) The Limestone Series

The upland white limestones of the Oceanic series consists of limestones of varying texture and hardness and probably average 2,000 feet thickness. In general, the Oceanic series occupies most of the plateau region of Jamaica and includes almost all the island under 3,000 feet altitude. It is estimated that 75 per cent of the land area is made up of this formation and consequently the importance of the derived soils to the agriculture of the Island cannot be over-emphasized. Three series of beds have been differentiated and these are:

(1) Montpelier limestone beds
(2) Moneague limestone beds
(3) Cobre limestone beds

Montpelier limestones occupy the lower parts of the plateau and are typically thin beds of white limestone interbedded with a soft chalky marl, the limestone beds invariably containing nodules of flint. The flint and chert contained in the limestone lie usually in flattened modular masses in the lines of stratification. These beds are typically seen in the parishes of St. James, Westmoreland and Hanover. On the road from Montego Bay to Adelphi, good examples are found in road cuttings. The flints are usually of brownish pink, brown and grey colours. At Knockalva and other places in the vicinity, the limestone contains small veins of silica and has been so thoroughly impregnated with that substance as to be completely changed into a siliceous limestone. The type of soil derived

over this series of rocks usually depends on whether marl or siliceous limestone occurs in the area. Where chalky marl is predominant the soil takes on the characteristics of a rendzina and where it is absent red limestone soils develop.

Moneague limestone beds. The Montpelier beds grade up into more massive limestones white in colour, firmer in texture, often semi-crystalline and occurring in well defined bands of stratification from one to five feet in thickness. These beds occur in many places in the western half of the island, at Brown's Town and Retreat in St. Ann, on the North Coast Road, and at many localities in Manchester, Trelawny, St. James and Hanover. The best examples are found on the road to Ewarton. The soil derived over these limestones is tawny brown in colour.

Cobre limestone beds. These limestones are of cavernous or honeycombed texture and are composed of small angular lumps of firm limestone, chalky white in colour. These limestones can easily be recognised apart from the Montpelier and Moneague formations due to the entire absence of lamination or traceable lines of bedding. Most of the parishes of St. Ann and Manchester and St. Elizabeth are composed of this series. The important feature of the Cobre limestone is that it weathers into the blood red limestone soils. From the above description of the geological formations which make up the limestone plateau of the Island, it may be inferred that the important soil types developed depend on the type of limestone which occurs in any particular area.

Weathering on limestone formation takes place through solution and the soils are considered to be the result of the removal of calcium and magnesium carbonate from the parent limestone by the action of rain water charged with carbonic acid. The impurities that are left behind are chiefly sesquioxide and generally contain 40 to 50 per cent aluminium and 20 per cent iron. There is no evidence available to show that there are any subsequent changes to modify the composition of this residual material. It is generally uniform in colour, structure and chemical composition to depths of from 5 to 50 feet over a parent limestone. Soils which have been differentiated are:

No. 73. Chudleigh Clay
No. 78. St. Ann Clay Loam
No. 74. Lucky Hill Clay Loam
No. 75. Union Hill Stony Clay
No. 77. Bonny Gate Stony Loam

73. **Chudleigh Clay.** This is a brown limestone soil which is developed over Moneague limestone beds and is found in St. Ann and in Trelawny around Wakefield and Bunkers Hill. This is also the major soil type of the Christiana-Chudleigh-Devon-Mile Gully and Balaclava areas of North

Manchester and North St. Elizabeth. The topsoil of Chudleigh Clay is a strong brown clay loam with a strong subangular blocky structure which is granular and friable. This exceedingly good structure results in excellent intake of water by these soils and subsequent fast drying out of moisture. The strong structure also makes this soil type exceedingly suitable for root crops, such as Irish Potatoes, yams, sweet potatoes. Mulching, however, is very necessary to regulate soil moisture on this soil type. Below the topsoil at about 3 feet in the profile the colour changes to yellowish red clay with a weaker structure. When moist, the clay becomes slightly plastic. The nutrient status of this soil is good, and the only limiting factor to the production of most crops is a marked potash deficiency which can usually be overcome by the application of 2 cwts. Muriate of Potash to the acre. Citrus, coffee and other deep-rooted crops flourish on this soil and it is undoubtedly one of the best soil types of the Island. Soil conservation measures should be aimed at increasing the intake of water and limiting the loss of moisture from the soil when it is drying out.

78. St. Ann Clay Loam. This is the most widespread soil type in Jamaica and makes up most of the parishes of St. Elizabeth, Manchester, St. Ann and Trelawny. It is also found in parts of St. Catherine and St. Andrew, and it is typically a dark red clay loam with a good structure which overlies structureless uniform red clay of varying depth over the parent material—hard white limestone of the Cobre Beds. Drainage on this soil is very good and moisture control is one of the most important factors in the growth of crops particularly in the dry areas. The fertility of this soil is confined to the top 6 inches and is directly proportional to the content of organic matter in this layer. Once this fertile topsoil is removed by erosion there is nothing left behind but hard structureless clay on which plants will not grow. The occurrence of blind spots in fields over most of the area on which the soil type is found is a common occurrence and is chiefly due to sheet erosion moving all the top organic layer.

The fixation of phosphate fertilizer is high in this red St. Ann Clay Loam and it is one of the chief problems in the economic growth of agricultural crops on this soil type. Phosphate fertilizer should be applied in the form of compost, rich in phosphates, in order that the roots may take up the fertilizer before it can be fixed by the soil. Potash is also deficient in many areas of St. Ann Clay Loam. This soil type is also very suitable for the growing of root crops and deep-rooted plants provided that steps are taken to ensure that sheet erosion is stopped and that the content of organic matter in the soil is kept at a high level.

74. Lucky Hill Clay Loam. This soil occurs in the limestone areas on gently sloping land in small valleys and hollows and it is associated with Bonny Gate and St. Ann soils. It is typically a dark brown clay loam with a good structure which overlies compact brown clay at 18 inches depth. It

varies in depth becoming deeper in the centre of the valley and depressions. The internal drainage of the soil is often slow due to its positions in depressed areas and the compact heavy subsoil limits the internal drainage. It is of fairly high natural fertility and most of these lands have not been subjected to erosion. It is, therefore, very suitable for food crops and citrus provided that steps are taken to correct its main limitation by putting in graded drains into suitable outlets.

75. Union Hill Stony Clay. This is a dark brown, shallow, well-drained soil that occurs on moderate to steep slopes over hard white limestone. It is associated with Bonny Gate soil on the steeper slopes and because of its shallowness and stoniness it is very suitable for grass. The internal drainage is good and the fertility status is medium to high. Nitrogen and phosphate fertilizers may be necessary in this soil to correct deficiencies of these elements.

77. Bonny Gate Stony Loam. This is a shallow, dark brown to reddish brown soil that occurs over hard limestone on most of the steep slopes in the limestone plateau. It may be so shallow as to merely occupy the crevices and depressions in the limestone and when these areas are cleared of cultivation the soil is relatively easily removed by water and bare limestone rock is frequently exposed. The soil is usually highly humid and its position and shallowness render it susceptible to drought conditions. Bonny Gate Stony Loam is often merged into St. Ann Clay Loam on the less steep slopes and the only variations in the soil type are its shallowness and stoniness. Most of this land in Jamaica is rented to small farmers who often burn off the vegetation and in as short a time as two years of clean vegetation under corn and food crops there is no soil remaining and the farmer has to shift his cultivation to another site. These lands should be left undisturbed as far as possible and the natural vegetation should be thinned for the planting of food and timber trees in areas of good rainfall.

79. Bundo Clay. This is a dark red brown to red brown poorly-drained soil occurring in some colluvial basins and hollows in the limestone plateau on flat to gently sloping sites. It is an acid soil of medium fertility, but is highly acid and suffers from very impeded drainage in the subsoil. Due to the compact subsoil and its position often in hollows without drainage outlet, it may at certain seasons have a high water table. When well dried, this soil becomes very hard. Shot, often of quite large size, may be common.

At present this soil is in pasture and mixed crops. If intelligently cultivated and drained, Bundo Clay is suitable for crop use or pasture.

(iii) Inland Basin Alluvium

Under conditions of imperfect drainage the red and brown limestone undergo a process of degradation and a characteristic type of soil develops.

This occurs through the hard white limestone plateau in the valleys between the hills and to a greater extent in the inland basins which have been formed by lateral weathering of limestone rock. In these areas the red and brown soils become heavy clays, mottled red, white and brown and the reaction of the soil drops to pH 4·0 to 5·0. Phosphate becomes very

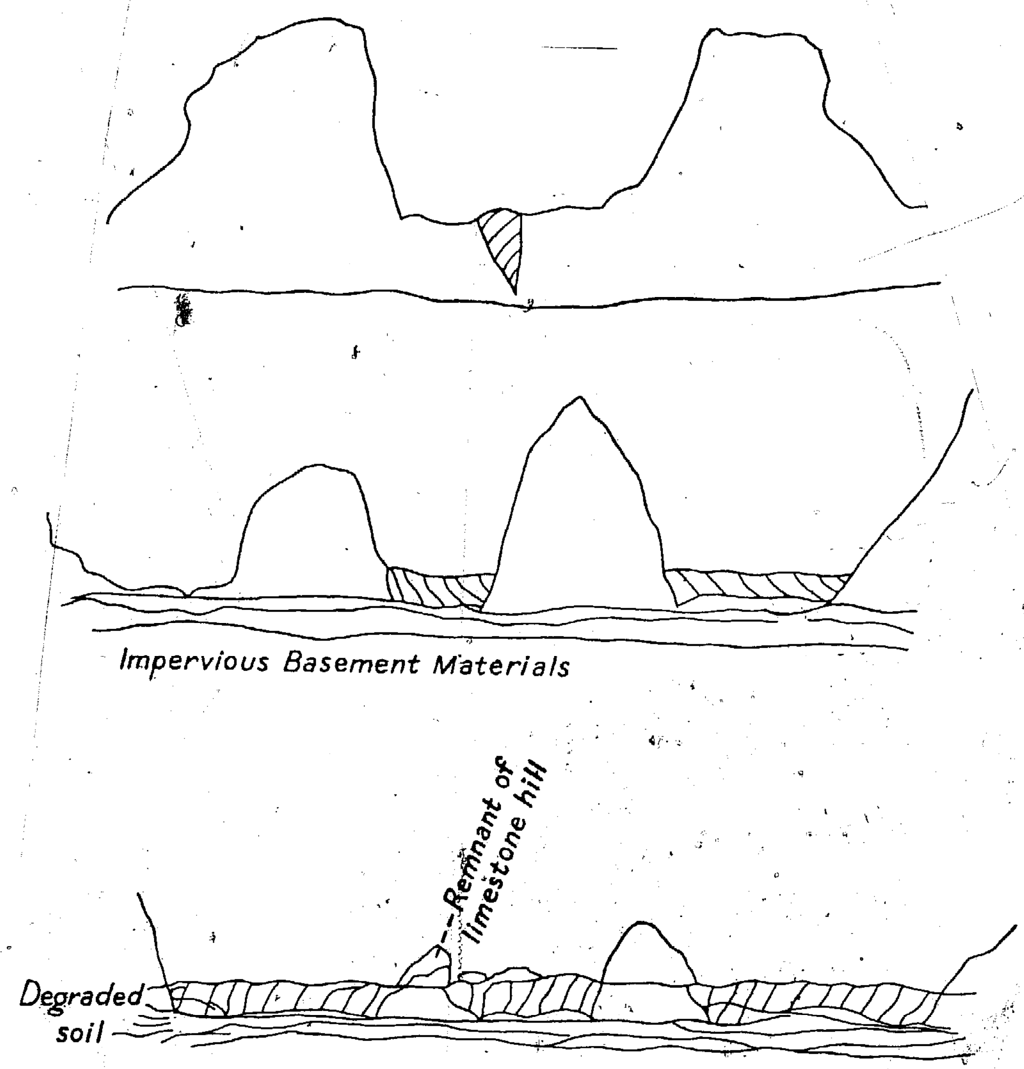


Fig. 2. Stages in the formation of inland basins

deficient and the potash content usually is high. This soil may be recognised easily by the presence of 'shot' which are concretions of iron and manganese dioxide formed under alternating waterlogging and drying conditions which occur in these inland basins. The formation of inland basins is a unique geological phenomenon and is well worth detailed description. Ordinarily, weathering of the limestone plateau takes place downward by solution and large sink holes of cockpits are formed in between the denuded hills (Fig. 1).

However, when the more impervious basement rocks are reached, the drainage becomes impeded and lakes and ponds are formed on the floors of the valleys. Weathering then takes place laterally until a basin-shaped lake is formed with remnants of the limestone hills remaining in it (Fig. 2).

The most important inland basin soil is that of St. Thomas in the Vale of St. Catherine. Others are the Westmoreland Basin, the Queen of Spain's Valley on which is Hampden Estate and the Oxford Basin in St. Elizabeth. Sugar cane is the most important in these areas. The soils that have been differentiated in these basins are:

No. 61. Linstead Clay Loam
No. 64. Rosemere Fine Sandy Loam

61. Linstead Clay Loam. This is a mature soil developed over all inland basin deposits particularly in the basin of St. Thomas in the Vale. The topsoil is a reddish brown clay loam with a large amount of small iron concretions 'shot'. At from 4 inches to 7 inches it changes to a red clay which also contains concretionary materials which generally become fewer and softer with depth. At 18 inches yellow brown mottling begins until at about 3 feet depth the soil becomes an intensely mottled red and grey heavy clay. The soils are very acid in reaction with pHs as low as 4·0 and are generally very deficient in available phosphates and potash. These soils respond to liming and the application of phosphates particularly on local phosphate fertilizer. Sugar cane is grown extensively on this soil but it is undoubtedly more suitable for crops that prefer an acid soil such as citrus, pineapples, cocoa.

Drainage is another limiting factor to high production of crops and graded drains emptying into well grassed main channels are very necessary on this soil type. Successful management also depends upon being able to produce an adequate depth of free-draining surface soil and this can be attained by carefully ploughing up a limited amount of the mottled subsoil each time the land is cultivated. It is most important that deep ploughing and the bringing up to the surface of large amounts of the subsoil should not be attempted.

64. Rosemere Fine Sandy Loam. On the moderate slopes and on flat hilltops in the interior basins there is formed a brown or pale brown, fine sandy loam with very weak structure and which is very susceptible to erosion. At from 6 to 12 inches the fine sandy loam passes into deep yellow brown clay with grey mottling. The areas of this soil type are very limited and due to its low fertility are often left in poor ruinate to be used as pasture for communal grazing.

(iv) The Alluvial Series of Soils

Old and recent alluvium of marine and river origin make up large areas on the southern coast of the Island. The Liguanea Plain, the St. Catherine and Clarendon Plains and the lower St. Elizabeth Plain may be treated separately due to the different formations from which they have been formed.

The Liguanea Plain on which the city of Kingston stands, is made up chiefly of coarse and pebbly alluvium which was laid down by the Hope River when this river flowed across the plain to the sea. Liguanea alluvium is free-draining and large amounts of humic material are needed for crop production. Nitrogen is the most important plant nutrient for crop production.

The South Clarendon and St. Catherine plains are made up of varying deposits, the most important being the marine clays and the alluvium of the Rivers Cobre and Minho. The St. Elizabeth plain consists of pebbly marls and marshy alluvium. The Black River flows through this plain and rice is the only crop that could be grown in the area.

Recent river alluvium occurs at the mouth of most of the large rivers of the island the alluvium of the Plantain Garden, Swift, Montego Bay and Wag Water is both fertile and easy to till. Large banana and sugar cane cultivations are established on these alluvia. The alluvial soils that have been differentiated so far may be classified as follows:

Loams or Gravelly Loams over Sandy or Gravelly Material

10 Berkshire Stony Sandy Loam
11 Berkshire Sandy Loam
17 Heartease Gravelly Loam
— Gravelly Loam of Liguanea Plain
— Clay Loam of Liguanea Plain.

Poorly Drained Clays with Grey or Mottled Subsoils, not saline (Old Alluvium)

223 Cotton Tree Sandy Loam
Grey Clay of Coastal Plains
212 Lodge Clay Loam
220 Sydenham Clay Loam
Ferry Silty Clay
102 Trout Hall Sandy Clay
224 Innswood Clay
221 Sydenham Sandy Loam
203 Four Paths Clay
222 Springfield Clay
226 Morgan's Clay Loam

Poorly Drained Saline Clays (Marine Clay)

210 Churchpen Clay
213 Lodge Clay Loam (saline)
217 Bodles Clay Loam
202 Rhymesbury Clay
204 Four Paths Loam

Well Drained or Fairly Well Drained Loamy or Sandy Soils on Recent Alluvial Flood Plains

6 Tulloch Sandy Loam
15 Cave Valley Clay Loam
16 Riverhead Gravelly Loam
18 Yallahs Stony Loam
19 Yallahs Loam
215 Colbeck Sandy Loam
24 Agualta Sandy Loam
124 Whim Sandy Loam
128 Caymanas Sandy Loam
Mears Sandy Loam

Well Drained or Fairly Well Drained Clays on Recent Alluvial Flood Plains

127 Caymanas Clay Loam
21 Water Valley Silty Clay
25 Fontabelle Clay Loam
106 Lluidas Gravelly Loam
Soil in Terrace Position Similar to 25
Stony Phase of 25
125 Whim Clay Loam
7 Tulloch Silty Clay

Poorly Drained Clays on Recent Alluvial Flood Plains

13 Rosehall Clay
28 Frontier Clay
14 Sterling Silt Loam
12 Wallens Silty Clay Loam
126 Ferry Silty Clay Loam
Tulloch Silty Clay Loam

The following is a description of one of the more important soils in each group:

Berkshire Sandy Loam. This soil occurs over recent alluvium in some small valleys near the northern edge of the St. Thomas–Ye-Vale Basin.

This alluvium is derived from limestones and andesitic rocks of the northern slope of the basin and is of a sandy and gravelly nature.

On nearly flat land in narrow valley bottoms this soil has a topsoil of brown sandy loam of weak structure. This topsoil grades into a deep subsoil of similar nature but paler in colour and often containing much gravel.

Some of the small extent of this soil is in ruinate but much is in cane. This soil is suitable for many crops—cane, citrus, cacao, coffee are probably the best.

Sydenham Clay. This is a soil that occurs over very large areas of old alluvium mainly west and south-west of Spanish Town on the St. Catherine Plains.

The topsoil is black or very dark grey brown clay with coarse strong blocky structure and often small white specks throughout. This topsoil is deep-cracking and very hard when dry but very sticky when wet. At 4 to 9 inches is a change to pale brown to pale brownish grey clay with weak structure and abundant white speckling. This changes to sandy clay of similar colour with depth, and this sandy clay in turn changes at from 24 to 60 inches into yellow brown loose sand.

This is a soil of very poor internal drainage and its present uses of cane, rice and grass are recommended. Where irrigation water is available much of the area under grass could be more intensively used by rice.

Rhymesbury Clay. This is a saline soil found on flat land over old alluvium mainly in the north-eastern part of the plains of Vere.

A dark brown clay topsoil of weak structure overlies at 18 to 24 inches structureless yellow-brown clay which may have some small black shot at the top and some fine orange mottles below. At lower depths there may be layers of loose gravelly sandy loam.

This is an acid soil, acidity increasing with depth. It is a soil of medium to low fertility. It is a soil of extremely poor internal drainage and it may be highly saline below 12 inches. Hence it is a soil of few uses and difficult to farm. Rice is one of its best uses, and with weathering and drainage to reduce salt content, it is a reasonable soil for cane cultivation.

Caymanas Sandy Loam. This is a deep recent alluvial soil found over the recent alluvium of the Rio Cobre River on the St. Catherine Plains south, south-east and east of Spanish Town.

A dark brown to brown sandy loam topsoil of moderate structure is followed at 8 to 12 inches by a yellow brown sandy loam of weak structure. This passes at 18 to 30 inches into very deep fine sandy loam or loamy sand, paler in colour and almost structureless.

This is a rich fertile soil, alkaline throughout, and of high nutrient status. Given irrigation water, it is a soil of very varied uses and great possibilities. With its very good internal drainage, it is a fine soil for sugar-

cane, bananas and coconuts. If cultivated for long periods without rotation loss of organic matter means deterioration of the structure of its topsoil.

Fontabelle Clay. This soil is found over recent alluvium mainly derived from Richmond Beds and soft limestones and their soils. It is found on almost flat situations in valley bottoms. This is a dark olive brown or very dark brown clay or clay loam with good structure, and often with many small white specks. This is an alkaline topsoil passing at from 8 to 20 inches into very alkaline pale yellow brown or pale brown silty clay or silty clay loam with weak structure and high free lime content.

This is a soil of high fertility and of moderate to good internal drainage. Most of its extent is at present occupied by bananas or cane, for both of which it is eminently suitable.

Rosehall Clay. This soil is found over recent alluvium in some river valleys in interior basins. This recent alluvium is mainly derived from limestones and their soils and from interior basin soils. Usually, on flat land this soil has a grey brown clay or clay loam topsoil of moderate structure. At from 4 to 8 inches this passes into a paler brown clay of poor structure with grey and yellow-brown mottling. Small brown shot may be common in this deep subsoil.

This is an acid soil of low to moderate fertility, and of poor to very poor internal drainage. There may be an actual watertable at depths varying from 20 to 45 inches. Much of this soil is at present in cane or mixed ground crops. Cane (if drained) and improved pasture are probably its best uses, although if water is available rice could be grown well.

Description of Soil Areas

The following list contains a short description of each of the areas shown on the map on page 100, along with the approximate area and some notes about soils and slopes. Soil names, where used, are those of the Soil Survey. Acreages given are rough approximations.

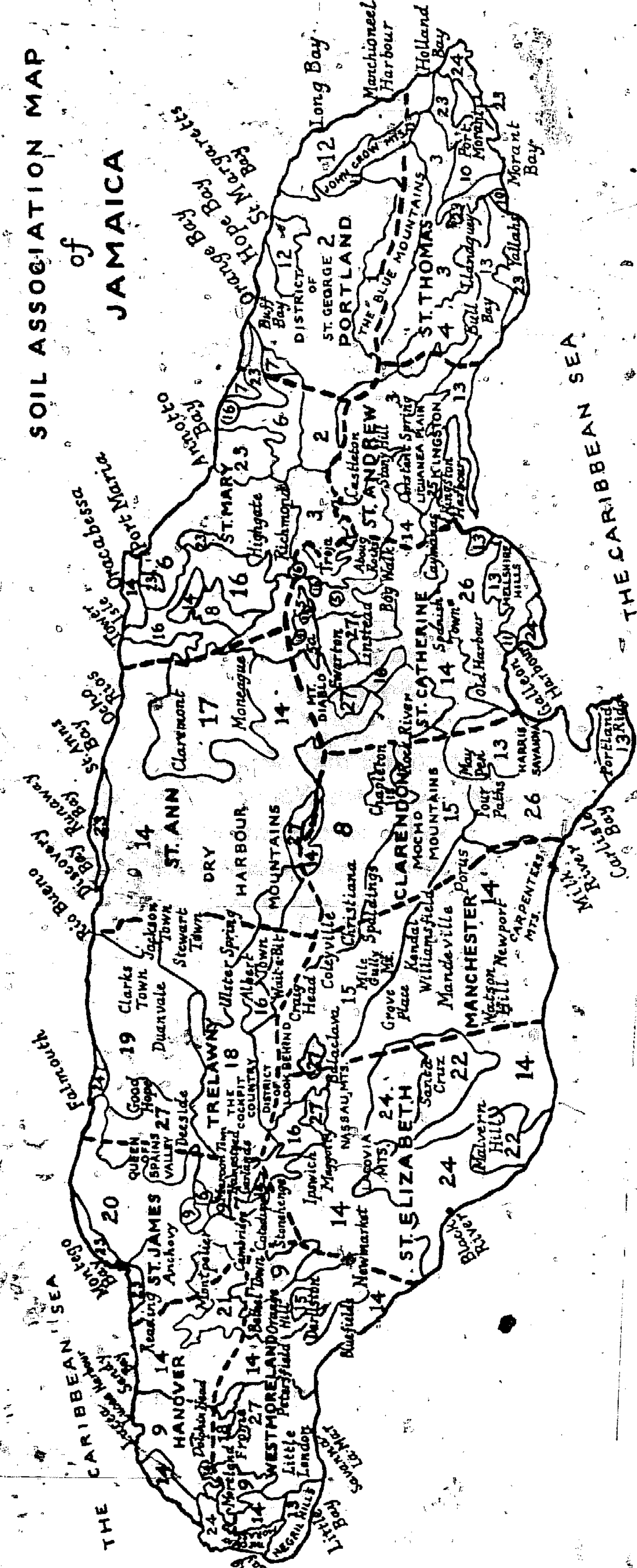
A. Mountains and hills of shale, conglomerates, tuffs, or igneous rocks

1. Blue Mountain area; Hall's Delight soils. 69,300 acres (2·4% of Jamaica). Steep mountain slopes, most of them above 4,000 feet, covered with forests. Soils are shallow and contain a high proportion of small rock fragments, which usually are shale or schist.

2. Moist, steep, chiefly shale hills, north east of Blue Mountain; Hall's Delight soils. 71,900 acres (2·5% of Jamaica). Shallow soils, full of small rock fragments, on steep slopes in moist climate. Well suited for trees.

3. Moderately dry, steep, shale and conglomerate hills, south and west of Blue Mountain. Hall's Delight, Cuffy Gully. 118,000 acres (4%). Shallow soils, full of rock fragments, on shale or purple conglomerate.

SOIL ASSOCIATION MAP of JAMAICA



A. Mountains and Hills of Shale Conglomerates; Tuffs or Igneous Rocks.

1. Blue Mountain area, Hall's Delight soils. 69,300 acres, 2·4% of Jamaica.
2. Moist steep, chiefly shale hills, north-east of Blue Mountains, Hall's Delight soils. 71,900 acres, 2·5%.
3. Moderately dry, steep, shale and conglomerates, Halls Delight, Cliffy Gully. 118,000 acres, 4%.
4. Steep hills and mountains, Newcastle porphyry sill, Valda soils. 18,000 acres, 0·6%.
5. Steep hills of deeply weathered granite [illegible] River soils. 69,300 acres, 2·4%.
6. Moderately sloping, well-drained soils on shale of Richmond Beds, Belfield-Highgate, Marymount. 57,800 acres, 2%.
7. Moderately sloping or steep shale hills of yellow limestone formation, Wait-a-Bit soils. 16,700 acres, 0·6%.
8. Centrally hilly area of conglomerates, tuffs and shales, Halifax-Donkington-Wait-a-Bit soils. 139,900 acres, 4·8%.
9. Soils formed from shales and tuffs and conglomerates Belfield, Marymount, Wait-a-Bit, Halifax. 86,000 acres, 2·9%.

B. Mountains, Hills and Moderate Slopes of Limestone.

10. Moderately sloping soils, soft limestone or shale, Killancholly-Nonsuch-Belfield-Highgate. 33,400 acres, 1·1%.
11. John Crow Mountains, steep mountains of limestone, wet climate. 18,000 acres, 0·6%.
12. Limestone hills, moist climate, Bonnygate, Killancholly and Nonsuch. 53,000 acres, 1·8%.
13. Dry limestone hills, dry climate, Bonnygate-Killancholly. 118,000 acres, 4%.
14. Rocky limestone hills, red soils in valleys, Bonnygate-St. Ann. 886,900 acres, 30·2%.
15. Rocky limestone hills, brown soils on slopes, valleys, Bonnygate, Chudleigh. 136,000 acres, 4·6%.
16. Moderately sloping or steep slopes on soft limestone yellow formation, Carron Hall, Wait-a-Bit. 105,200 acres, 3·6%.
17. Gently or moderately sloping red soils, rocky limestone hills, St. Ann, Bonnygate. 43,600 acres, 1·5%.
18. Limestone hills and sinks, Cockpit Country, Bonnygate. 132,200 acres, 4·5%.

B. (continued)

19. Limestone hills, generally well-drained basins, dry climate. 65,500 acres, 2·2%.
20. Dry limestone hills. 44,900 acres, 1·5%.
21. Moderately sloping soils, flinty limestone, poor drainage. 39,800 acres, 1·4%.
22. Red soils, gentle or moderate slopes, dry climate, St. Ann, Bonnygate. 24,000 acres, 0·8%.

C. Plains, Basins and Valleys.

23. Recent alluvial plains. 41,000 acres, 1·4%.
24. Swamps and adjacent plains. 113,000 acres, 3·8%.
25. Gravelly, sloping, alluvial fan, moderately dry climate. 20,500 acres, 0·7%.
26. Gently sloping plains, poorly drained, dry climate. 166,900 acres, 5·7%.
27. Gently sloping basins, imperfectly drained. 247,700 acres, 8·4%.

Many steep fields are cultivated, and serious erosion occurs. Many trees will grow, although not as rapidly as on the north side of the mountains.

4. Steep hills and mountains, Newcastle prophyry sill. Valda soils. 18,000 acres (0·6%). Light coloured, easily eroded soils, often containing numerous angular rock fragments a few inches in diameter. Soils are deficient in most nutrients, especially where the original topsoil has been lost by erosion. Slopes over 20 degrees are subject to rapid erosion if cultivated.

5. Steep hills of deeply weathered granitic rock (granodiorite); Flint River soils. 69,300 acres (2·4%). A characteristic pattern of steep, sharp ridges nearly uniform in height. Soils now consist almost entirely of weathered light coloured rock, a sandy loam that contains very little organic matter. Good land for most trees. Slopes over 20 degrees are subject to rapid erosion if cultivated.

6. Moderately sloping generally well drained soils on shales of Richmond Beds; Belfield-Highgate-Marymount. 57,800 acres (2·0%). The principal soil, Belfield Clay, is a shallow, well drained soil over extremely weathered, soft, slightly calcareous shale that is permeable so that the soil, functionally is moderately deep or deep. Much of the land is in a fairly moist climate and is used intensively for bananas. Soils with imperfect or poor drainage, the Highgate and Marymount soils, occur on some of the ridges and benches. They are less suited for bananas, but will grow fairly good grass. Cultural methods especially on many of the banana plantations, permit considerable soil erosion.

7. Moderately sloping or steep shale hills of the Yellow Limestone formation; Waitabit soils. The areas designated as number 7 on the map amount to approximately 16,700 acres (0·6%). Large bodies of similar land, however, occur within area 8, the central hilly area of conglomerates, tuffs and shales. Slopes are moderate to steep, not many of them over 30 degrees. Soils are generally imperfectly drained, extremely erodible, and if eroded are low in most of the plant nutrients. Small outcrops of limestone which give Carron Hall soil occur throughout these areas. Carron Hall Clay is the principal soil of area 16. The soils are easily cultivated and are much used for food crops. The shales that form these soils are generally not calcareous, although considered by geologists as part of the yellow limestone formation.

8. Central hilly area of conglomerates, tuffs, and shales, Halifax-Donnington, Waitabit. 139,900 acres (4·8%). The long, steep or moderately steep slopes of this area are covered for the most part with rather thin soils formed by weathering of the rock underneath. On some of the ridges and upper slopes the original topsoil and subsoil were underlain by deeply weathered rock of silty texture that had a characteristic mealy feel and is mottled with red, grey and often pink colours. This material is

extremely erodible, low in nutrients, and unsatisfactory as soil material in many respects. It is easily cultivated and is used to some extent for yams and other food crops. Rehabilitation of severely eroded areas will be difficult. In parts of this area there are considerable spots of Waitabit soils with scattered limestone outcrops that are described under area 7.

9. Western areas of soils chiefly from shales but with some tuffs and conglomerates, moderate to steep slopes; Belfield-Marymount, Waitabit, Halifax. 86,000 acres (2·9%). Most of the areas designated by symbol 9 contain a mixture of the types of land described under areas 6, 7 and 8. Soil materials are shales, clay shales with occasional limestone outcrops, conglomerates, and in some places tuffaceous rocks. Slopes are generally moderate and steep, and erosion in some places has been extremely severe. The climate is generally moist or fairly moist and suitable for growing most of the common crops.

B. Mountains, hills and moderate slopes of limestone

10. Moderately sloping soils on soft limestone or shale; Killancholly-Nonsuch, Belfield-Highgate. 33,400 acres (1·1%). This area in the vicinity of Port Morant in St. Thomas appears to consist for the most part of thin soils on soft limestone, some of them poorly drained. There are also soils on shales similar to those described under area 6. The climate is moist and most of the land is used for cultivation of bananas or cane. Some soil erosion has occurred but erosion in general is not as severe as in many other areas.

11. John Crow Mountains. 18,000 acres (0·6%). Steep mountains of limestone. Wet climate.

12. Limestone hills, moist climate. 53,900 acres (1·8%). Bonny Gate, Killancholly and Nonsuch soils.

13. Dry limestone hills near southern coast; Bonny Gate-Killancholly. Mountains, hills or gentle slopes in dry climate, mostly covered with bush or poor forest, along the southern coast of the eastern half of the Island, and also on the extreme western tip. Thin rocky soils of low capability. Some areas between May Pen and Old Harbour have been planted to sisal.

14. Rock limestone hills, with red soils on slopes and in valleys; Bonny Gate-St. Ann. 886,900 acres (30·2%). This area includes most of the white limestone country of Jamaica. The rocky limestone hills are not suitable for cultivation but will support poor forest in the crevices where some soil has accumulated. The valleys between the rocky hills consist mostly of St. Ann Clay Loam, a uniform red, moderately acid soil that fixes phosphate readily, has little moisture-holding capacity, and is difficult to manage as an agricultural soil. It is not highly subject to erosion but if the topsoil, which contains a little organic matter is washed away, the remaining red soil does not respond readily to cultivation and other treatment. This area

as outlined on the map includes a considerable range of climatic variations from southern Manchester and St. Elizabeth to northern St. Ann. Further sub-division may be necessary in order to express more adequately some of these differences if they are found to be significant.

15. Rocky limestone hills, with chiefly brown soils on slopes and in valleys; Bonny Gate-Chudleigh. 136,100 acres (4·6%). Area 15 has a slope pattern similar to that of area 14, but the soil in many of the valleys is brown rather than red. The brown soil has many properties in common with the red soil but is somewhat better supplied with plant nutrients and is a better agricultural soil. Like the red soil it is somewhat acid. As stated elsewhere, the boundary between the areas having dominantly red soils and those having dominantly brown soils has been drawn only approximately and will need to be revised.

16. Moderately sloping or steep soils on soft limestone of yellow limestone formation; Carron Hall-Waitabit. 195,200 acres (3·6%). The agricultural importance of this area in Jamaica appears to be somewhat greater than its size would suggest. These soils often occur on the boundary between the white limestone and the shale or conglomerate. The principal soil is Carron Hall Clay, a dark brown soil with yellowish brown subsoil free from mottling that lies over soft limestone. The thickness of soil or subsoil over the lime is usually from 18 to 24 inches. Fragments of hard limestone are common in the soil or on the surface. The soil is fairly well supplied with plant nutrients. It is good for many crops but since the subsoil is alkaline, should not be used for crops that require an acid soil. It is not highly erodible, and slopes up to 30 degrees may be used for occasional cultivation if suitable precautions are taken.

17. Gently or moderately sloping red soils with some steep rocky limestone hills; St. Ann-Bonny Gate. 43,600 acres (1·5%). Several valleys, most of them in Eastern St. Ann, consist of gently or moderately sloping, rather deep red soils between limestone hills. The soils and slopes are the same as those of area 14, but the pattern is one of a greater proportion of gently sloping land. A considerable amount of this land has been acquired by the bauxite companies.

18. Limestone hills and sinks. 'Cockpit Country'. Bonny Gate. 132,200 acres (4·5%). The Cockpit Country consists chiefly of rock limestone hills with red soils in the narrow valleys and sinks. Most of it is covered with forests.

19. Limestone hills and gently sloping, generally well drained basins, dry or moderately dry climate. 65,500 acres (2·2%). The limestone hills of this area are used mostly for rather poor forests. Annual rainfall is less than 60 inches over most of the area and the dry season lasts for 3 or 4 months. Many of the basins contain well drained acid clay soils with excellent structure in the subsoil that are fairly good cane soils.

20. Dry limestone hills near northern coast. 44,900 acres (1·5%).

Generally shallow soils and rather dry climate. Used chiefly for pasture with some cultivation in favourable locations.

21. Gently or moderately sloping soils partly on flinty limestone, some with poor internal drainage. 39,800 acres (1·4%). These gently or moderately sloping areas in Hanover and Westmoreland consist in part of clay soils that have poor internal drainage. There are also brown soils that appear to have good internal drainage at present but contain concretions ('shot') apparently left over from a former poorly drained condition. These well drained brown soils resemble the brown bauxite materials. Some of the soils contain numerous flint fragments.

22. Red soils, chiefly gentle or moderate slopes, dry climate; St. Ann Clay, some Bonny Gate. 24,400 acres (0·8%). Two areas of red soils in Southern St. Elizabeth consist chiefly of gentle or moderate slopes with only occasional rocky hills. They are the Pedro Plains, and the gently sloping area between the Santa Cruz Mountains and Spur Tree Hill.

C. Plains, basins and valleys

23. Recent alluvial plains and narrow, nearly level plains along coast. Alluvial soils. 41,100 acres (1·4%). Area 23 contains some of the largest bodies of alluvial land in Jamaica. Other important areas of recent alluvium, however, occur within area 26. Some also occur in narrow bends along of the streams and cannot be shown on a map of this scale. These are some of the best soils of Jamaica, nearly level, not subject to erosion, and excellent land for many different crops.

24. Swamps and adjacent plains. 113,000 acres (3·8%). These areas consist of swamps of St. Elizabeth, the Negril swamp in the West End, a small area at Falmouth and the swamp of the East End at Morant Point.

25. Gravelly, sloping, alluvial fan, moderately dry climate. 20,500 acres (0·7%). This is the sloping gravelly alluvial fan known as the Liguanea Plain. Soils are loams or clay loams over more or less stratified sand and gravel. Climate is somewhat dry with rainfall ranging from less than 40 inches to as much as 60 inches in some places, and with an intense dry season of 3 or 4 months.

26. Gently sloping plains, chiefly imperfectly or poorly drained soils, dry climate. 166,900 acres (5·7%). This area includes the plains of St. Catherine and Clarendon. Soils for the most part are imperfectly drained cluas, some of them wet and difficult to drain. There are, however, considerable areas of recent alluvial soil that are highly productive. A considerable acreage is irrigated by the Rio Cobre works, and by the canals recently built in the Mid-Clarendon Irrigation district. Some water for irrigation is also obtained from wells. Although the area is commonly called a plain, most of the land has enough slope to make efficient irrigation by surface methods difficult.

27. Gently or moderately sloping basins; chiefly imperfectly drained soils. 247,700 acres (8·4%). The four largest of these important agricultural areas are the Westmoreland Basin, Queen of Spain's Valley, Bog Walk Basin, and Lluidas Vale. Soils are generally gently or sometimes moderately sloping, and imperfectly or poorly drained with slowly permeable mottled subsoils. Cane is grown on much of the land. Sloping land is subject to soil erosion, although it can be protected fairly easily with good cultural methods.

Land Capability Classification of the Soil Groups and Slope Classes

Soil Group	*A* 0–2°	*B* 2–5°	*C* 5–10°	*D* 10–20°	*E* 20–30°	*F* 30° *or more*
A. Soils on shale, conglomerate, tuffs, or igneous rocks						
A1. Thin soils on purple or volcanic conglomerate	—	—	—	IIIe	IVe	Ve
A2. Thin soils on shale	—	—	IIe	IIIe	IVe	Ve
A3. Moderately deep, fairly well drained soils on shale	IIs	IIs	IIe	IIIe	IVe	Ve
A4. Poorly drained upland clays, mottled subsoils	—	IIw	IIIe	IIIe	IVe	Ve
A5. Soils on granitic rocks or porphyry	—	—	IIIe	IVe	Ve	Ve
A6. Sandy or gravelly soils	IIIs	IIIs	IIIe	IVe	Ve	Ve
A7. Clay soils on deeply weathered tuffs or conglomerate	IIs	IIs	IIIe	IVe	Ve	Ve
B. Soils on limestone						
B1. Red bauxite	IIIs	IIIs	IIIe	IVe	IVe	Ve
B2. Brown bauxite	IIs	IIs	IIe	IIIe	IVe	Ve
B3. Moderately deep brown plastic soils on limestone	—	IIw	IIe	IIIe	IVe	Ve
B4. Very thin brown or reddish soils on hard limestone	—	—	—	Vs	Vs	VIs
B5. Thin soils on soft limestone	IIw	IIw	IIe	IIIe	Ve	Ve
B6. Very thin soils on soft limestone or coral, dry areas	VIc	VIc	VIc	VIc	VIc	VIc
B7. Dark coloured, imperfectly drained clays on soft limestone	IIw	IIw	IIe	IIIe	—	—
C. Soils of coastal plains, inland basins, a. alluvial valleys						
C1. Loams or gravelly loams over sand and gravel	IIIc	IIIc	IIIc	—	—	—
C2. Well drained soils in basins	I	I	IIe	IIIe	—	—
C3. Imperfectly or poorly drained soils in basins	IIw	IIw	IIe	IIIe	—	—
C4. Poorly drained clays, not saline	IIIw	IIIw	IIIw	—	—	—
C5. Poorly drained saline clay (marine clay)	IIIw	IIIw	IIIw	—	—	—
C6. Well drained loam or sandy recent alluvium	I	I	—	—	—	—
C7. Well drained heavy textured recent alluvium	I	I	—	—	—	—
C8. Poorly drained recent alluvium	IIIw	IIIw	—	—	—	—
C9. Shallow soils over cemented gravel (Hayes Beds)	—	VIs	VIs	—	—	—
D. Miscellaneous land						
D1. Rock outcrops, rock slides, stony riverwash, etc.	VII	VII	VII	VII	VII	VII

CHAPTER 7

Soil Science and Land Capability

We use land for agriculture by growing useful plants on it. Some plants require tillage, and tillage exposes the soil to erosion. Others, like some of the grasses, have fibrous roots that bind and protect the soil. Still others, like forest trees, grow best after a layer of leaf litter accumulates on the soil under them, and this litter protects the soil from rain and running water.

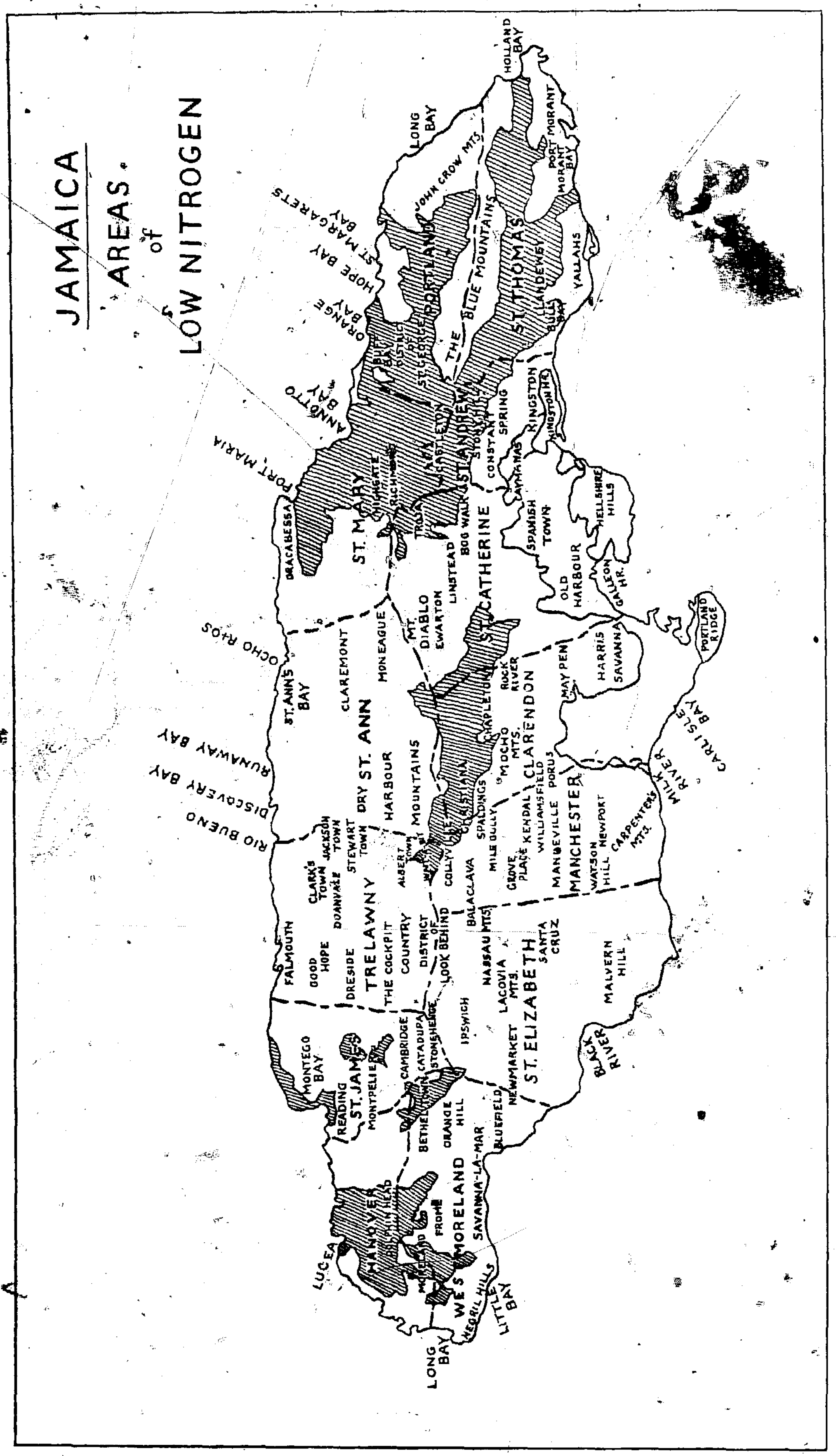
A soil is much more than a layer of topsoil that we can scuff with a foot or turn with a fork. Soils have thickness; each soil has a particular sequence of topsoil and subsoil layers. Soils occur on different slopes, and the steeper our land is, the greater the chance that it will wash away.

In soil conservation we are concerned with the behaviour of water. We all know that water runs downhill, that a rapid stream can carve a gully; and that grass in the bottom of a channel can help make water run slowly.

Some information about soils can also be obtained by making certain tests on soil samples. A soil test, however, gives us at the best only a small amount of the information that we need to use and manage our land intelligently. It reveals something about the nutrient status and lime requirement. Other important properties such as thickness of topsoil, structure of topsoil, presence of soggy, mottled subsoil, effective depth of root zone, slope of the land, degree of past erosion, and susceptibility to future erosion cannot be sampled but must be observed and estimated as we look at a soil outdoors.

Characteristics

A soil is part of the outer crust of the earth. It is a three-dimensional body, with area and thickness. It has shape, with a characteristic conformation or slope pattern. Internally, it usually consists of several layers, each having characteristic properties and thickness. When we want to predict how a soil is likely to perform, we look especially at such things as texture and structure of the topsoil, depth and water-holding capacity of the root zone, and permeability of the subsoil to water, air and roots. The supply of plant nutrients is fairly important, but can be modified more easily than the physical properties just named. Some soils contain fragments of gravel, stones or boulders. The five important factors that



influence soil formation are commonly listed as parent material, climate, vegetation and other organisms, land relief, and time. We expect to find different soils wherever there are differences in any one or more of these. Thus, on a single type of parent material, like the shales of the Richmond Beds, we find several soil types with distinctly different properties and potentialities.

Looking Inside

Each of us can learn, with a little practice, some of the ways of observing soils that are used by a soil scientist.

We must know more about a soil than we can learn by merely looking at the surface. We must look inside. To do so we must have a suitable tool to uncover the subsoil layers. An auger is often useful for this purpose, especially in identifying soils for routine soil mapping. An auger, however, is a totally inadequate tool for studying or sampling soils. It can be used where you merely want small samples of topsoil and subsurface soil for certain chemical tests. To study the succession of soil layers from the surface downward, we must dig a pit and then observe carefully the soil that is thus exposed. For much of our work we can dig quickly with a spade or fork a small pit 18 inches or two feet in depth, enough to see the topsoil and at least part of the subsoil. A fork is often better than a spade for loosening blocks of soil that we can study and take apart, because it causes less disturbance of the natural structure.

As soon as we have exposed for study a profile of undisturbed soil, we look at it carefully to see if we can distinguish different layers. In most soils we see a dark or at least fairly dark coloured topsoil, and one or more layers of lighter coloured subsoil. We want to observe at least four different items about each significant layer in the soil. Look first at the topsoil, and observe:

1. Texture. Texture, as used in the science of soils, refers to the proportions of particles of different size classes that make up the soil. We refer now to the individual particles after they are fully separated from each other, and not grouped into granules or other clumps. The size classes are sand, silt and clay. Sand grains can be seen with the naked eye, and have a gritty feel; silt particles are too small to be seen with the naked eye, but can be seen with a microscope. They have a floury feel, and when dry will usually retain a mould of your thumb print. Clay particles are of colloidal size, too small to be seen with a microscope. Soil physicists, however, have learned a great deal about size, shape, and composition of the particles that make up different kinds of clay. Clay particles make a soil sticky, and hold most of the water, and most of the plant nutrients that are held by the mineral components of the soil. A soil that contains 40% or more of the clay fraction, along with a mixture of silt and sand, is called a clay soil.

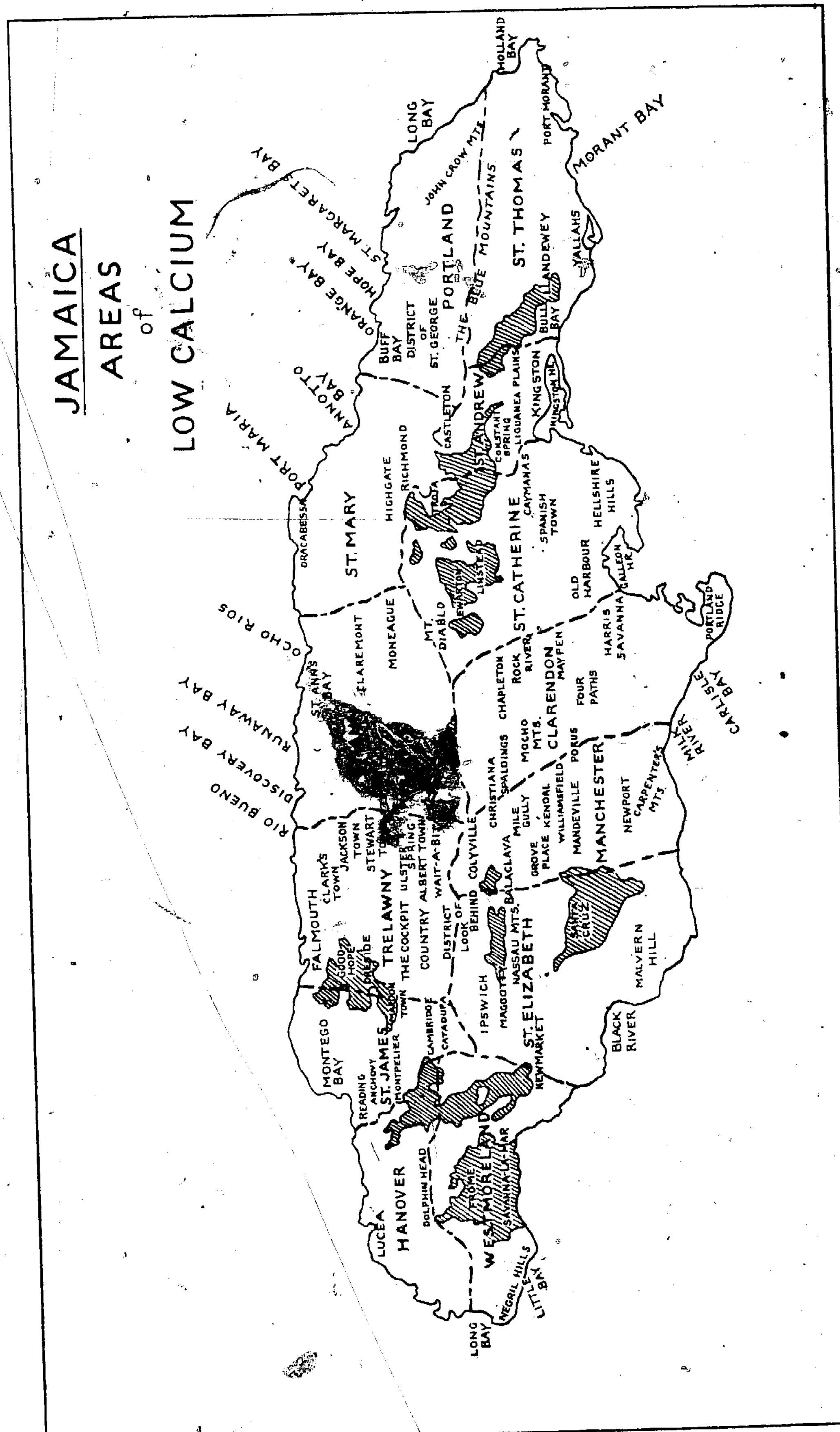
One that contains 70% or more of the sand fractions is called a sand or a loamy sand. Between these two extremes we have textures as sandy loam, loam, silt loam and clay loam. You should learn the feel of these different soil textures. Note that the term loam in soil science refers to soil texture. Another usage is common among farmers of Jamaica, who refer to a clay soil of good structure as a 'loamy' soil.

2. Structure. In most soils other than nearly pure sands, the individual soil particles stick together in lumps or aggregates of some kind. These aggregates usually have a characteristic size, shape, and durability. The structure is called by such names as blocky, platy, prismatic, granular, sub-angular blocky, or irregular angular blocky, according to the shape of the aggregates. A granular or crumb structure of durable (strong) grade is desirable in a topsoil. If a structure is weak so that the individual particles become dispersed easily, the soil is likely to become sealed, when hit by raindrops, then does not admit as much water as we would like, and washes away easily. Organic matter is extremely important in obtaining and keeping good soil structure. As you study your topsoil, see if it appears to have good structure. If subsoil has been turned up anywhere, has it weathered and slaked more completely than the topsoil?

3. Thickness. Observe the thickness of the topsoil. Has some subsoil been mixed with it by ploughing or forking? Do you think this is the original topsoil that was here before cultivation began? Is there much chance that the original topsoil has been made thinner by erosion, or thicker by deposits of material eroded somewhere above? Are there any indications that the present topsoil has been developed from former subsoil or underlying material by the process of cultivation or by vegetation?

4. Colour. Look carefully at the colour of the topsoil. It does not mean much in itself, but it is our best way of distinguishing topsoil from subsoil. When we examine subsoil we will find that the colour there tells us a great deal about the situation with respect to moisture.

After you have examined the texture, structure, thickness and colour of the topsoil, do the same for each of the deeper layers. Texture of the subsoil is often more sticky than that of the top soil; that is, the subsoil contains more clay. Structure sometimes is not as durable. An experienced person can estimate permeability of the subsoil fairly well from close observations of the structure. (Water moves mostly through cracks and pores, not through the soil mass.) Thickness of each layer is important, because a little later we want to judge the 'effective depth' of soil down to a layer that is likely to be unfavourable for roots or for movement of water. Perhaps most important of all, look at the colour of each subsoil layer. Wherever you see mottling, that is, variegated colours of gray, brown, often red, and sometimes nearly black, you can be sure that the soil is wet and soggy for at least part of the year. Often a highly mottled subsoil layer



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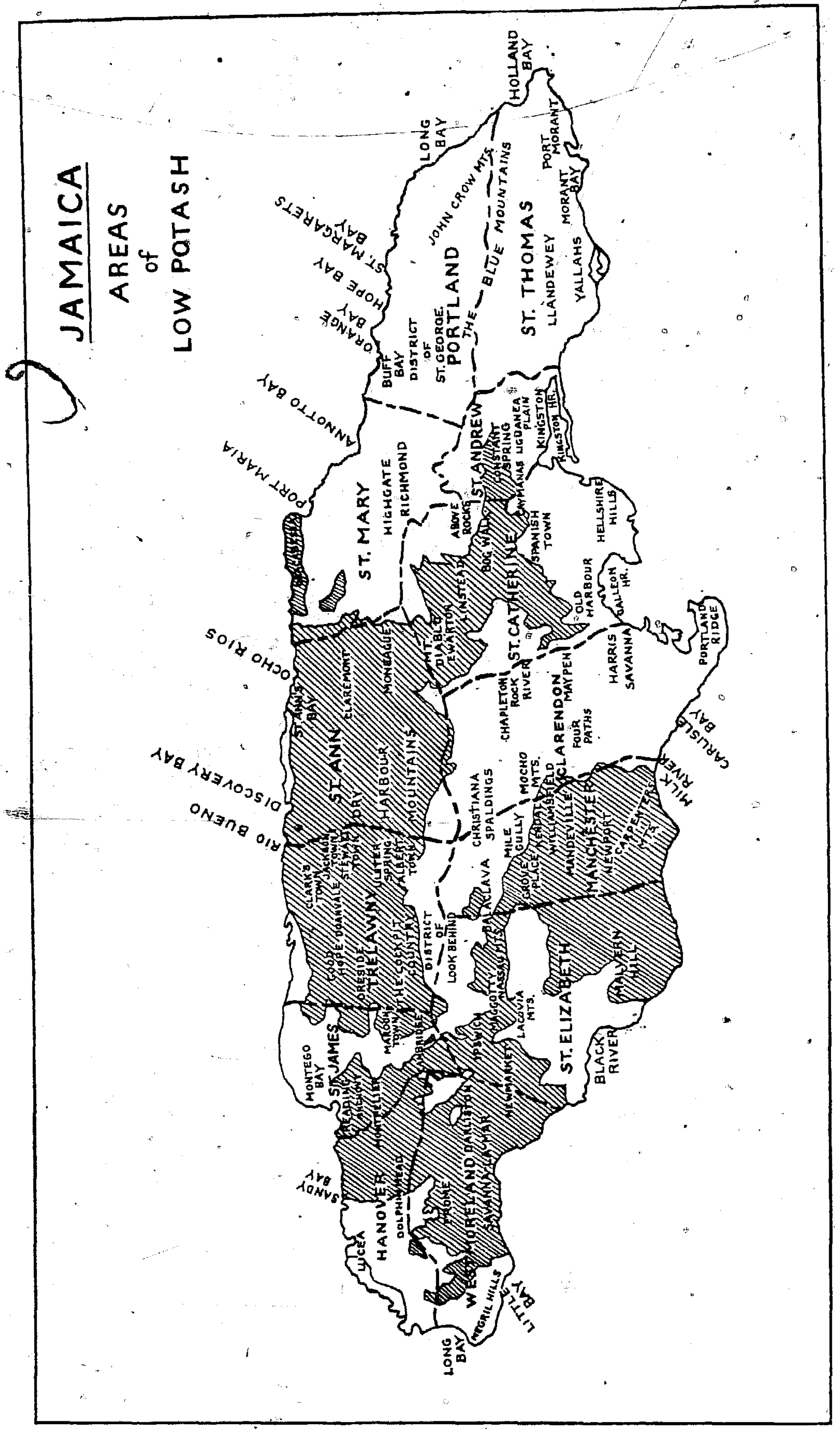


is not a favourable place for roots, and marks the bottom of our 'effective depth' of a good root zone.

Under the Subsoil

Look at the material under the subsoil. If you haven't time to dig your pit deep enough, bore into it with your auger. You will gradually learn that some soils are underlain by soft limestone, others by hard limestone, clay, weathered shale, or other materials. Incidentally, it is a good idea to have a soil auger, although one must know its limitations as well as its usefulness. The facts that we have learned about our soils and climate give us also a guide to how the land should be managed and the type of soil conversion works necessary for different soils, e.g., unless the soil shows signs of being naturally wet (mottling of the subsoil), there is no necessity to recommend contour drainage. If the soil has a good structure and takes in water easily (e.g. the red bauxite soils) contour drains again should not be recommended. Dependent on the type of soil and the distribution of rainfall, barriers of grass or undisturbed strips of land reinforced with quick stick may be the cheapest types of soil conservation needed on the land.

Look at the slope of the land. Which of the slope classes occurs at the site where you are standing? Remember you can measure slopes with a home-made protractor and plumb bob if you do not have an Abney level.

Look around you. How far away in each direction is there a change in the class of slope? Where would you expect to find a different soil?

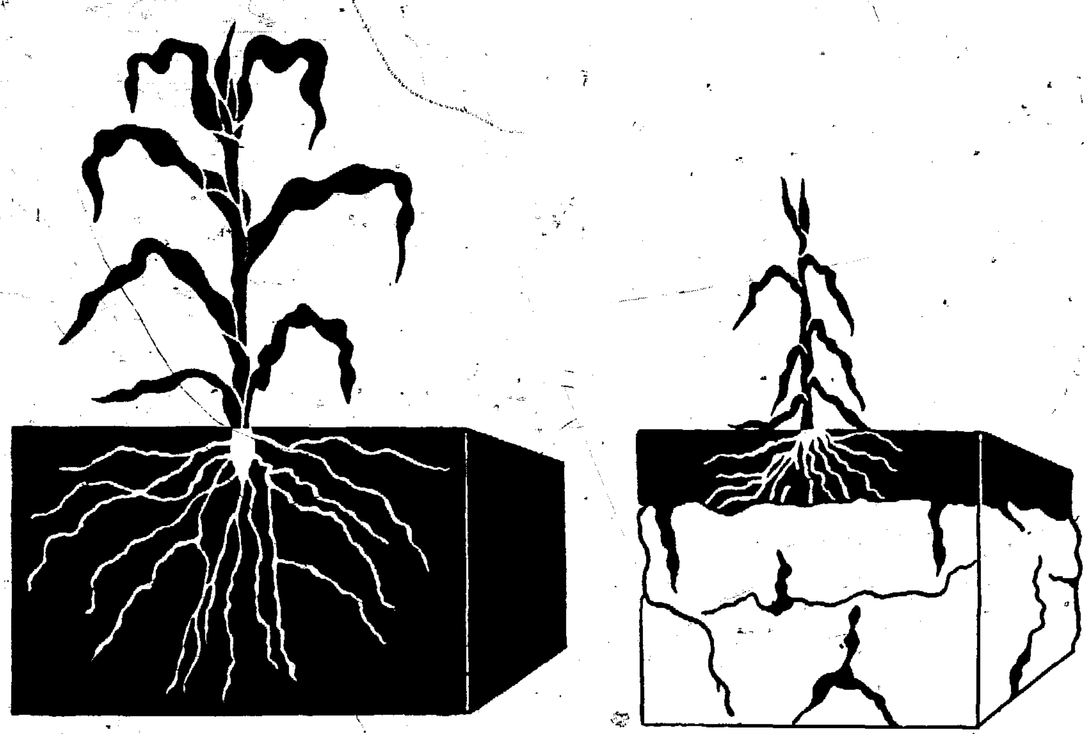
Think of what you know about the climate. Is the rainfall enough and does it come well enough distributed through the year to support a number of different crops? We cannot measure or map climatic factors precisely, but we need to consider them as we think about the capability of different kinds of land.

The Idea of Land Capability

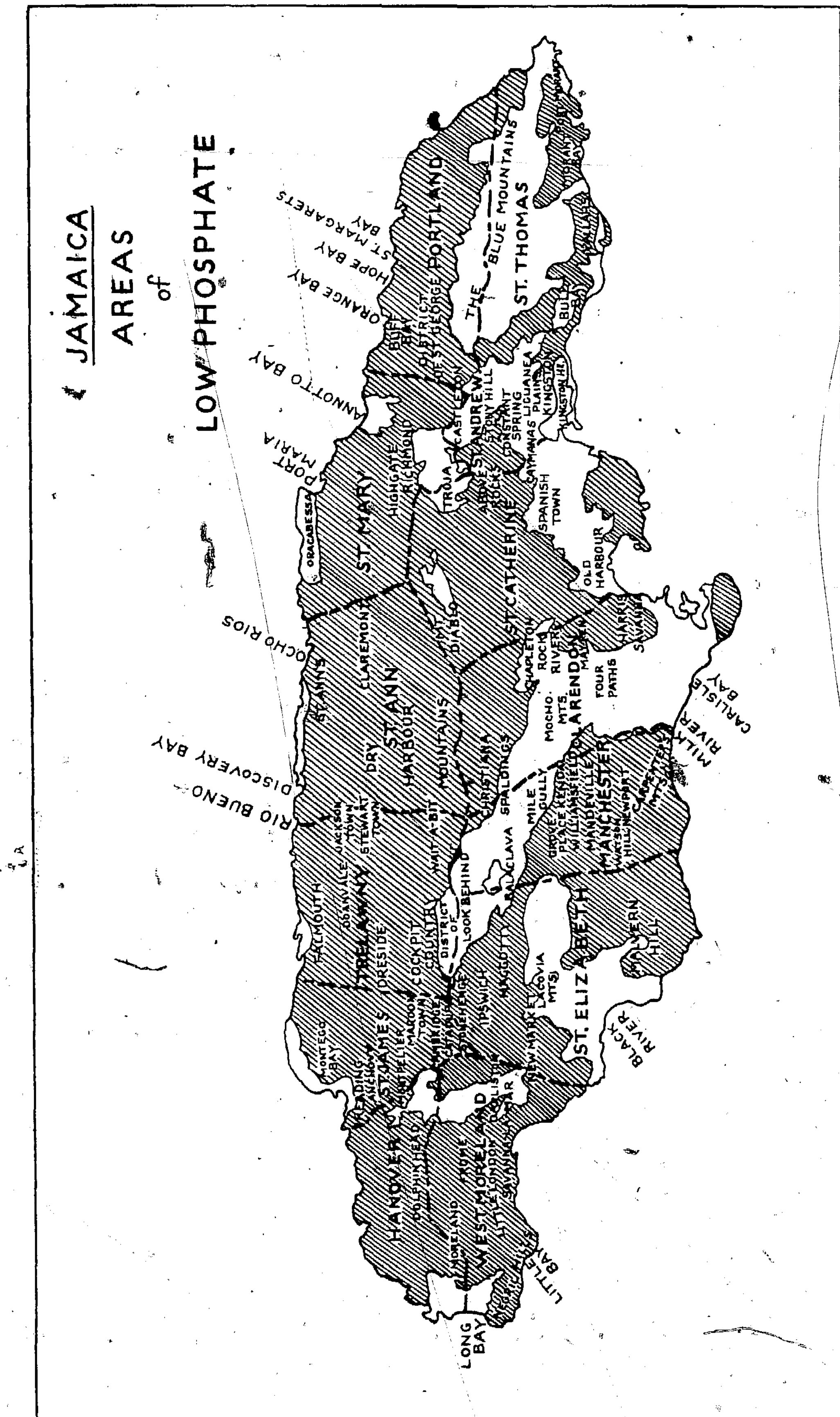
We can use the facts of the soil survey, plus the best information that we have about the climate, to classify different kinds of land according to their capability for use. In soil conservation work, as indeed in all land use, we are concerned with the relative suitability of land for several main types of use. Some land can be used for annual or short-term crops, which require preparation of the land, and perhaps also a tillage while the crop is growing; some is suited better for less intensive uses such as crops or pasture, which occupy the land for several years. Still other land is best used for perennial tree crops, which require control of undergrowth and in some cases, of shade trees, but can be managed without much disturbance of leaf litter and soil; and some should be in forest trees or bush, which once established are managed without any disturbance of litter or soil.

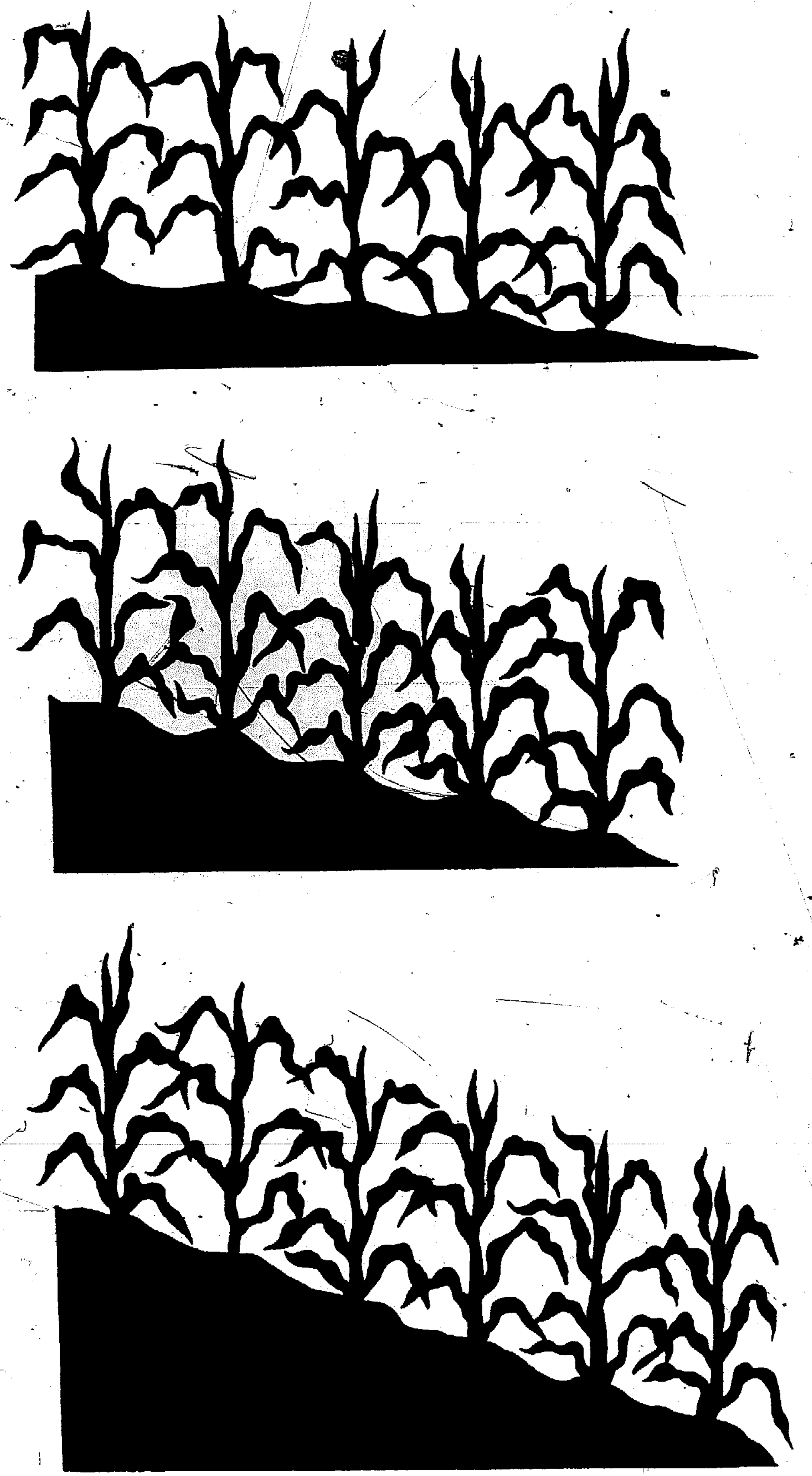
As we think about different kinds of land and their capability for these different uses, we find it convenient to think of a few broad classes of land capability. For this purpose we can make a broad grouping of the many kinds of land that occur in nature. We distinguish these broad classes according to total suitability of the land for crops, grass, tree crops or forest, rather than by specific qualities such as slope, degree of natural drainage, or depth of useful soil. The best land, almost ideal for cultivation or most other uses, is nearly level and not subject to erosion, well watered either by rainfall or irrigation, with a deep, productive, naturally well drained soil. Unfortunately, we do not have much of it in Jamaica. Some land might be moderately sloping so that erosion-control practices are needed to hold the soil in place. Other areas might be nearly level but somewhat difficult to manage because of soil-fertility problems. Still other land might be nearly level but difficult to manage and drain because the soil is a shallow heavy clay over fine-textured, chalky lime that functions fairly well as a subsoil but requires some care for adequate drainage.

Some land can be used for regular cultivation but requires a great deal of care to control erosion on rather steep slopes, or to cope with other natural limitations as the poor internal drainage of a dense, tight clay subsoil, the low water-holding capacity of a sandy or gravelly soil, or a combination of gravelly soil in a fairly dry climate. These types of land can be recommended for regular cultivation but are not as desirable for

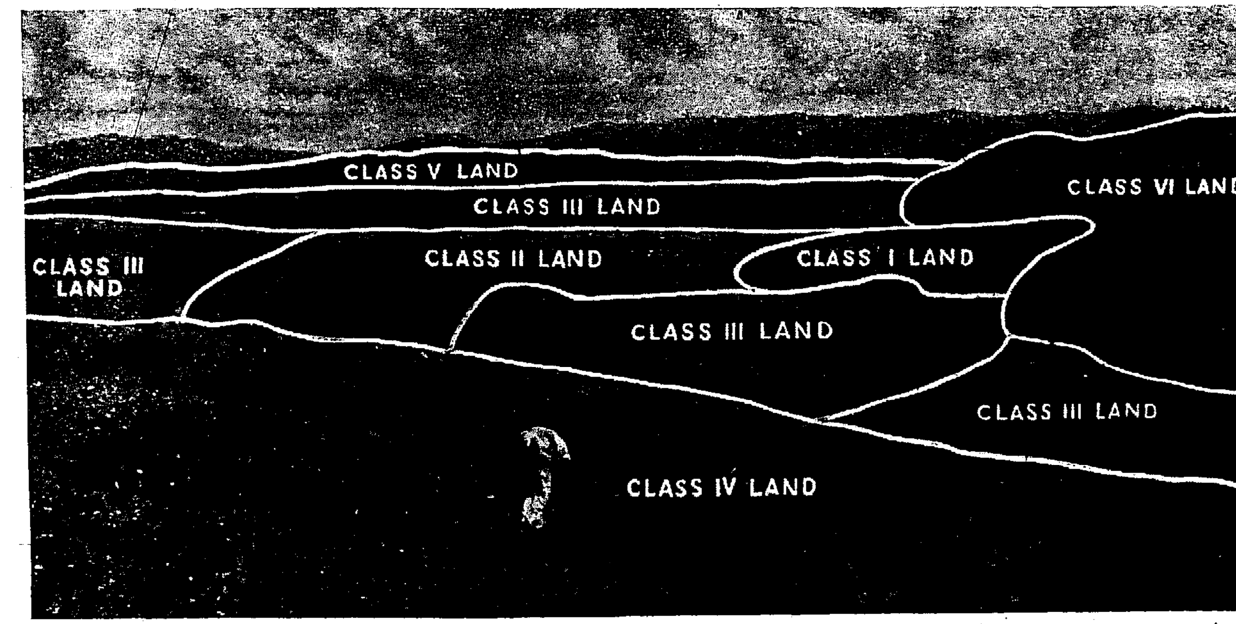


Effective depth of root zone makes a difference





Slope is important



all-round uses as others. Some kinds of land may be good for specialized uses, however. For example, some wet, nearly level land because of the difficulty of drainage may be better for growing rice than the better drained, more versatile classes of land.

Summary

The foregoing may be conveniently epitomized in twelve brief 'sermons' condensed into 'texts':

1. Know your land and make good use of it. The nature of your land affects the crops you can grow best.

Your need for fertilizer.

Your soil conservation practices.

2. Soil makes a difference. Learn to look inside your soil. Find out the thickness of the topsoil. Determine the depth of useful root zone. Find out the nature of the subsoil. Plants grow best on deep soils.

3. Erosion is active on much of the land in Jamaica. Has part or all of the original topsoil been washed away from your land? Are there any gullies on your sloping land?

Soil Conservation and Fertilizers will help to restore the fertility of your lands.

4. Slope is important. Soil will wash away on sloping land if water is not controlled. Slopes over 30° are sure to wash severely if cultivated.

On some soils, over 20° will also wash.

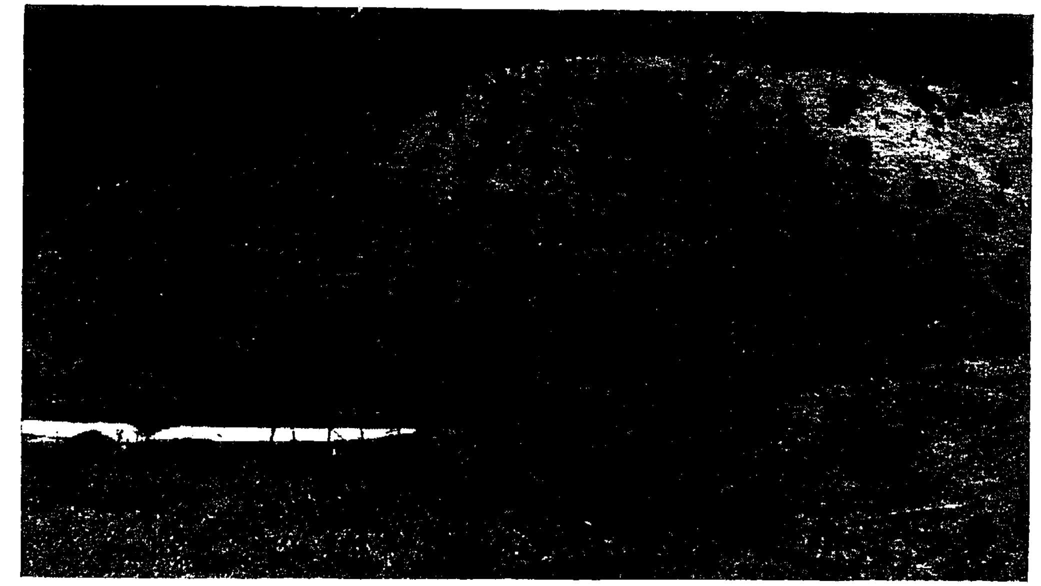
Slopes from 20° to 30° of most soils must be cultivated with extreme care.

Slopes from 5° to 20° need soil conservation practices.

Class I Land (see page 119)

5. Does your soil need drainage? Most heavy lands need it. A mottled subsoil is a sure sign of poor drainage. Contour drains should be used to remove excess water from land that needs drainage.

Class II Land (see page 120)

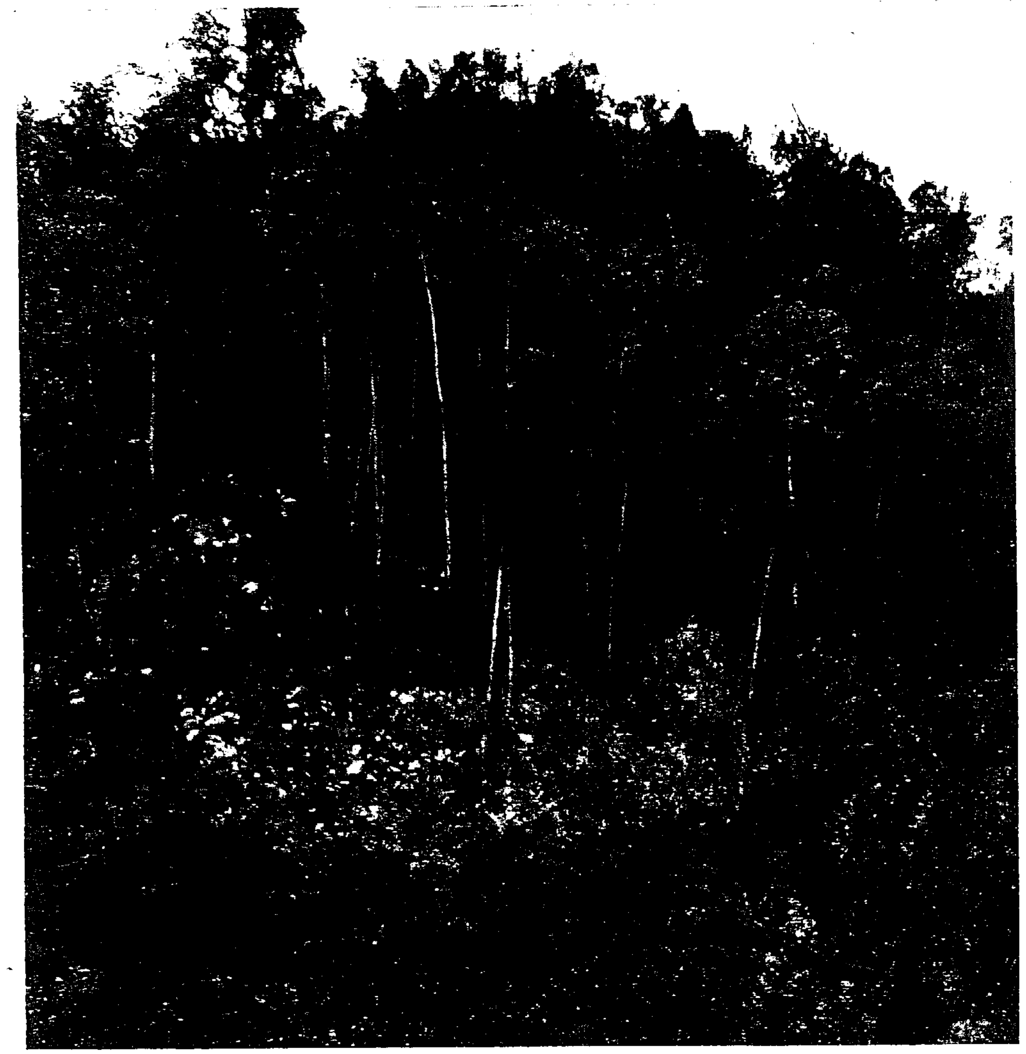


Class III Land (see page 120)

6. The soil survey is a record of facts about land.
The soil type;
The class of slope;
The degree of soil erosion;
These facts and the climate give us a good idea of land capability.

7. Class I Land. Level land with a deep fertile soil well watered either by rainfall or irrigation, which may be cultivated without the risk of erosion. This type of land is well suited for intensive cropping.

Class IV Land (see page 120)



Class V Land (see page 121)

8. Class II Land. Gently sloping land recommended for crops that need fairly intensive cultivation of the soil. Soil conservation measures are necessary to prevent erosion on this land.

9. Class III Land. Land that is sloping recommended. Good soil conservation practices must be used to prevent erosion. The land should be put into grass for at least one year out of three.

Moderately sloping land that should be cultivated carefully because of the risk of soil erosion. This land is best suited for tree crops such as bananas that need moderate cultivation of the soil.

10. Class IV Land. Steeply sloping land which is not recommended for cultivated crops. Where land in this class must be cultivated extreme care should be taken to prevent erosion and gullying. This class of land is best used for tree crops such as citrus, which do not need a great deal of cultivation of the soil.

Class VI Land (see below)

11. Class V Land. Land that is too steep or too rocky for cultivated crops. Tree crops i.e. cacao, coffee, coconuts are recommended. This class of land may also be used for timber tree planting or improved grassland.

12. Class VI Land. Steeply sloping land or rocky areas that should never be cleared. Selective thinning and the planting of economic forest or food trees is recommended for this land.

CHAPTER 8

Manures, Composts and Fertilizers

Manures may be divided into three general types as commonly used on farms

(i) Farm Manure.
(ii) Green Manure.
(iii) Composts.

Of these, farm manure and green manure are by far the most important and the most widely used.

(i) FARM MANURE

Farm Manure consists of the solid and liquid excreta of farm animals mixed with the litter used in bedding of the stock. The solid excreta (dung) are composed of the undigested portions of the food; the liquid excreta (urine) contain products resulting from the digestion of the food, in fact, that portion of the digested food that has done its work in the animal, but is not retained in the production of flesh, milk, wool, etc.

The response obtained from applications of manure will vary with the type of soil, with the crop grown and with climatic conditions. The agricultural value of manure depends on its content of organic matter, nitrogen, phosphoric acid, potash and other constituents, as well as on the physical effect it has on the soil.

The composition of farm manure is determined not only by the relative proportions of solid and liquid excreta and litter making up the whole, but upon such factors as the kind, age, food and function of the animals producing it, the nature of the litter employed, and the care taken in the treatment and preservation of the resulting manure.

There are considerable differences in plant food content between solid and liquid excreta, and also between the manures of the various animals.

The liquid portion (urine) is much richer in nitrogen and potash than the solid excreta, weight for weight. These constituents are present in the urine in a soluble form, and therefore pound for pound they are worth more than those in the solid excreta, which contain them mainly in the insoluble forms.

In the soil the nitrogen of urine (present mostly as urea) is quickly converted into available plant food, whereas the nitrogen of undigested food in the solid excrement is but slowly changed into available forms.

Factors influencing the Composition

(i) Source of Manure

The composition of a manure varies with the kind of animal producing it.

Sheep and poultry manures are richer in plant-food constituents than horse, cow and pig manures, mainly because of the character of the ration used.

(*a*) *Cow and Horse Manures.* On most farms the cow produces the largest amount of manure, and while this is least rich in fertilizing elements, its large volume makes it the most important manure in mixed and dairy farming. Horse manure is distinctly richer in nitrogen, phosphoric acid, and potash than cow manure, but its open character makes it more liable to excessive fermentation, by which it may lose much of its valuable nitrogen. For this reason the best plan is to mix these two manures in the pile if they are to be kept for any length of time.

(*b*) *Pig Manure.* Pig manure varies widely in composition, and its content of plant-food elements depends largely on the character of the food consumed. Where the animal is well-fed on high protein concentrates, such as meat meal, and sufficient litter is used to absorb all the liquid excreta, the resulting manure is of high quality. The liquid portion of the manure of pigs fattened on such a diet contains a high percentage of nitrogen, sometimes as much as 1 per cent.

Less attention is paid to pig manure on the farm than to other manures, and some farmers are against its use for certain crops, but there does not appear to be any justification for such an attitude, as average pig manure may be considered somewhat richer than mixed cow and horse manure. However, as a general rule, better results follow the application of mixed manures than of the manure of any one species of animal.

(*c*) *Sheep Manure* is very rich, containing in its pure state about twice as much plant food as cow manure. Owing to its concentrated nature and the facility with which it can be distributed, it has been found of special value for top dressing and for the enrichment of the soils of gardens, lawns and golf courses. It is common practice to dry the manure artificially and to pulverize it for the market.

(*d*) *Poultry Manure* is the richest manure produced on the farm, but in common with all other manures it has not a fixed composition. The fact that the liquid and solid excreta are voided together as a moist mass ensures against the loss of urine from drainage and explains in part its higher nitrogen content. Another reason for its richness in nitrogen and phosphoric acid may be found in the character of the feed used. Fresh poultry manure has from two to three times as much nitrogen and from three to eight times as much phosphoric acid as fresh cow manure. Care should be taken not to apply more than one-third to one-half as much poultry as cow manure.

Poultry manure ferments very quickly, losing, if left exposed, a large proportion of its nitrogen as ammonia. This fact emphasizes the desirability of systematic and frequent cleaning of the boards beneath the roosts—a plan that also helps the fowl to maintain general good health. Where pits are used rather than boards under the roosts, and the manure accumulates for long periods, frequent cleaning would obviously defeat the purpose of such pits, which is to save the labour of cleaning.

If the manure cannot be immediately used, it should be mixed with a fair proportion of dry soil or sawdust, together with a little superphosphate to fix the nitrogen; packed tightly in barrels or boxes; and protected from rain until required. In the case of droppings pits, sprinkling the above materials over the manure in the pits from time to time would serve the same purpose. Lime and wood ashes should not be used for this purpose as they liberate ammonia from the manure.

If pens in which droppings are voided in the litter are cleaned frequently, the amount of manure in relation to straw and other litter would be very small. If the built-up litter system is used, however, after a year the litter in the laying house is almost clear droppings and the plant-food content resembles that of the droppings from the boards or pits. Such manure can be used the same as clear droppings and should be as beneficial to crops.

Poultry manure, being highly nitrogenous, is particularly valuable for garden and leafy crops generally, and the majority of poultry keepers will do well to reserve it for this purpose. However, if the amount available permits, it can be employed for the cereals, grasses, roots and corn.

(*e*) *Bone Meal*. Bones are rich in phosphorus and lime and are excellent for field and garden crops. When the bones are not finely crushed they decompose slowly and consequently their fertilizing properties are more lasting, but the supply of phosphate for one crop is less. Bones reduced to meal consistency increase the supply. An average sample of commercial bone meal should contain $3\frac{1}{2}\%$ of phosphoric acid.

Bone meal is especially beneficial when used on soils deficient in lime. Soils rich in organic matter are greatly enhanced in fertility by an application of bone meal. Citrus crops draw heavily on the phosphate content of the soil, and consequently an annual dressing of bone meal restores the loss and improves the crop.

(ii) Food of the Animal

The richness of the manure is chiefly dependent upon the nature of the food consumed. The richer the food in proteins or flesh-formers, the richer is the manure in nitrogen. The same holds good regarding phosphoric acid and potash. Again, the digestibility of the diet has much to do with the quality of both the solid and liquid excrement.

(*a*) *Age*. Young animals retain for their growth a much larger percentage of their food than do those that are mature. Consequently the manure of young animals is not so rich as that of mature stock. Approximately 50 to 75 per cent of the nitrogen phosphoric acid and potash of the food consumed by young stock and milch cows is found in the manure and from 95 per cent in that of full-grown and fattening stock.

(*b*) *Function*. Animals producing milk and wool make a greater draught upon the plant-food elements in their food than fattening stock or animals that are working or are at rest. Mature animals at rest void practically all the fertilizing constituents of their food in their excrements, whereas cows in milk utilize about 25 per cent of the plant-food elements in their diet. The manure of fattening steers is therefore much richer than that of cows producing milk, when factors such as food and litter are kept equal in quantity and quality in both cases.

(*c*) *Litter*. The bedding material employed in stables and yards serves a dual purpose: it keeps the animals dry and comfortable and soaks up the liquid manure, lessening its loss through seepage.

Straw is the bedding material universally used on the farm. It absorbs from two to three times its weight of liquid. If the supply is scanty, it pays to cut all the straw used as litter, for when finely cut it absorbs about three times as much liquid as when uncut.

Dry sawdust and fine shavings can be recommended as clean and satisfactory bedding materials. Their absorptive capacity depends upon their fineness and dryness, and is from two to four times that of ordinary straw.

There is a more or less general impression among farmers that manure from stables and cowbarns in which sawdust has been used as litter is injurious to the land. Temporary injury to the physical condition of very light soils might occur following very heavy applications. It is on heavy soils that this class of manure proves most beneficial.

Care and Preservation

Too great emphasis cannot be laid upon the necessity of caring for manures from the time they are voided until they are spread on the land. Even with the best of care some loss is unavoidable, particularly of the liquid portion. Losses result from improper facilities for preventing excessive fermentation and leaching of the urine.

To save the urine, the floor and gutter of the stable should be tight enough to prevent seepage. Concrete floors and gutters are most satisfactory for this purpose. Sufficient litter should be spread in the stall and in the gutter behind the stock to absorb completely all the liquid excrement. The importance of saving the urine of stock will be recognized, since, as has been shown, more than one-half the nitrogen and at least three-fourths of the potash of manure are contained in the liquid portion. These fertilizing constituents, being quickly available, represent the most valuable portion of the manure.

From the time of voiding, decomposition of manure may take place quite rapidly, the rate of fermentation depending largely on the methods of handling and storing. If left in a loose heap through which the air can permeate, manure ferments rapidly, and serious losses of nitrogen by the escape of ammonia result. This is particularly true of horse manure, and to a lesser extent of sheep and poultry manure. Horse manure, being loose in texture and containing a larger proportion of undigested food, ferments more readily than cow manure. To prevent excessive losses through fermentation, the manure heap should be kept compact and reasonably moist.

The use of a preservative such as superphosphate may help to some extent in preventing loss of nitrogen in the form of ammonia. When used for this purpose the material is usually scattered in the gutter behind the stock; a valuable feature of its employment is that it tends to lessen the odours in the stable by the absorption of ammonia. Superphosphate increases the phosphoric-acid content, thus producing a better balance of plant food in the manure. It is also effective in absorbing ammonia. Spreading the superphosphate in the gutter at the rate of one pound per day per animal of about one thousand pounds weight is recommended.

Losses through leaching occur when the manure heap is exposed to heavy rains. In districts of heavy rainfall, manure kept on the farm should be stored under cover, if possible. The yard in which it is stored should have a cement or other impervious bottom such as puddled clay, to prevent seepage of the liquid portion, and sufficient absorbent material such as straw and peat should be used to soak up the drainage.

When the drainings of a manure pile are allowed to escape there is a great loss in the soluble, and hence more valuable, elements of plant food. Such 'leached' manure is worth but a fraction of its original value. Depreciation caused by fermentation and leaching before the manure is carted to the field frequently exceeds 50 per cent of its value as it came from the stable and cow barn.

A number of experiments seem to show that of plant food constituents in rotting manure the chief losses take place during the first three months of rotting; about 10% more organic matter is destroyed in 'exposed' than in 'protected' manure; nearly twice as much nitrogen is lost from the

'exposed' as from the 'protected' manure; and, while the phosphoric acid and potash remain practically constant in the protected manure, the losses of these elements from the exposed manure are considerable, especially in the case of potash.

Relative Values

In the rotting of manure, fermentation decomposes the litter, the fertilizing constituents of which are rendered more available for plant growth. Fermentation also converts the organic matter into substances that more readily form humus in the soil, increases the availability of the phosphoric acid, and destroys the majority of the weed seeds that may be present. However, even under good rotting conditions, there is a loss of fertilizing constituents. Weight for weight, rotted manure is more valuable than fresh manure, since it contains larger percentages of plant food in a more available condition, but the losses in rotting may out-balance the benefits. Unless there is some special reason for employing rotted manure, the sooner the farmer gets his manure into or on the soil the better.

If for any reason it is desirable to rot manure in a large heap, the importance of keeping the mass compact cannot be over emphasized. Compactness and the right degree of moisture are essential to reduce the losses to a minimum and to make a manure of high value.

Fresh manure is better suited to clays and heavy loams than to light soils, since its coarseness does much to improve their physical condition by opening them to the air and making them more friable. On the other hand, rotted manure is better suited to light sandy soils, tending to make them more compact and retentive of moisture.

Fresh manure may with advantage be used for crops that have a long season of growth, while rotted manure, with its more available plant food, gives better results for crops that gather their food and reach maturity during a short period, and where early marketing is an important consideration.

Methods of Application

Losses of the valuable fertilizing constituents of manure through fermentation and leaching may be prevented to a large degree by hauling the manure to the fields as soon as possible after it leaves the stable. Its best storehouse is the soil, and so far as practicable it should be immediately spread and incorporated with the soil. If there is no danger of surface wash, it may be spread and left on the surface of the land. The application is best made with the manure spreader. On sloping ground the dressing of manure should be withheld until it can be incorporated with the soil shortly after its application, otherwise surface drainage may carry away valuable constituents.

(ii) GREEN MANURE

From time immemorial the turning under of a green crop to better the condition of the soil has been considered good farm practice. The object of green manuring is to return to the land the plant food removed from the soil by the green manure crop, and to enrich the soil with humus-forming materials. If the crop used is a legume it has the additional advantage that it adds considerable amounts of nitrogen to the soil, since such crops obtain nitrogen from the air.

One value of green manuring is that it adds organic matter or humus-forming material to the soil. Apart from that portion of the nitrogen which legumes obtain from the air, all of the mineral matter and the rest of the nitrogen originally come from the soil, and ploughing down the crop simply returns these nutrients to the soil. Nutrients such as phosphoric acid, potash, and lime may be taken by the roots of some plants from depths below the plough layer, and when the crop is ploughed down these nutrients are added to the surface soil in a more readily available form and in a location where the roots of plants grown subsequently may reach them more easily.

Green manure crops have the additional value of exerting a conserving action on soluble nutrients in the soil by utilizing these nutrients in their growth and preventing their leaching away in the drainage water. This is particularly valuable in seasons of the year when the soil would otherwise be left bare. At such time the crop may not only prevent leaching losses, but also loss by wind or water erosion.

Nitrogen added to the Soil by Legumes. Green manure crops are most valuable to supplement an inadequate supply of farm manure. Where potatoes are grown for a cash crop and little or no livestock is kept, commercial fertilizers and a green manure crop ploughed down occasionally will help to maintain the general fertility of the soil.

Under mixed-farming conditions where regular field crops are produced, it is doubtful if ploughing down green manure crops will prove economical if a regular crop has to be sacrificed. Under no condition can green manure alone be used to build up a run-down soil, or even to maintain the fertility of a relatively good soil. If the soil is very poor it is impossible to grow a good green manure crop without first adding plant food by means of barnyard manure or commercial fertilizer. On the other hand, fertile soil which will produce a luxuriant growth of a green manure crop would hardly need the crop ploughed down. A more economical procedure would be to feed the crop to livestock, and the manure produced therefrom, together with the roots, stubble and other residue from the crop itself would, under most circumstances, add the necessary humus-forming material to the soil.

(iii) COMPOSTS

On most farms some materials, which are generally neglected or allowed to go to waste, might well go to form humus-forming material for the soil, e.g. garden refuse, leaves, kitchen garbage, sweepings, ash residues, stable manure and grass refuse, sweepings from chicken coops and roosts, refuse and droppings from rabbit pens, etc. etc.

Composition and Value

The value of compost as a fertilizer and improver of the soil when well mixed into the earth is considerable, particularly when added in a finely-divided state just before planting. The structure and other related physical properties of very sandy soils or heavy clayey soils are greatly improved by the incorporation of this organic material. In a clayey soil porosity is increased and plasticity reduced, and in sandy soil the organic matter has a binding effect and retards excessive draining away of moisture. Generally, the incorporation of compost with the soil, in addition to the fertilizing value, makes the soil more easily worked, more suitable for the spread of roots.

While the chemical composition of compost must vary with the types and quantities of materials used in making it, an example, the result of a test of compost carried out by the Agricultural Chemistry Division of the Department of Agriculture, showed the nitrogen content at ·83%, phosphoric acid ·70% and potash ·54%, with the compost of approximately 50% moisture content.

How to Prepare

Two Methods. There are two methods of making compost in general use—the *pit method* and the *stack method.* In the pit method the component materials are stored in a shallow pit in the ground; in the stack method the materials are piled in a stack on the surface of the ground. Apart from this initial difference, the continuing operations are identical in both methods. In areas of low rainfall the *pit method* is more desirable, but in areas with high rainfall it is more advantageous to use the *stack method* in order to avoid swamping and consequent loss of nutrients by leaching, unless the heap is suitably roofed over for protection against rain.

Location. The compost heap should be as near as possible to the plots to be treated. This saves the extra labour involved in carrying the compost from a distance.

Dimensions. The size of the pit or stack will depend on the amount of raw material that will be available. There is no standard size. A fair estimate where there is a sufficiency of stable manure available would be 12 ft. long by 8 ft. wide, and 2 ft. deep if the pit method is used. The sides of the pit should slope inwards toward the bottom, so as to prevent the sides caving in. A pit or heap of this size will yield about 2 tons of compost in three months.

Starting the Heap. Begin with a layer of bedding, i.e. dried leaves, chopped grass, crop wastes, etc., spread over the floor, ranging in thickness between 2 and 4 inches. Over this spread if possible a thin layer of old compost or well-rotted manure or leaves. This will contain many active microbes and hasten the decomposition of the mass.

Now prepare enough 'slurry' in a water-tight barrel to water the bed liberally. Slurry is a thin watery mix of wood ash, yard sweepings, animal droppings, urine, etc.

Continue the process of laying a bed (not to exceed 4 inches thick) of leaves, chopped grass and weeds, kitchen and crop wastes, etc., and watering with slurry, until the pit is filled or the stack attains the required height.

Aeration. Now comes an important part in the process. The interior of the heap should be warm, in order to encourage microbe action and so hasten decomposition. To secure this, the heap must be regularly aerated by turning over. One of the chief causes of insufficient aeration is trampling or packing the heap too tight, and also putting in too much earth or ashes. Neglecting to turn the heap regularly also reduces aeration.

Turning the Heap. The object of turning is to ensure proper mixing, control the amount of moisture, and provide aeration so as to hasten decomposition.

First Turn. This is done approximately 10 days after the pit or heap has been completely charged. If any old compost is available, scatter it over the top to inoculate with suitable bacteria. The heap is then lightly moistened and turning starts from one end.

An even, vertical slice is taken from the end where the operation has begun, and this slice is broken up and spread over the opposite end of the undisturbed portion and lightly watered. Now cut another slice and repeat as before.

Continue until *one-half* of the heap has been cut away and piled on top of the undisturbed half. Thus *one-half* has now been well mixed. Leave for 24 hours, then water again.

Second Turn. Do the second turn two weeks later. Begin from the top and turn in thin layers into the open space left from the first turning, giving each layer a slight watering. The undisturbed half at the first turning will now be loosened and spread (moistened) in thin layers at the top, while the half that was treated at the first turning will now lie at the bottom, only one-half of the pit or stack space being occupied. The other half will still be empty. In dry weather two more waterings should be given at intervals of a week before the third turning is made.

Third Turning. Four weeks after the second turn the heap should be

watered and then moved and stacked as near as possible to the plot to be worked. Let it remain there for a further four weeks, watering once a week. By this removal beginning at the top of the heap, the third turn will have been completed.

Testing Efficiency. The rate of decomposition can be tested by observation. The heap should exhibit well-distributed, white cobweb-like formations of fungoid growth in the course of the first month. At this stage also the temperature should be quite hot. After that the mass gradually becomes darker in colour. The finished product should be dark, finely divided, moist and crumbly between the fingers.

Some Don'ts. Avoid excessive watering. This may be as harmful as too little watering. Water lightly.

Don't let rain soak into the heap. Keep the top of the heap sloping, and if there is excessive rain, protect with a covering of grass, banana leaves, coconut boughs, or other protection. Don't put chunks of stuff, heavy corn stalks, heavy stems of weeds (like broom weed), corn cobs, or other woody materials into the heap. These decay slowly. First chop them into small bits. The aim is to produce a complete compost in the shortest time.

Protection

As has been mentioned before, the heap both during formation and after completion should be protected from heavy rainfall. If it is necessary to keep the compost for any time before using, some kind of a permanent covering should be provided against both sun and rain.

How to Apply

The plot to be treated should be well forked and weathered, or ploughed and harrowed. The compost should then be evenly spread over the surface and immediately turned in and well mixed, and the final result tightly smoothed down. If fertilizer has to be applied, it should first be mixed with the compost. This is particularly the case when applying phosphates to red earth soil.

FERTILIZERS

The subject of chemical agricultural fertilizers is extremely large and complicated, although there are many people who imagine that it consists of a single material, a substitute for farmyard manure, suitable for all crops and soils and applicable under all conditions. But the fertilizer problem is not quite as simple as that, and other factors such as light, warmth, moisture and soil texture play their part in increasing the supply of nutritive elements to plants. In this chapter the subject will be strictly limited to those fertilizing compounds most commonly needed by farmers in the development of their crops.

The essential elements for the development of plants, assimilated through their roots, are nitrogen, phosphorus, potassium, calcium, magnesium, iron, sulphur, manganese, copper, zinc and boron. A deficiency of one of the essential elements will check the plant's development and render it liable to disease.

The correct method for giving the plant the deficient elements is in the form of fertilizers, so returning to the soil what it has lost through cropping, or increasing the fertility of poor soils not previously cultivated.

The main elements required in any programme of fertilizing are nitrogen, phosphorus and potassium, with smaller quantities of calcium, magnesium and sodium, and trifling quantities of iron, copper, manganese, zinc and others. The first three, however, are those which are most usually in short supply.

The elements nitrogen (N), phosphorus (P), and potassium (K), then, occupy the predominant places in the fertilizing problem. They are required by crops in very large quantities, and removed from the soil in the form of crop and livestock products.

It should be noted that increased production is not the only result of the application of fertilizers. Their discriminate use also brings about an improvement in the quality of the produce.

Nitrogen. Nitrogen is largely the motive power in the growth of the plant, especially the leaves. Its application stimulates growth and enhances the green colouring. Lack of nitrogen is indicated by small leaves tending to a yellow-green or reddish-green colour, with diminished shoots and root system.

Excessive application of nitrogen adversely affects the keeping qualities of the produce, and may even constitute a real danger in the disproportionate development of green parts to the detriment of seed, fruit or tubers, and may produce plants that are constitutionally weak and susceptible to attacks by insects or fungus pests. Rice crops may show excessive development of straw and sucrose content of cane may be reduced by the presence of too much nitrogen.

The legume crops, far from depleting the nitrogen content of the soil, actually enrich it owing to their capacity to absorb nitrogen from the air and deliver it to the soil in the form of root nodules rich in nitrogen content.

The only advantage of nitrogen application to legume crops is in their early stage of growth, when a small dose may give a good start.

Phosphorus. Although the action of phosphorus is less striking it is not less important than that of nitrogen, being closely associated with the health and vigour of the plant and the quality of the produce. Actually, phosphorus deficiency is of more common occurrence than that of nitrogen or potassium.

Phosphorus stimulates the growth of roots, so providing the plant with a good foundation for its development. Also it encourages germination of the seed, promotes rapid early growth, and expedites flowering and fruiting. It also stimulates the capacity of legumes to absorb nitrogen.

Phosphorus being indispensable to animals and man, plants on which both depend should be supplied with a sufficiency of phosphorus. Thus all grazing pastures should have a good supply of absorbable phosphate for the better development of beef and dairy cattle.

Generally speaking, there is a close relationship between the phosphorus content of animal and vegetable produce and their nutritional value, taste, flavour and keeping properties, all of which are favourably influenced by the presence of phosphorus. Fruit trees to which phosphates are applied yield fruit with less acid content, with improvement of taste, flavour and keeping qualities.

Phosphatic fertilizers are almost invariably sold on their content of P_2O_5 (phosphoric oxide).

Potassium. What has been said about phosphorus is also true of potassium, although one cannot be substituted for the other. Potassium also promotes the health and vigour of the plant, and counteracts against rank growth and liability to fungus disease. It is actively concerned in the leaf functions and stimulates those parts of the plant responsible for the accumulation of reserve food, production of starch and sugar, and filling the grains of cereals, etc. It is of special importance in the development of tubers (potatoes, yams, etc.).

Potassic fertilizers are usually sold on their content of K_2O (potassium oxide).

The foregoing account of the functions and effects of the three principal plant foods shows clearly the great importance of chemical fertilizers in relation to quality. Also that their functions differ and that they are not interchangeable. It would be wrong, however, to limit attention to the needs of crops to the application of nitrogen, phosphorus and potassium alone. Attention must be paid to the rate at which the nutrients become available, for if this is ignored, growth of the plants may be limited, due to a deficiency of available plant food.

The availability of plant foods is determined by the processes they have to undergo in the soil before they can perform their function as nutrients.

In the case of *Nitrogenous fertilizers* they fall into three groups in respect of their availability, namely, those containing nitrogen in the form of nitrates (e.g. nitrate of soda), those having it in the form of ammonia (e.g. sulphate of ammonia), and those with nitrogen in an organic form (e.g. blood meal). Strictly speaking, the last-named type (which also contains phosphorus) does not come within the term chemical fertilizer.

Nitrogenous Fertilizers: Sulphate of Ammonia is probably the cheapest and commonest source of nitrogen, containing about 20% nitrogen in the form of ammonia. This nitrogen is not immediately available to plants, as is the nitrogen in nitrate of soda, but has to be converted in the soil by chemical and bacterial action into nitrate nitrogen before plants can absorb it. This reaction is much more rapid in the tropics than in the temperate zones. Since it is an acid fertilizer its continued use over a number of years in soils poor in lime tends gradually to exhaust them of lime, and to render them acid and unhealthy for normal plant growth. It should therefore be replaced every two or three years by nitrate of soda, or the land should receive periodical dressings of lime to neutralize the acidity which it tends to produce. This property is sometimes rather an advantage, as pineapples and certain other crops appear to prefer an acid soil. An average application is 1½ to 2 cwt. per acre for field crops (but it is frequently used as a source of nitrogen in 'complete' mixtures). For the garden, it may be applied at the rate of 1 to 1½ ozs. per square yard, preferably dissolved in 1 to 2 galls. of water. To supply this evenly in a dry state, it should be mixed with some fine sand or finely sifted soil, e.g. as a top dressing for lawns.

Nitrate of Soda contains its nitrogen in the soluble and immediately available nitrate form. It does not, therefore, have to undergo any change in the soil before plants can assimilate it. Its action on crops is very rapid, and its effect has been observed 24 to 48 hours after application. It is therefore often used as top dressing for backward crops and in late seasons.

Being readily soluble in water, this fertilizer is easily washed out of the soil by heavy rain or frequent watering, and therefore several small applications are preferable to a large dressing. Applied in large quantities over a period of years it tends to make heavy clay soils sticky, intractable and difficult to work. It does not produce soil acidity as does sulphate of ammonia. An average dressing is 1 to 2 cwt. per acre, and for gardens it may be used at the rate of ½ to 1 oz. per square yard; or the same quantity may be dissolved in 1–2 galls. water and applied with a watering-can and hose. It is computed that 100 lbs. of nitrate of soda contains as much nitrogen as about 1¾ tons cattle manure in the tropics.

In the case of phosphatic fertilizers there is a pronounced distinction between those having phosphoric acid in the water soluble form and the others. The water soluble phosphoric acid is immediately and wholly available to the plant, while insoluble phosphoric acid must first be converted into an available form in the soil, the rate depending partly on the fertilizer itself and partly on the condition existing in the soil. All water insoluble phosphatic fertilizers are much slower in action than the soluble ones, so that when using the former there is always the risk of the plant not finding a sufficiency of phosphoric acid when it most needs it. Consequently, water soluble phosphatic fertilizers are in the great majority of cases preferable.

There is another aspect of this matter that requires attention. When phosphoric acid is applied to certain types of soil (for instance, the red limestone-derived soils of Manchester and St. Ann) even in the water-soluble form, it may combine with iron, or alumina, with the result that the phosphoric acid fixed in this way is largely lost to the plant. Apart from this fixation, it is well to apply phosphoric acid generously. Unlike nitrogenous fertilizers, phosphatic fertilizers are not liable to leaching.

Superphosphates. The great advantage of this form of fertilizer lies in the water-soluble form of its phosphoric acid, which ensures a rapid and complete effect. It guarantees the plant abundance of phosphoric acid when mostly needed, causing rapid germination, an extensive root system, and speedy growth in the early stages. In addition, seed production is stimulated and maturity hastened. Further, the well-developed roots enable the plant to absorb the other nutrients more easily and quickly.

As pointed out before, the disadvantage of excessive stalk and leaf growth from over-supply of nitrogen may be corrected by the use of superphosphate to a harmonious and increased development. Consequently, leguminous crops which derive nitrogen from the air respond readily to a dressing of superphosphate.

Superphosphate is sold on its content of phosphoric acid (P_2O_5), and ordinarily contains a small amount of phosphoric acid insoluble in water but nevertheless available to plants, though less quickly.

Potassic Fertilizers are almost without exception all soluble in water, and the potassium may be absorbed directly by the roots of the plant.

Compound or Complete Fertilizers.

This class of fertilizer, containing usually the three main nutritional elements, fills an important place in the supply of farming requirements. Their use relieves the farmer of the necessity to work out a well-balanced fertilizer programme, and offers the advantage of distributing on the land all the plant foods in one operation, thus saving the cultivator both time and labour.

The method of application is of first importance. It is not sufficient for the field to receive well-balanced fertilizing; every plant should receive it. The latest method of supplying mixed fertilizer is in the granular form. There are many advantages in this method. The risk of unbalance in the supply of nutrients is eliminated, and as the granules are solid and porous they are perfectly soluble and resistant to leaching and fixation. They approximate more to the idea of a storehouse, holding the nutritive elements at the disposal of the plant and protecting them from external disturbances. Also they have no action on the container sacking, so that the bags

CHAPTER 9

Small Holdings, Water Supplies and Mixed Farming

The development of small holdings is not a matter for which a cut-and-dried plan can be prepared. Each separate holding must be considered on its own merits, and an overall picture of the farm, and the life of the farm family in all its aspects, must be gained before any single factor involved in development can be considered.

Once the complex pattern of farm life has been studied as a whole, the individual factors which form the pattern must be considered, each in turn. Within the pattern each factor bears as definite a relationship to one another as do single bricks in a brick wall, and it cannot be said that any one factor is of much greater importance than another.

The social life and the economic life of any one holding are very closely interrelated, but only the more important economic factors are discussed here.

Several factors listed are selected at random, and not in any order of presumed importance:

1. Acreage of the holding, and its condition in respect to fragmentation.
2. Tenure—freehold, leasehold, rented, encumbrances.
3. Location in relation to towns, villages, estates, railway, motor roads, milk routes, factories.
4. Labour supply and size of the family group.
5. Soil type, average rainfall, and water supplies.
6. Supplementary water supplies.
7. The percentage of arable soil on a holding.
8. Degree(s) of slope, and the degree of erosion.
9. Altitude.
10. The position of the holding in the watershed, and its relation to adjacent farms.
11. The farmer's experience and personal inclinations.

1. Acreage of the Holding. The size of the holding to a large extent determines the programme of development pursued by the holder, and in

the absence of intensive cultivation which is not practised in Jamaica, larger holdings are necessary to the farmer for mixed farming than he usually possesses. (There are no less than 10,267 'farms' of between 2 and 3 acres, and 19,908 between 3 and 6 acres.) The tendency has always been in the direction of fragmentation of holdings on the death of the owners.

2. Tenure. The freehold farm is best from all points of view. Even if encumbered, the owner is more disposed to bestow his best efforts in cultivating and putting improvements on land that he feels really belongs to him. Actually, most of the holdings are freehold (with a lamentable absence of proper titles for the same) and very few are leaseholds. A considerable number of holdings are held on yearly tenancies for the cultivation of provision fields, the sites shifting from year to year. Land Settlement, sponsored by the Government, has in recent years very considerably increased the number of freehold plots ranging generally from 2 to 5 acres, although in the majority of cases the land remains encumbered, only part of the purchase money having been paid by the settlers, on a twenty-five year payment plan.

3. Location. The ideal location for a holding is near to a town of good size, where farm products can be readily marketed and supplies obtained.

Railway and motor road facilities (especially bus routes) are desirable. So, too, are proximity to a condensery milk route and to a factory, but it will be obvious that all holdings cannot be so fortunately placed. Some will of necessity be in more remotely situated regions—with the advantage, however, that in purchasing, the price for these latter will be much smaller.

4. Labour Supply and Size of the Family Group. While not altogether avoidable, it is not desirable for the holder to employ outside labour for home production on a small family farm. The members of the family should be sufficient for this. Labour should only be hired when the economy of the project warrants it, for instance, in planting crops for marketing, and in development enterprises, but here again it will be found more advisable for a group of holders in the same district to get together and pool their efforts in communal labour, so avoiding the expenditure of cash of which they may not be actually possessed.

5. Soil Type, Rainfall, Water Supply. The soil type should be determined in order to know:

(1) In what it is deficient and what elements should be supplemented.
(2) What crops are most suitable to that particular soil.

Rainfall is probably the most important single factor in determining the possibilities of a holding. In very heavy rainfall districts many crops will not succeed, e.g. corn, legumes, onions, tubers, vegetables; while, on the other hand, in the dry districts bananas, cocoa, rice and coffee will not do so well.

The development of holdings in very wet and very dry areas must accordingly be based on projects to conserve soil and water in the latter, and to conserve soil but dispose of surplus water in the former. In both cases the success of the whole farm development will depend upon the suitability of the conservation and water disposal measures, and a close study must be made of both.

In very wet districts thought must be given to suitable livestock projects. Capital should be invested for sheltering dairy animals, and it should be remembered that other than ducks, poultry are not likely to succeed. On the other hand, a livestock project in a dry area will involve capital investment in water storage and silos and adequate provision of poultry feed all the year round.

6. Supplementary Water Supplies. Rainfall being the principal source, supplementary water supplies include wells, springs, rivers, and tanks or ponds for farm use.

The provision of a supplementary water supply (not for irrigation) based on rainwater storage, impounding a spring, pumping from a well or spring or river, should only be considered with a view to a definite economic purpose, enabling a farm project to be established or expanded —e.g. coffee pulping, banana spraying, watering stock or a vegetable garden, etc. The expenditure on a supplementary water supply should always be considered in terms of the expected returns from the resulting increased production.

7. The Percentage of Arable Soil on the Holding. It is seldom, except on a very small holding, that the entire plot is arable. A ten-acre holding with eight acres of stony land, is really only a two-acre farm as far as the investment of capital funds is concerned. The economic production of crops depends largely upon the speed and cost of tillage, so, generally speaking, it is unwise to invest funds and labour on holdings with a low percentage of arable land. Regard should, however, be given to the value of the non-arable portion as contributing small timber, sticks, wattling material, mulch, etc., all of which are from time to time needed by the farmer.

8. Degree(s) of Slope and Degree of Erosion. An overall study of a farm will reveal roughly the nature and extent and the approximate cost of adequate conservation measures. Measures must be adequate, otherwise they are worse than useless, and may contribute to even more serious erosion.

It must, then, be decided whether a section of the farm may be independently conserved, or whether it is necessary for the whole farm to be treated; it must also be considered whether conservation work on a holding will be satisfactory if an adjacent higher holding is not also treated.

The degree of previous erosion should be studied, for it may become

apparent that inert subsoils have been so extensively exposed that a great deal of work and money must be spent on restoration of soil fertility before economic production may follow. This point is particularly true of non-shale soils, where the weathering of subsoil is likely to be very slow. Soil tests will, of course, reveal the soil nutrient requirements, and the costs may then be considered in the light of the farmer's resources and the assistance available under Farm Improvement Schemes.

The degree of slope bears an important relationship to various farm projects; it will be apparent that on very steep land grazing of heavy stock such as cattle should not be the only alternative. Again, the degree of slope will largely determine the extent to which the farmer invests in permanent tree crops and annual cultivated crops; the former is much more suitable for steep slopes, partly from the point of view of the cost of tillage; steep slopes cannot be ploughed.

9. Altitude. Plants in general have definite requirements of heat and intensity of light, and these requirements again in general govern the performance of the plants at varying altitudes above sea level. There are many plants, notably the grasses, which are known to thrive at a great range of altitude from sea level to four or five thousand feet, but the principal crops of the country are definitely affected by variation in altitude.

Vegetables are reasonably versatile in respect to altitude, and may be grown with success at sea level, but it is known that these crops improve in yield and quality as altitude increases, and it is probable that with the exception of the tomato and its relations the tobacco, the egg plant, and the pepper, common vegetables grow most successfully at four or five thousand feet in elevation in the latitude of Jamaica.

It is generally known that coffee improves in quality with elevation, while on the other hand such crops as coconut and breadfruit will not thrive at elevations over two thousand feet, and are most successful at or near sea level. Coffee should not be produced for the export market at elevations under 1,500 feet.

The citrus family is very variable in requirements of heat and light; the grapefruit thrives best at low altitudes—over 1,500 feet growth is diminished and the plant becomes susceptible to scab; sweet oranges on the other hand, including the ortanique, produce better quality fruit at elevations over 1,500 feet, up to 2,500 feet. In the citrus group, the lime is the most exacting, presenting the paradox of requiring less heat in its system, but at the same time requiring higher air temperatures than other species; limes, of course, generally grow best at or near sea level.

The common food crops of Jamaica, roots and tubers, and grains and pulses are reasonably versatile, with the sweet potato and the congo pea exhibiting the greatest tolerance of variability in elevation. Yams in general do not grow well at elevations over 3,000 feet, and at the same time are not at their best at sea level. Corn is limited to the sea level to 2,500 feet range, and very much the same conditions obtain in the case of the cassava. Irish potatoes generally do not grow well below 1,500 feet, but climb to a range of 4,000 feet and over.

Finally, the banana and plantain will grow at any elevation, but rate of growth at 4,000 feet is probably less than half the rate of growth at sea level. The most effective range for bananas in respect of rate of growth lies between 500 and 2,000 feet.

10. The Position of the Holding in the Watershed and its relation to adjacent holdings. The watershed's position is important when a programme of development is being studied, with special reference to water supplies and to soil conservation. The floor of the watershed is normally the only position offering the possibility of well water supplies, and normally springs begin to appear halfway down from the upper limits of the watershed. In the upper limits of watersheds, farmers usually are obliged to provide their own supplementary water supplies.

A soil conservation programme should always be started at the top of a farm, or the top of a watershed, for water always runs downhill, gathering speed as it goes down. A farmer at or near the top of a watershed need fear no flooding from surplus surface water from above, and neither need he fear landslides from above. On the other hand, a farmer located down in the watershed often is obliged to dispose of his own surplus ~~surface~~ water, and that of his neighbour above, with corresponding increase in the cost of the installations. Every farmer located below eroding farms ~~should bring~~ his influence to bear on his neighbours above to join in a general conservation programme. In the final analysis, a general watershed programme of conservation is the most economical and the most effective.

When a single farm is being provided with soil conservation measures, even if neighbouring farms do not join in the programme, a careful study of the neighbouring terrain should be made, with the aim that the treated farm may fit properly into any later expanded programme, and to protect the treated farm from external surplus water.

11. The Farmer's Experience, and Personal Inclinations. Many present-day farmer started life elsewhere than on a farm, and later, perhaps very recently, decided to go in for farming; this is particularly true of Land Settlement farms. A farmer who is farmer in name only having no agricultural traditions and no real practical experience, will either give up farming sooner or later, or will become a burden on the Instructor, requiring advice and assistance for every detail of farm work. Any project started on the land by an inexperienced man should be started in a very small way, with one cow, or a half acre of citrus, or a dozen hens, or an acre of annual crops.

Decisions in respect of projects to be undertaken on individual farms

must not only be related to soil, weather, markets, etc.; they must be related to the farmer's own personal inclinations. There are farmers who will not rise early to milk their cows, and would much prefer to maintain steers for beef or keep pigs or poultry. There are also farmers who do not care for livestock at all, and will invest only in permanent crops such as citrus, with a limited area of annual crops for food. Investments in projects which are not in line with the farmer's personal inclinations will surely be lost.

Equipment of the Holding

Livestock. Livestock form an integral part of any farming programme. The animals not only breed for profit, and supply domestic food, but also provide supplies of soil nutrients, either in soluble or in organic form, so replenishing the drain on the soil from repeated crops. The programme should be well thought out, so as to fit into the general pattern of the settler's home life—e.g. if there are children, they can look after the rabbits and poultry. In all cases adequate provision should be made for sheltering the animals, a regular and ample supply of fodder, and secure fencing to keep them within bounds.

Vegetable and other Crops. These will depend on such factors as altitude, type of soil, rainfall. The common vegetables can all be grown. Other crops like corn, plantains, bananas, pineapples, yams, cane, potatoes, etc., will be according to the locality and whether marketing surplus crops is anticipated.

Permanent Crops and Orchards. This should be an integral part of the planned lay-out of the farm. Being permanent, the location should be so fixed as not at any future time to interfere with or come in the way of other activities or developments of the farm, and it should also be well secured against entry by livestock. Of the numerous plants available—citrus, pears, mangoes, breadfruit, ackee, sweetsop, soursop, naseberry, otaheitie apple, jackfruit, guinep, coconut, cashew, a sufficiency suited to the particular type of land involved will be readily found.

Preparation of Crops, Seed Boxes, etc.

Sowing the Seeds.

Planting and Maintenance.

For full particulars on these, see under chapter *Vegetable Gardening*.

Fertilizers and Composts. For full particulars on these, see chapter on *Manures, Composts and Fertilizers*.

MIXED FARMING

The soil cannot live by itself alone; man, animals, soil, water, plants and air are all closely bound together, and help each other. For this reason it is considered that mixed farming provides for most efficient usage of land.

A description of mixed farming is given as follows in an African Welfare book called *Water and Land*.

'One advanced way of farming is called Mixed Farming. In mixed farming, animals are kept; and the farmer not only feeds them on grass from unoccupied bush, but keeps special grazing land for them and gives them extra food from his crops together with dried grass (hay). (The Jamaican farmer should use silage, which is grass stored wet.) The farmer receives a number of different products: meat, milk, wool from sheep, skin from goats, eggs and many different kinds of crops. Some kinds of crops are very good rotation crops, but not very pleasant to eat, though they may be very good as feed for animals. On a mixed farm, the most suitable land for crops is cultivated, and the best grass land is kept for grazing. It is often advisable to give a cultivated field a rest; then, instead of leaving it to grow worthless weeds, the farmer plants good kinds of grass for his animals. The animals feed there, dropping dung, and after a few years the field is fertile again and can be cultivated.

'The animals are shut up at night in covered buildings, with a bedding of straw or grass. They drop dung during the night. The straw and dung is kept to decay for a time and is then added to the fields, thus supplying humus and other plant foods.

'Animals kept like this grow much finer and yield better meat or more milk than neglected animals which have to search for their food on waste lands. The fields also profit, partly because of the manure and partly because a use is found for rotation crops (including grass) which men do not want for themselves.

'The farmer profits most of all because he has many kinds of products. This not only ensures him better food, but it ensures him money. If the price of corn is very low for a few years, very likely the price of milk will be quite good. Or if the price of milk falls, perhaps the price of tobacco is good. The farmer who plants only one crop for sale and just enough food for himself will have money when his crop is selling well, and very little when his one crop goes at a low price.'

Mr. Wakefield in his report on *Agriculture in Jamaica* recommends mixed farming. He advises the change-over from time to time of grass with crops, the animals helping to manure the fields and always having the chance to eat young tender grass, which is very much better for milk

and meat production than the older grass which slows down digestion and lessens milk supply.

He likes mixed farming, especially because it brings about a happy family life with good returns in health and cash. A farmer can feed and house his family by the products of his own labour; father, son, mother, and daughter can all find profitable, healthy occupation both in the house and around the homestead. It does not take a rich man to make a success of mixed farming. A small homestead with one animal and a well-planned plot with rotation of crops can be the starting point for a large successful farm.

CHAPTER 10

Farm Machinery and Implements

THE PLOUGH

The main types of ploughs used in Jamaica are the following:

1. *The Swing Plough.* This type is the common single-furrow, fixed-mouldboard, walking, animal-drawn plough for use with one or two animals.
2. *The Turnwrest Plough.* This is the 'hillside' plough, used for 'one-way' ploughing. The draught requirements are the same as in 1.
3. *The Double Mouldboard Plough.* This implement is used for cutting furrows and twigs, and is also known as a ridging plough, or middle buster.
4. *Mounted Tractor Ploughs.* These ploughs are designed to fit the special lifting mechanisms of particular types of tractors.
5. *Trailer Tractor Ploughs.* Ploughs designed to be drawn behind tractors. The disc plough is the commonest example of this type.

Ploughs which are made of steel are the most satisfactory; ploughs made of cast metal are so easily broken that they are generally regarded as nuisances.

The terms used to describe plough parts are numerous, and many are local in origin; a glossary of the proper terms commonly used is supplied at the end of this chapter.

Adjusting the Plough

On most small ploughs adjustments involving the shape of the body of the plough are made by the manufacturer. These adjustments may be altered by wear or by abuse, and efficiency will deteriorate accordingly. The adjustments referred to are usually related to the share, and are listed as follows: (*a*) *Suction*; (*b*) *Pitch*; (*c*) *Wing bearing.*

(*a*) *Suction.* If a swing plough is placed on a level concrete floor, it should rest on the point, the heel of the landside, the edge of the share and the wing bearing at the end of the share opposite to the point. Maximum clearance under the landside is known as 'suction', and is normally approximately one-eighth to one-quarter of an inch, but may often need to be greater on very hard soils (see Fig. 2).

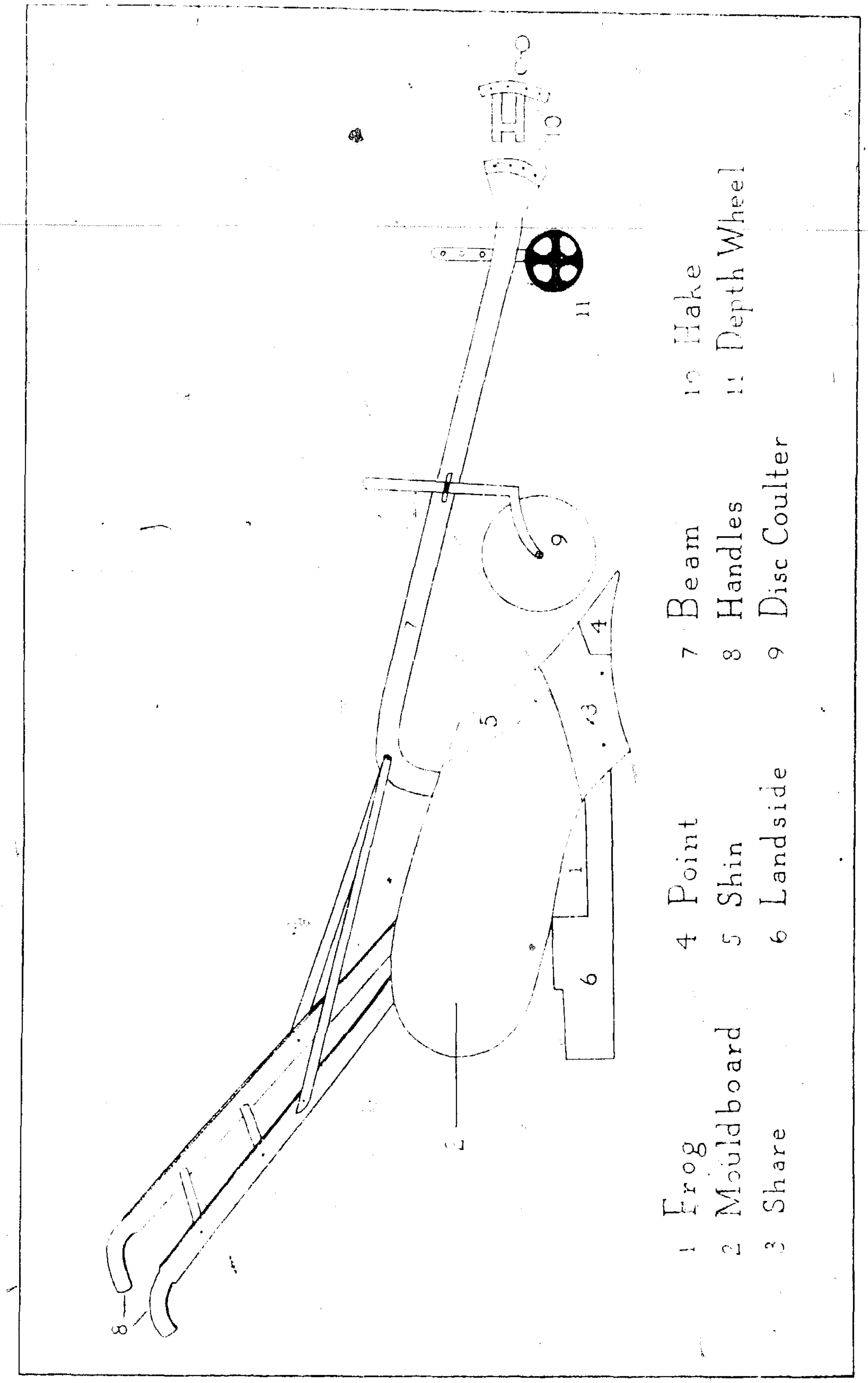


Fig. 1. Plough Parts

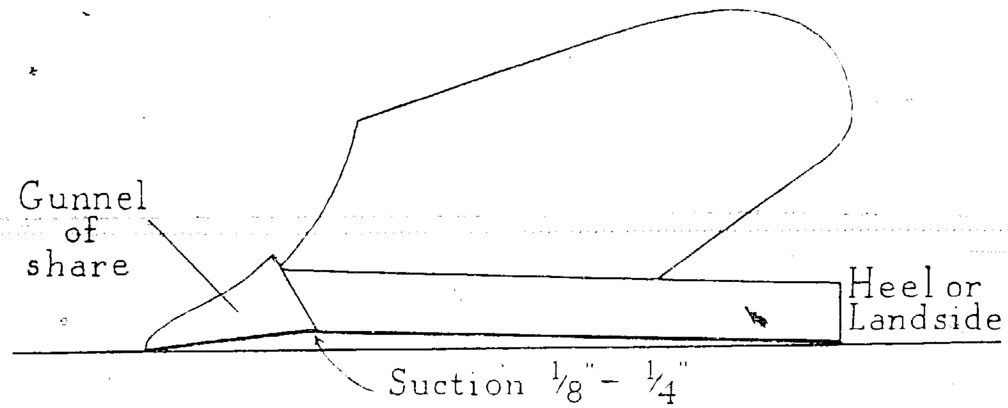


Fig. 2. Side View of Plough showing Suction

(*b*) The 'pitch' of the share of a plough is the maximum distance between the landside and a straight line from the point to the heel of the plough viewed from above. The point of the share should always be turned slightly towards the unploughed land, to a distance equal to the 'suction' measurement described above (see Fig. 3).

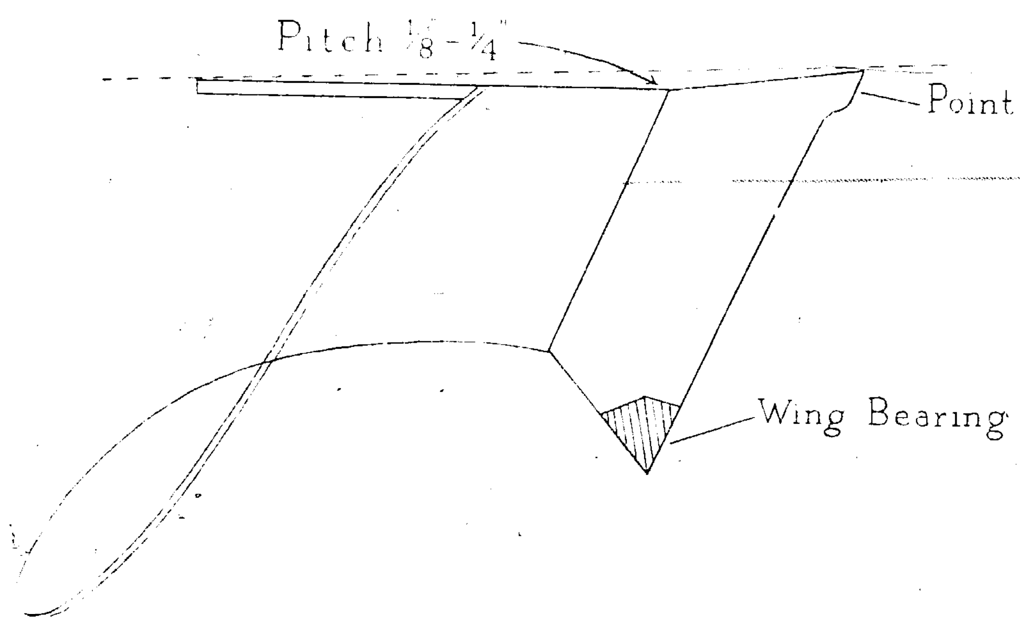


Fig. 3. View of Plough from above showing Pitch

(*c*) The wing bearing acts as a rudder to keep the plough running level. If its area is too small, the plough will cant towards the ploughed land. In a plough equipped with wheels, the wing bearing is not as important as in the case of a wheelless plough, as the wheel adjustment affects levelling.

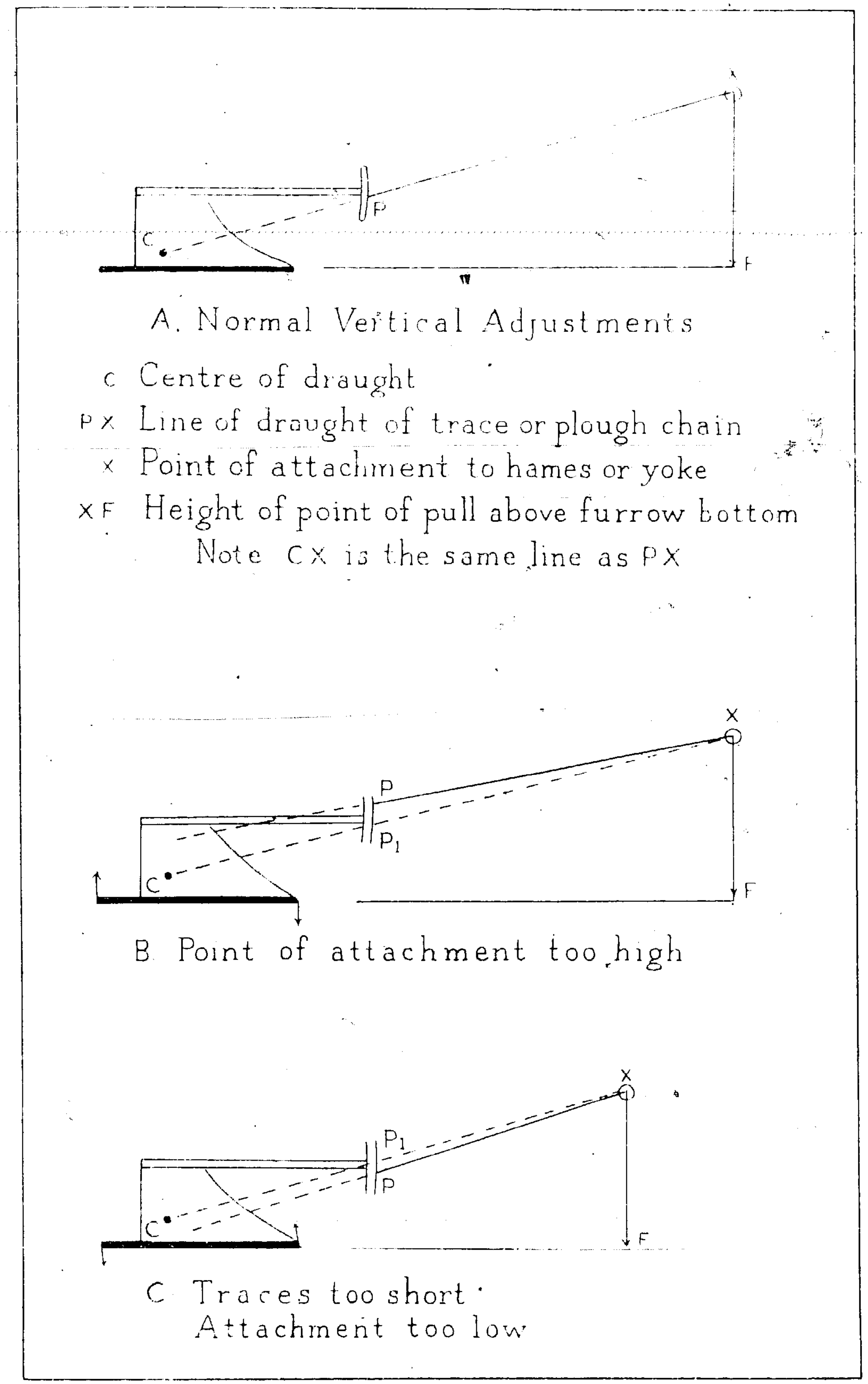


Fig. 4. Vertical Adjustments

Suction and pitch cause a plough to enter the soil freely and to maintain depth and constant direction. The measurements vary in each different make of plough, and it will be found useful by the owner of a new plough to take measurements, including the shape of the beam, for future reference when adjustments and repairs become necessary. Adjustments and repairs may take the form of straightening or building up by welding, for which purpose pieces of old spring blades may be used by a skilful welder.

The method of attachment or 'hitch' of a plough is often found to be at fault. When the ploughman finds it necessary to use excessive effort to keep the plough in work, then it is very likely that the hitch is in need of adjustment.

The line of draught on a plough should be a straight line from the yoke or hames through the hake to the centre of draught of the plough which is the point at which resistance to motion is concentrated (see Fig. 4–A). The position of centre of draught varies with the design of the implement and with soil conditions, but is normally located in the frog approximately half the height and one-third the width of the furrow cut from the bottom and the wall of the furrow. For purposes of adjustment the centre of draught can be estimated by sighting.

In Fig. 4–B the point of attachment of the trace PX is too high. The line of pull passes above the centre of draught and the point of the plough will turn down while the landside cocks upwards as indicated by arrows. The work will be uneven, and unnecessary strain will be imposed on man and beast.

On the other hand, if the trace is coupled too low on the hake, the point of the plough will ride upwards, and depth of ploughing cannot be maintained.

In Fig. 4–C the effect of a short trace is shown. The line of pull passes below the centre of draught, and the result is the same as when coupling at the hake is too low. If adjustment permits, the point of attachment may be raised, but it is better to lengthen the traces or chain.

If the cut of the plough is too narrow and the pitch is adequate, then the pull may be tending to swing the point of the plough towards the ploughing. If so the attachment at the hake should be moved horizontally *towards* the ploughing, so that the point of the plough will be pulled in the direction of the raw land (see Fig. 5).

In multiple furrow ploughs incorrect horizontal adjustment causes 'crabbing'. This means that the rear body and furrow wheel jump from the furrow and the tail swings towards the unploughed land. The principle of adjustment is the same, i.e., the drawbar of the plough should be shifted on the horizontal hake towards the ploughed land. In the case of a disc plough other factors beside line of draught may cause crabbing.

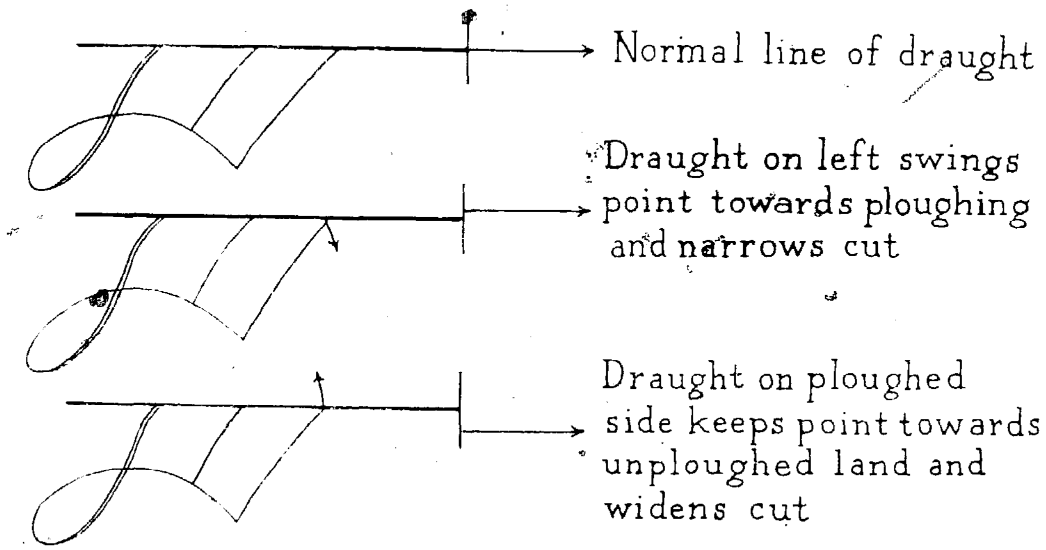


Fig. 5. Width of Cut. Horizontal Adjustment of Hake

On trailer tractor ploughs and larger types of walking ploughs two front wheels are provided. The right hand or furrow wheel works in the furrow, and the left or land wheel works on the unploughed land. Depth of ploughing is usually set by adjustments to the land wheel, and levelling is usually accomplished by adjustments to the furrow wheel which, on most types of ploughs, will also correct deviations in the direction of draught.

Swing ploughs are sometimes provided with a small single wheel, mounted near the hake, running on the unploughed land, helping to control depth of ploughing. This wheel does not eliminate the need for adjustments to maintain correct suction, pitch and line of draught.

Types of Mouldboards

The shape of a mouldboard affects the quality of ploughing. A short, sharply curved mouldboard pulverizes the soil rather than packing unbroken furrow slices against each other. A longer, more gently curved mouldboard has the latter effect. The former type, known as a digger or semi-digger, is popular in Jamaica, owing to lower draught requirements and to the tilling effect of the sharply curved mouldboard.

Coulters

Coulters are knives which assist by clearing the way in front of the plough.

Knife coulters often give trouble by clogging with weeds and trash; rolling disc coulters give superior performance under similar conditions, provided they are kept sharp, smoothly rolling, and properly adjusted.

Rolling coulters are not often used on light ploughs as they require weight for penetration.

Rolling coulters should not be set deeper than is necessary for cutting a clean furrow wall; the normal position is vertically over the point of the share, 1½ to 2½ inches above it. The blade should cut one-half to one inch to the left of the shin of the plough. In hard soil the centre of the coulter should be behind the point of the share. When stones are common, and the plough light, the coulter may be set forward of the point, and may be set deep, thereby helping to protect the point (see Fig. 6).

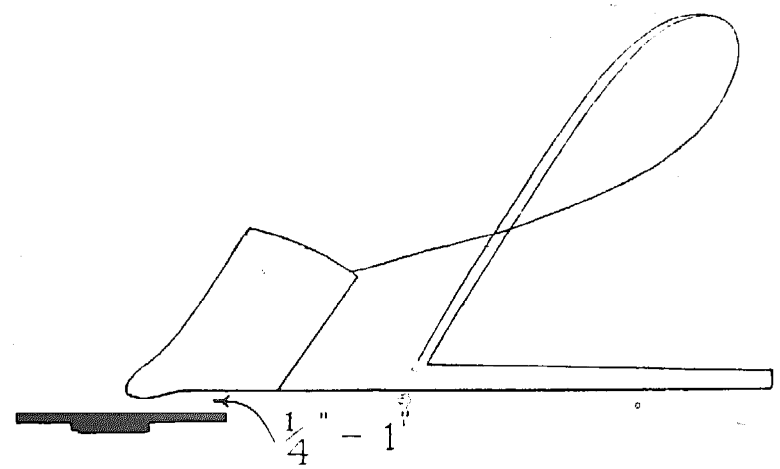


Fig. 6. Position of Disc Coulter relative to Plough Point

One-way Ploughs

A one-way plough is capable of turning a furrow either to the right or to the left. In the turnwrest swing plough or hillside plough the share and the mouldboard are mounted on a pivot; they are so shaped that in alternate positions the edge of the share becomes the shin, and vice versa. The mouldboard is curved backwards and serves in either position, but because of its shape does not invert the furrow slice so well as does the conventional plough, and does not perform so clean and thorough a job on level land. On hilly land the advantage of the one-way plough is that it is possible to turn all the furrows downhill simply by ploughing backwards and forwards along the contour.

Recently tractor-mounted one-way ploughs have been introduced. Mouldboard ploughs carry two sets of bodies for left and right furrows, which means that the tractor carries double the normal number of bodies for the number of furrows cut. Reversible disc ploughs are also available. These use the same discs for casting soil either to the right or to the left.

The Tractor Disc Plough

Adjustments to a disc plough are similar in many respects to those necessary on a mouldboard plough. On the trailing type of disc plough

there are two furrow wheels, a forward and a rear wheel, and the width of the cut is approximately the distance between the tracks of the two wheels. The land wheel, on which the depth control and the self-lift mechanism usually operate, is placed to the rear. The axle of the land wheel is housed on a main casting to which are attached the rear furrow wheel and the beam bearing the discs. Levelling, which is very important, is effected by adjustments to the front furrow wheel, which is also linked to the land wheel, so that they operate in conjunction.

The angle of incidence of the discs to the soil is adjustable in some ploughs; as a rule, the more nearly vertical the discs, the better the operation on dry, hard soils; on soft wet soils the opposite is the case.

Disc ploughs are particularly susceptible to sideslip or crabbing in the direction of the unploughed land. If it is difficult for discs to penetrate the soil because it is hard, then weight and grip tend to be lost from the wheels, and the plough tends to follow the direction of the rotation of the discs. Additional weights may be bolted to the furrow wheels, particularly the rear, if the trouble is due to difficult penetration. Crabbing may also be due to faulty adjustment of the draught or of the rear furrow wheel. The bias of the rear furrow wheel, the leading edge of which is inclined towards the ploughed land, may in some ploughs be increased; this tends to increase the thrust against the furrow wall, and so counters the forces tending to swing the tail of the plough around. It is essential for the rear furrow wheel to 'track' in the furrow, for not only must adequate side thrust be created, but it is impossible otherwise to adjust the depth of ploughing.

On some makes of disc ploughs the vertical axle which carries the rear furrow wheel may be lengthened or shortened in relation to the body of the plough; the adjustment should be altered according to the type of soil. On hard soil the wheels should be raised so as to throw more weight on the discs; on soft soils it should be lowered so as to check excessive penetration.

Owing to the need for a firm grip by the rear furrow wheel, cross ploughing often introduces difficulties; some measure of improvement may be effected by setting the implement deeper in the second operation than in the first.

The drawbar of a disc plough has horizontal adjustment on a cross beam corresponding to the hake bar on a mouldboard plough. Under ideal conditions the plough drawbar should be parallel to the furrow and form as straight a line as possible from the tractor drawbar through the hake to its attachment on the beam or rear casting of the plough. The tractor drawbar should be slightly higher than the guide on the hake bar. This last tends to keep the rear furrow wheel pressed to the floor of the furrow. If, in spite of all adjustments, crabbing still takes place, it will probably be necessary to soften the soil by knifing.

The land wheel should be adjusted so that it runs parallel to the furrow. Under conditions of hard soil the front edge may be inclined slightly towards the ploughed land. The front furrow wheel should be parallel with the furrow, and adjustment is made by a steering bar attached to the drawbar.

The drawbar and hake bar should be long enough to allow the plough to be run offset in relation to the tractor. This is essential for track-laying tractors, the right tracks of which should be run approximately one foot from the furrow. The plough should take up this position freely. Pinning of the drawbar should be avoided.

A disc plough should always be lifted at turns, otherwise undue strain leading to damage is likely to occur. Disc bearings and other points require frequent lubrication.

In setting a disc plough for the first time a practical method is to run it in the raised position while driving the tractor in a straight line on level ground. Observation of the unit is made from the rear, and adjustments should be made so that land and furrow wheels run parallel to those of the tractor and the position of the front furrow wheel in relation to the driving wheel or tracks of the tractor is as required.

When ploughing has been started, the first cut should be made mainly with the rear disc, with the front discs lifted. On the second time around the front furrow wheel should be run in the furrow and the plough be levelled and adjusted for the required depth of cut.

Most manufacturers make provision for altering the number of discs carried. When a reduction is desirable the rear disc should be removed and the rear casting should be shifted forward. The remaining discs and the casting should be spaced according to the makers' recommendations.

Self-lift Mechanisms

Trailing ploughs are designed to be lifted out of work when required. There are two main types of mechanisms manufactured for this purpose, the rack, and the hub. The latter is the more popular, and it operates on the land wheel. When lift is required, the pull of a cord freezes the wheel to its axle. The axle is crank-shaped, and as the plough is pulled forward the crank revolves, lifting the plough; when a certain position has been reached, automatic tripping takes place, freeing the wheel once more, but retaining the crank in the lifted position. A second pull on the cord returns the plough to work.

Strong springs are provided; the tension of these springs should be adjusted so that the plough may be lowered gently into work. The self-lift pull-rope should be fastened near the driver's hand by a piece of string. Should an undue strain be placed on the rope, the string will snap before damage is done to the lift mechanism.

Mounted Tractor Ploughs

Mounted tractor ploughs are manufactured especially to fit particular makes of tractors; the various adjustments should be based on makers' recommendations to be found in instruction manuals. The adjustments usually out of order are the position of the plough relative to the tractor and the levelling when at work. Depth control is usually effected by the hydraulic mechanism.

PLOUGHING

Neat, efficient, and economical ploughing requires considerable experience as well as application of a suitable system. Each field presents its own problems of technique and equipment. In many instances animal draught is either complementary to tractor draught or the only solution to the problem; in others, the plough must still bow to the fork and the hoe.

Level Land with few Obstructions

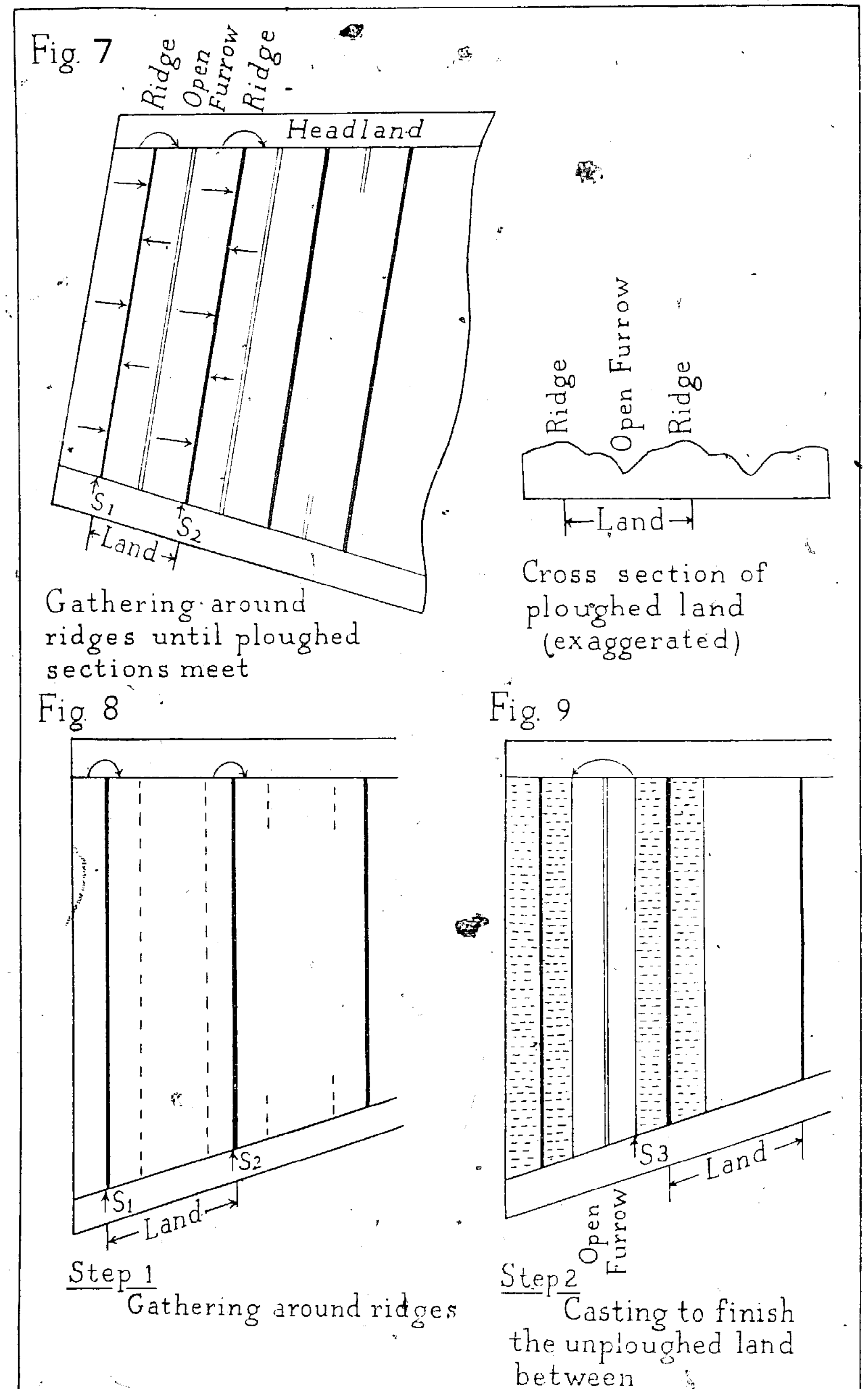
Animal Draught

1. Round and Round Ploughing. Round and round ploughing is the method adopted by most Jamaican ploughmen, i.e. starting at the boundary of the field and turning left at the corners. In the early stages of the work, provided the field is fairly level, there is little to be said against the method, but as the work nears completion the frequency and awkwardness of the turns waste time, cause land to be skipped, and strain the animals. In addition the finish is usually a depression which is difficult to drain.

The alternative is starting in the middle of the field and working outwards, turning right at the corners; this method gives a better job but to avoid finishing up with a lot of odd bits left undone the method should be applied to fields of regular shape only.

2. Ploughing Rectangular Sections. Headlands about five yards wide are first marked by furrows cut across the short side of the field; the rest of the field is then divided into 'lands' by ploughing equally spaced furrows, to mark the future location of ridges, accurately located by measurement and parallel to one of the sides of the field, preferably the longest side. In the simplest method, the first ridge is located *half* the width of a land from the fence. (Lands may be one half to one chain wide.)

Starting around the first ridge, and turning right on headlands (this system is known as 'gathering'), ploughing proceeds until the edge of the



Gathering around ridges until ploughed sections meet

Step 1 Gathering around ridges

Step 2 Casting to finish the unploughed land between

field is reached. The ploughman then moves to the next ridge and repeats the process until he makes contact with the first ploughed section; here there will be formed a 'finish', 'open furrow' or 'dead furrow'. At this stage one land and two half-lands will have been completed (see Fig. 8). In the illustration the straight arrows indicate the direction in which the soil is turned.

A variation of the method just described reduces the amount of free travel on the headlands to a minimum (see Figs. 9 and 10). The first ridge, S1, is cut one quarter of the width of a land, about a quarter of a chain, from the fence. The ploughman 'gathers' a strip on both sides of this ridge as before, and stops when the fence is reached; an equally wide strip is then ploughed around the second ridge, S2, which is separated from S1 by the width of a land. This leaves an unploughed strip a half chain wide between the two ploughed strips. This unploughed strip is now ploughed round the outside, from S3, the ploughman turning left at the headlands; this operation is known as 'casting'. The finish will be an open furrow mid-way between the ridges.

When the field has been completed, the headlands are ploughed either by gathering or casting.

The depth of an open furrow at the finish of a ploughing operation may be reduced by cutting another furrow around it, thereby filling or partially filling it; harrowing, following the completion of ploughing also assists in levelling and filling in depressions; however, the location of ridges should be altered in the same field from season to season in order to prevent the formation of permanent ridges and depressions.

There is a danger that furrow slices will cover unploughed land on the ridges. In order to avoid this, the soil thrown up in the first cut, which should be shallow, should be ploughed back on the return cut towards the furrow from which it came.

To sum up, the rectangular system is a combination of two alternative methods, turning right around a central furrow thereby building up a ridge, and secondly, working from the outside towards the centre, turning left, which leaves an open furrow in the centre at the finish.

3. Ploughing Rectangular Beds. In the ploughing of cane beds separated by drains, it is desirable to maintain the camber of the beds; this can be effected only by 'gathering' around a centre cut in the middle of the bed. Starting from the edge of the drain and casting around the bed would not only create a furrow in the middle of the bed but would tend to fill up the drains.

Tractor Ploughing

1. Round and Round Ploughing. This method is often practised in Jamaica, but there are even more objections in this case than in the case of ploughing with animal draught. Considerable areas of land remain unploughed at the corners having been repacked by the tractor. Turning while at work, and turning in one direction only are bad for gears, brakes and clutches, and the strain is particularly heavy on tractor ploughs which are designed for straight draught only.

If the method must be used, an improvement may be introduced by lifting the plough at each corner so that unploughed strips of equal width extend diagonally from each corner towards the middle of the field. These strips may be ploughed around by casting after the field proper has been completed. Invariably there will be small but difficult sections at the centre of the field and in corners, which may best be left for completion by an animal draught plough (see Fig. 10).

A method similar to that described under Animal Draught (1) and illustrated in Fig. 11 may be used effectively with mounted tractor ploughs which are lifted at turns, with the tractor unit being reversed. Trailing ploughs are obliged to make time-wasting loop turns in order to effect the same result.

As shown in Fig. 11 parallel lines are marked out each the same distance from corresponding boundaries of the field. (This distance should

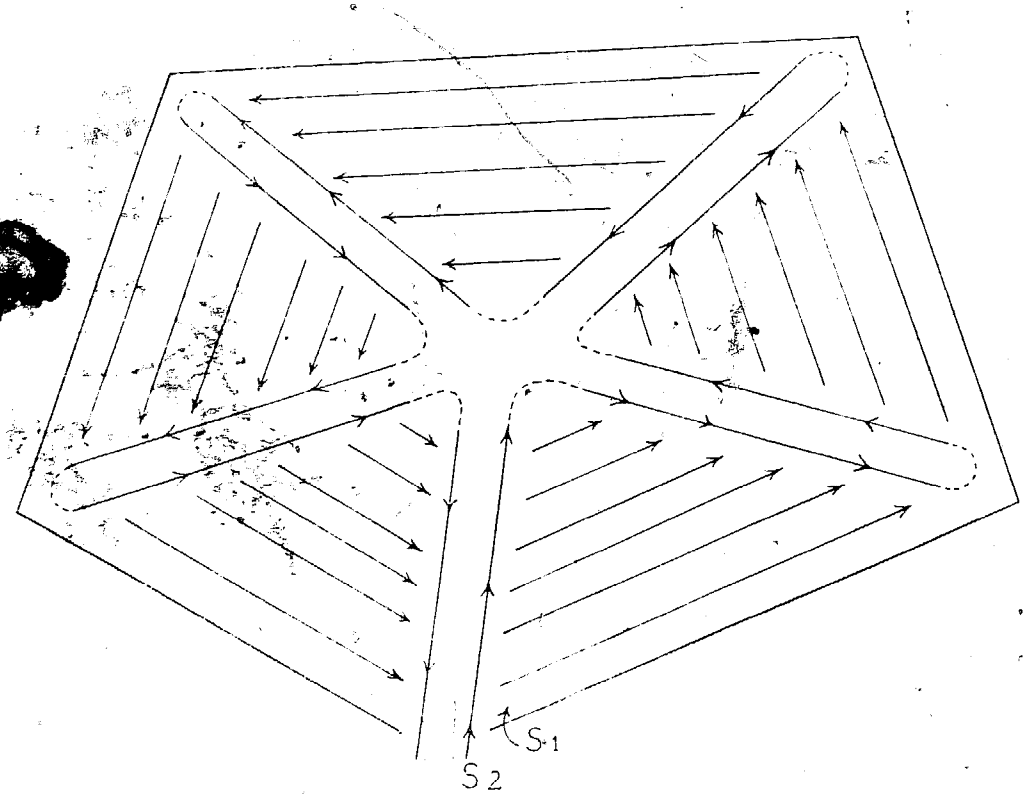


Fig. 10. Round the Field Tractor Ploughing

be a little less than half the narrowest part of the field measured through the middle.) Where these lines cross will be the corners of the replica of the field on a much smaller scale. This small piece is first ploughed in any convenient way and then the rest is ploughed by working round and round as shown.

2. Ploughing Rectangular Sections. In order to avoid difficult, sharp turns when using a tractor with a trailing plough, instead of gathering around a ridge it is more convenient to plough alternate strips one quarter of a land in width simultaneously. When this is done the maximum width a tractor will travel on the headland with the plough raised will be three quarters of a land.

It is usual also to mark out sidelands as well as headlands. Thus a strip eight to ten yards wide is left around the outside of the field, which is finally completed by round and round ploughing.

The first ridge should be marked out *three-quarters* of the width of a

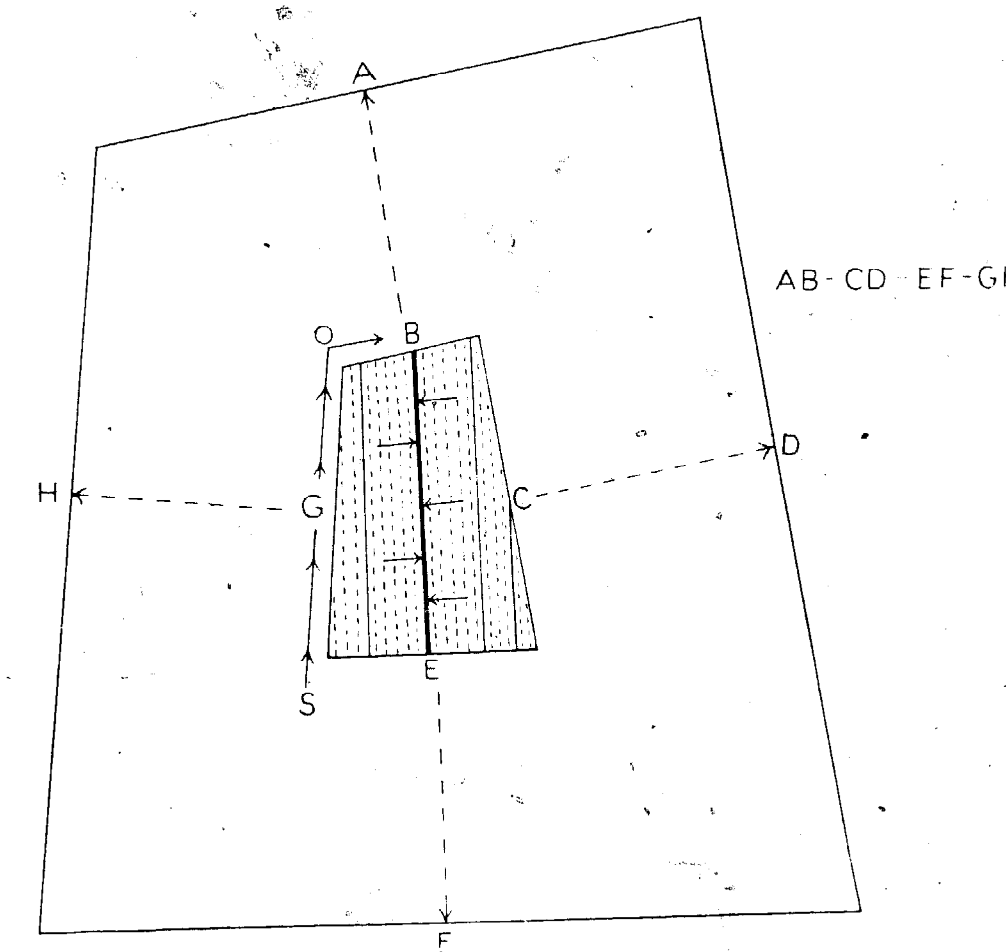


Fig. 11. Round and Round Ploughing (Starting from Inside)

land from the edge of the sideland. Starting at S1 (Fig. 12–A) the driver turns left at the end of the furrow and ploughs two sections, each one-quarter of a land wide, leaving an equal strip between them. When this has been done, the driver turns right instead of left, and ploughs the unploughed strip and a new strip of equal width to the right of the first ridge. Four strips one-quarter of a land wide will now have been completed (Fig. 12–B). The process should now be repeated, starting from the second ridge. In order to complete a field with parallel sides the number of strips one-quarter of a land in width must be made a multiple of four.

A somewhat simpler method of tractor ploughing layout involves left turns only. Headlands are marked out about twice the length of the ploughing unit as before and the start is made three quarters of the width of a land (the minimum width for turning) from the sideland as before. When the

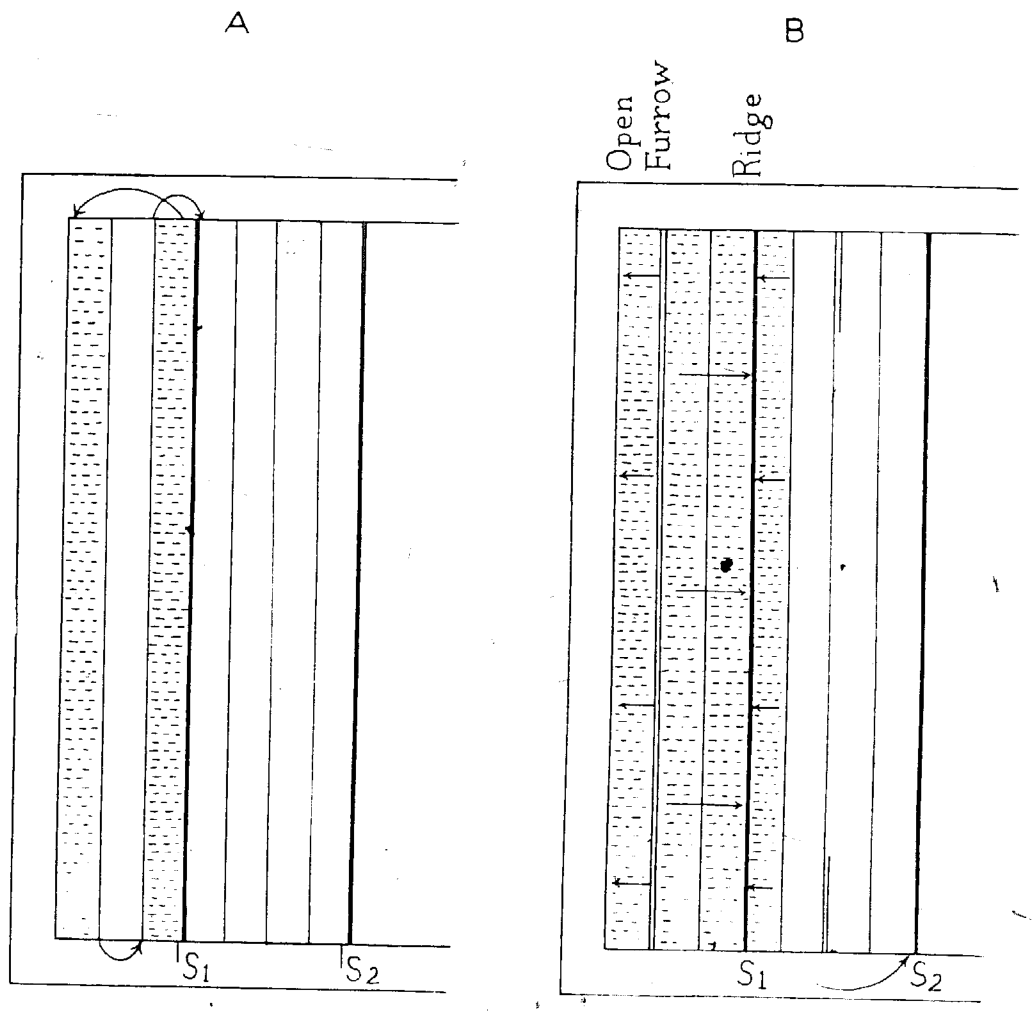


Fig. 12. Rectangular Tractor Ploughing. The straight arrows show the direction in which the furrow slices are thrown

unploughed space between the ploughed strips is about as wide as the two ploughed strips i.e. too narrow for turning, the operator moves to S_2 which is the width of a land or four times the width of a ploughed strip from S_1. The new strip and the unploughed land between the first two strips are ploughed together until it is finished. The operator then ploughs down the line of S_1 and continues until the unploughed strip is again too narrow for turning when the procedure is repeated. (Fig. 12–C).

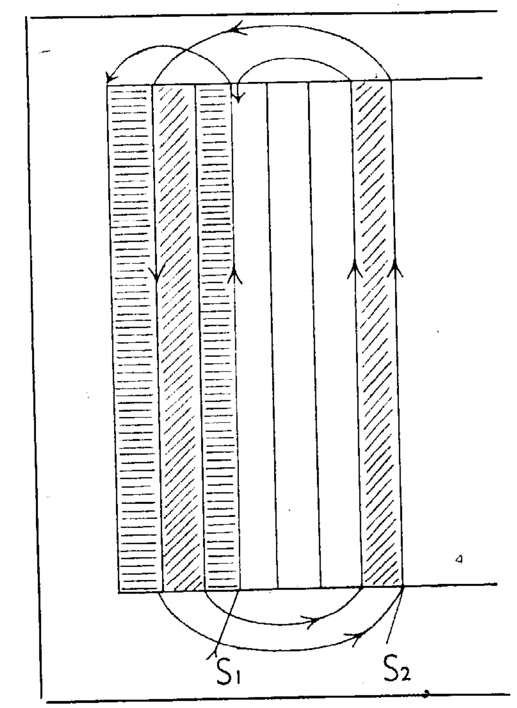


Fig. 12C. Tractor ploughing layout involving left turns only

Sloping Land

The use of animal draught ploughs on sloping lands makes it almost essential for a turnwrest type of plough to be used on the contour, with furrows being thrown downhill.

In the case of tractor ploughs, it must be recognized that tractors and their equipment at present available, especially disc ploughs, were not designed for the steep slopes common in Jamaica, or for cultivation on the contour. On gentle slopes some tractor ploughs may be adjusted to work on the contour. The turning of a tractor and its plough on a narrow contour strip introduces a difficult problem; this is met to some extent by the use of the mounted one-way plough, but even with this type as the slope increases so does the tendency of both plough and implement to side-slip, reducing the width of cut. Moreover, the angle at which the tractor tilts over is uncomfortable and often dangerous to the driver.

In cases where the degree of slope does not limit the action of a tractor

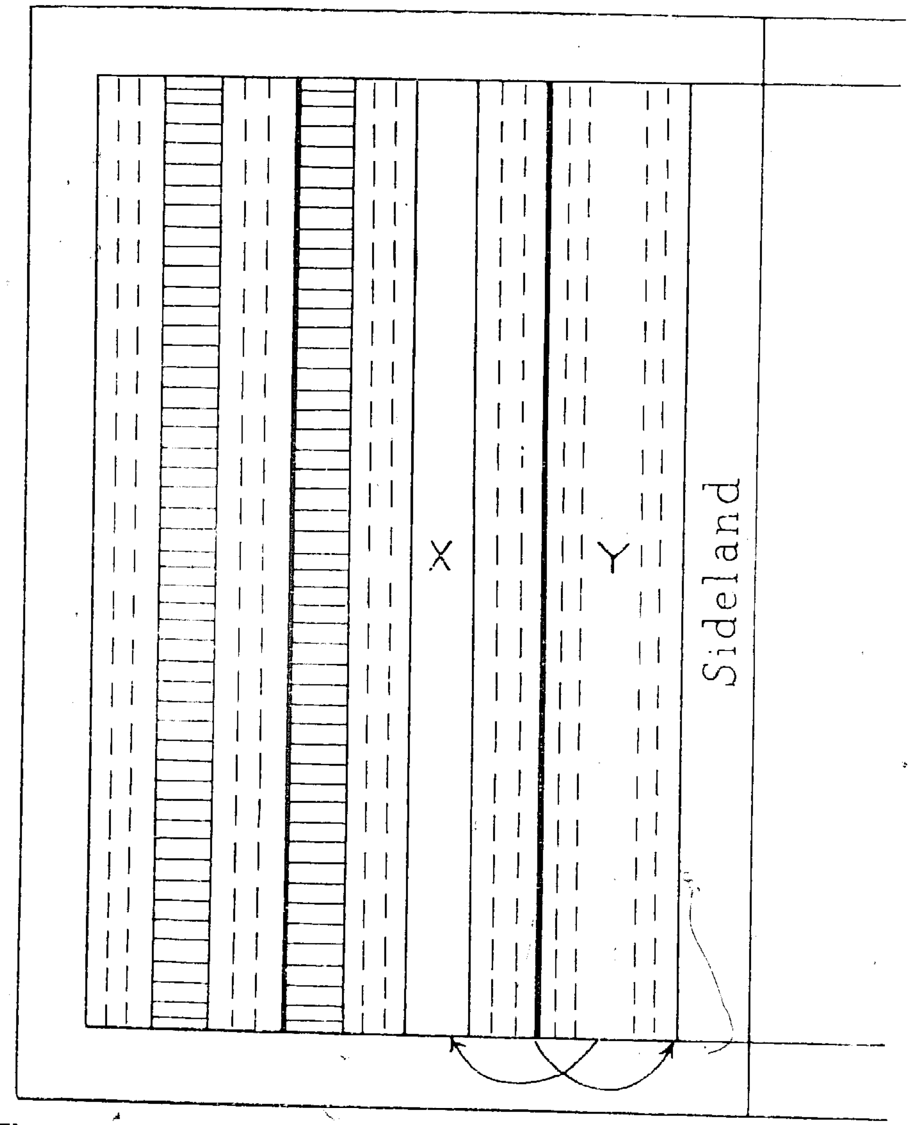


Fig. 13. Rectangular Tractor Ploughing. Alternative Method of Finishing

and plough, but where drains and barriers enclose strips of irregular shape it is usually the best practice to mark out a ridge or centre cut in such a way that the greater part of the area may be gathered. Odd small areas and bulges should be ploughed in one direction and completed before the main field is completed. This permits of turning the unit on unploughed land (see Fig. 14).

Miscellaneous

It is not generally advisable to cut grass and weeds and to allow the litter to remain on the land before ploughing. Sometimes a preliminary disc-harrowing is required, and it is often helpful to graze a field heavily with livestock before ploughing.

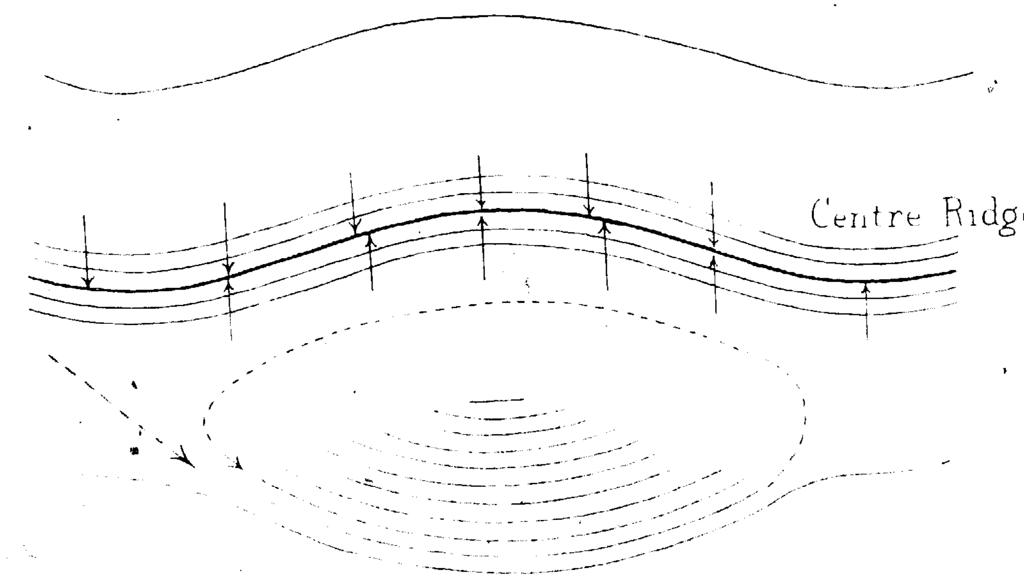


Fig. 14. Contour Ploughing on Gentle Slope. Dotted line indicates path of tractor with plough raised. It makes the circuit until the bulge is ploughed out when ploughing around the centre cut is resumed. Thus turning is done on unploughed land

A difficulty often experienced in ploughing is the short period of time available between the reaping of one crop and the proper time of planting of another; this situation often leads to the use of a plough on land too wet to be safely ploughed, with consequent damage to soil structure. Ploughing should not be carried out when soil sticks badly to the mouldboard except in the case of the red dirt soils of Jamaica which tend to stick to a plough under the best of conditions.

Many soils of Jamaica have very shallow topsoils, and great caution should be used in order to avoid the turning up of infertile sub-soils. On such soils aeration and drainage are better effected by knifing in dry weather than by deep ploughing during planting seasons.

In moist districts, weed control requires the inversion of the top-soil by ploughing, but in drier districts disc-harrowing alone may be adequate tillage, particularly in cases where land was ploughed for a previous crop.

Glossary of Ploughing Terms

Beam. The bar through which the pull is transmitted to the plough body. Beams are usually made of steel, but on some small walking ploughs may be made of wood.

Body. A comprehensive term for the parts of the plough which work in the soil. A multiple furrow or gang tractor plough is often spoken of as having two, or three, or more bodies.

Breast. Mouldboard.

Casting. The reverse of gathering. The plough starts at the boundaries of strip, and proceeds anti-clockwise, turning left, and finishes with a furrow left in the centre.

Clevis. The pins forming the hinge of the hake are known as the clevis pins.

Coulter. A knife or rolling disc attached to the beam on mouldboard ploughs for cutting the soil and surface trash ahead of the shin of the plough, thus forming the vertical furrow wall.

Gathering. Gathering is the process of ploughing around a central furrow, turning right (clockwise) at the ends. A ridge is left at the centre of the ploughed land.

Drawbar. The link connecting the hake and the tractor in tractor ploughs. In disc ploughs the drawbar extends to the rear and is attached to the beam or main casting.

Frog. The frame to which parts of the body as well as the beam are attached.

Hake. The part making flexible connection between the end of the beam and the source of draught. This part is capable of vertical and horizontal adjustment so that the line of draught may be altered.

Handles. Used on walking ploughs to enable the ploughman to steer the implement. Two-handle walking ploughs are easier to control than those with one handle only.

Headland. Sideland. Strips marked around the boundary of a field and used for turning the equipment; sidelands are used in tractor ploughing only.

Heel. The rear and bottom of the landside.

Gunnel. The side of the share point which runs along the furrow wall. It is an extension of the landside.

Jointer or Skim Coulter. A small auxiliary plough often used in temperate climates to assist in the complete covering of grass and green manure crops. It may be used alone or in conjunction with a disc coulter. This device tends to clog under Jamaican conditions and is therefore unpopular.

Land. Section of a field formed in rectangular ploughing; a land is bounded by ridges and presents an open furrow down the centre.

Landside. The plate which engages the vertical furrow wall. The rear is known as the heel and the bottom the sole or slade. In disc ploughs and in some tractor mouldboard ploughs a rear furrow wheel performs the function of the landside.

Mouldboard or Breast. The curving steel plate with which the furrow slice is lifted and turned over as the plough moves.

Point. The forward extremity of the share. On some ploughs the points are detachable. On most steel shares, points are integral parts of the shares. For stony land bar-points shares are sometimes used, with points consisting of short steel bars adjustable in length.

Ridge Backfurrow Centre cut. A furrow marking the boundary of a land.

Share, Wing or Sock. The blade which cuts the horizontal or bottom edge of the furrow, and lifts the furrow slice onto the mouldboard.

Shin. The vertical edge of the mouldboard. On some ploughs the shin is detachable, but on most small ploughs it is part of the mouldboard.

TILLAGE

Tillage includes all operations carried out to improve the physical conditions of the soil and render it more suitable for growing crops. Tilling includes, ploughing, harrowing, cultivating, subsoiling, weeding and draining.

Implements are used to undertake these operations and their design and use vary with the nature of the aim in view which should be to achieve the conditions of soil tilth which allow maximum growth to the crop concerned and at the same time maintain soil fertility.

The use of mechanical implements is in its infancy in Jamaica and too little is at present known of the most suitable implements to use, their most economical method of application, and their effect, beneficial or otherwise on the structure of the soil, erosion and fertility. In the absence of extensive experience (with the exception of the sugar industry) the tendency has been to follow foreign practice but a note of warning should be sounded that it does not always follow that what is routine practice in another country will necessarily be best for Jamaica, indeed in Jamaica itself soil and other conditions vary so much that within the Island the most effective tillage methods vary very considerably. No text-book article on the subject can substitute for practical experience. The farmer would be well advised to approach the subject with an open and enquiring mind.

SOME TILLAGE IMPLEMENTS

The basic tillage implement is the plough, of which there are two types—the mouldboard plough and the disc plough.

The **mouldboard plough** has been used since ancient times. The penetration of the mouldboard plough into the soil is effected by its shape

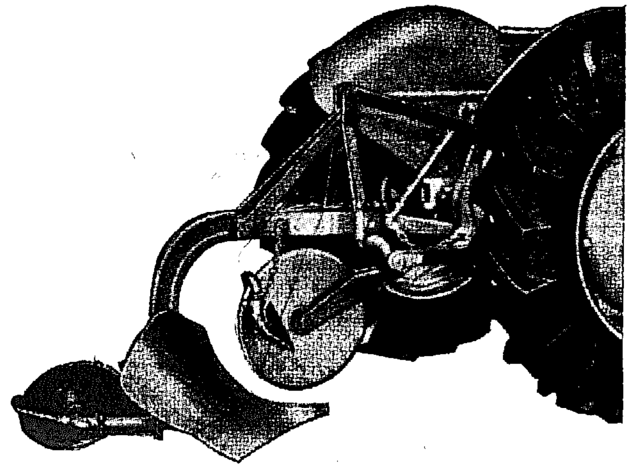


Fig. 15. Single Furrow Plough

as it uses the principle of the wedge to cut, lift, fracture and turn over the soil in strips which are known as furrows (see Fig. 15).

The disc plough as its name implies uses the edge of a concave steel plate which is free to revolve to do a similar job (see Fig. 16). The disc plough however depends largely on its weight for penetration of the soil. For this reason the disc plough is invariably a tractor drawn implement while where animals are used for draft purposes the plough is of the mouldboard type. The mouldboard plough in different sizes and multiple units is also available for tractors but although it is a cheaper unit than the disc plough, tractor mouldboard ploughs are not very popular in Jamaica for the following reasons. (1) They are apt to be bent and broken by roots and other obstructions, (2) They do not cope with dry stiff soils and heavy trash as effectively as the disc plough which is less subject to damage by obstruction. On the other hand the mouldboard plough under suitable conditions does a more thorough job at a more even depth than

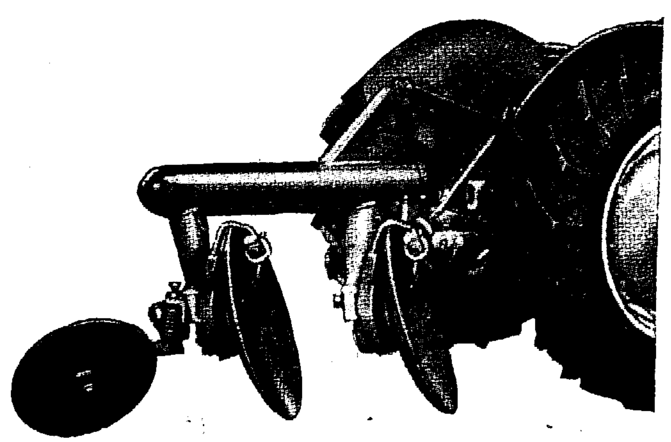


Fig. 16. Disc Plough

the disc plough which tends to plough deep in soft land and shallow in hard soil. Where weed control can be effected by means of ploughing and burying the surface growth the mouldboard plough is superior to the disc.

For tractor draft both types of plough are available as trailed implements attached to the tractor drawbar, or as mounted implements which are carried by the tractor and controlled by hydraulic mechanism. There is therefore a limit to the size of the mounted implements, which, however have great advantage of ease and simplicity of operation.

Both types of plough are available as 'one-way ploughs' that is to say they are reversible and can cast the furrow either to the right or left according to the wishes of the operator. These ploughs have two advantages. There is no need for planning a layout involving alternate strips and a field can be ploughed without leaving ridges or dead furrows as is necessary in the case of the plough that turns the soil in one direction only. The one-way plough can also be used on sloping lands when ploughing on the contour is practised. In very gentle slopes the soil may be turned uphill but in more severe slopes it can only be turned down hill. Such ploughing should only be undertaken in conjunction with soil conservation practices which aim at terrace formation. It should be noted that Americans call the one-way plough a 'two-way' plough (see Fig. 17).

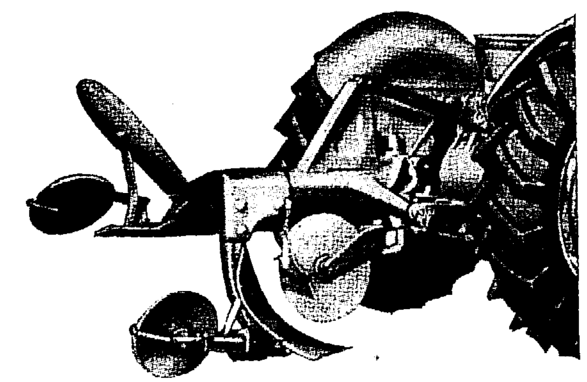


Fig. 17. Reversible Plough

Ploughing results very often in a harmful condition known as hard pan which is consolidation of the soil layer immediately below the depth of ploughing. This 'pan' adversely affects soil drainage and the supply of soil solution to crop roots. This condition is particularly serious in tropical countries where there is no annual frost action which tends to shatter the soil at its lower depths. More attention should therefore be paid to the need for periodic breaking up of the pan formation mechanically. This is done by means of implements known as subsoilers and the operation is known as subsoiling or knifing.

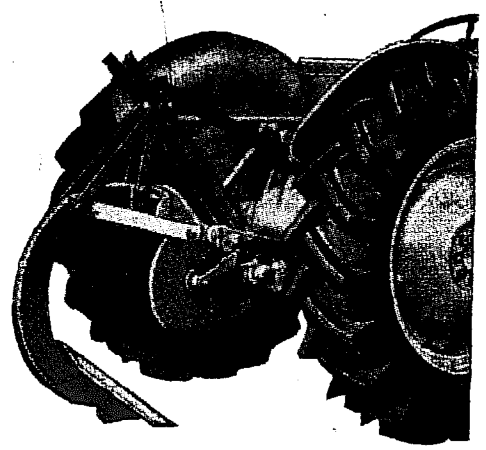


Fig. 18. Subsoiler

Subsoilers which operate down to 30 inches or more are tractor operated. They use suitably shaped knives which shatter the soil usually raising it a little but do not bring the subsoil to the surface. Small single units may be mounted on wheeled tractors but heavier machines are mounted on their own wheels and are drawn by very big crawler tractors. Subsoilers should not be confused with **rippers** which are similar but much more massive machines used for initial land clearing and the breaking up of semi-rocky subsoil (see Fig. 18).

Harrows

Harrows are implements of different shapes and sizes for a variety of purposes ranging from ploughing and land clearing and cultivation of tree crops to the refining of a seed bed.

The commonest type used in Jamaica is the tractor drawn disc harrow which consists of 2 or 4 gangs of discs mounted on square axles which

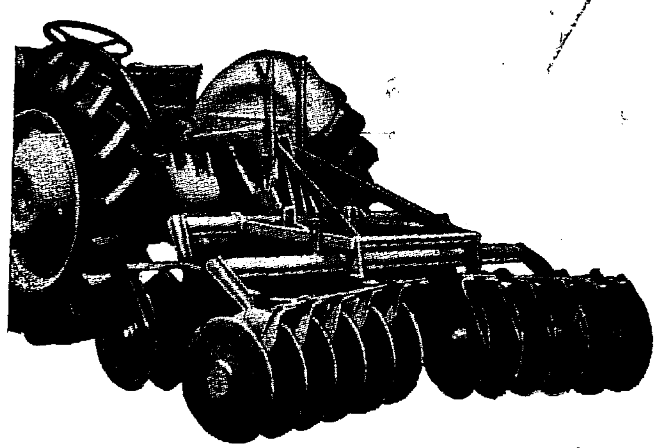


Fig. 19. Mounted Disc Harrow

revolve as the machine is drawn over the land. The penetration of the harrow depends on the angle which the axle makes to the direction of motion which is called the angle of cut, and the weight of the harrow. In heavy trash 'cut out' discs operate more easily as in the case of ploughs light harrows can be mounted to the tractor while heavier types are drawn behind the tractor (see Fig. 19).

Care should be taken in the selection of the harrow for the job in hand as too frequently these harrows are put to jobs for which they are not intended with poor results and rapid deterioration of the machine as a consequence. The commonest faults in the operation of a disc harrow are (1) Lack of adequate lubrication. (2) Allowing the nuts on the main axles to run slack. (3) Using dull discs. It is safe to say that the only harrow in Jamaica that has not been mistreated in one or all these respects is a new one.

Another aspect in the use of the harrow in Jamaica is that the average farmer is impatient and expects to see finished field after one or at most two operations. This is demanding too much in many instances for farmers abroad are willing to work land over many times before it is in satisfactory condition of tilth and weed control for planting. It is often better to repeat an operation than to overload the implement with extra weight and thus hasten its depreciation.

A heavy implement, the 'ploughing harrow' is often used with or without the assistance of the subsoiler for the initial cultivation of land in Jamaica. It is a favourite method of the contractor as it is fast. No authoritative comparison between this method and ploughing with conventional ploughs exists but it may be said that the thoroughness of harrow ploughing often leaves much to be desired and that in weed control conventional ploughing, where expertly done, may be expected to have more effective action.

Tine harrows consisting of a frame with a large number of tines or teeth attached are occasionally used for seed bed prepartion. They are not popular because few Jamaican crops require a very fine tilth for seed germination and the tine harrow is inferior to the disc under weedy conditions when it tends to clog and is difficult to clear. A tine harrow on the other hand is a cheap implement in comparison with a disc harrow and locally constructed ones have been used to good effect.

A similar implement which is useful but often overlooked is the **drag harrow** which in its simplest form is a heavy beam or framework of beams of wood or iron which is dragged over the soil after ploughing. This implement serves to level the land as well as to break clods down to a suitable tilth for planting. More use of this type of implement would save the disc harrow for jobs for which it is more suited.

Cultivators may be regarded as specialized harrows which are used for weeding and tillage of a growing crop planted in rows. There are three

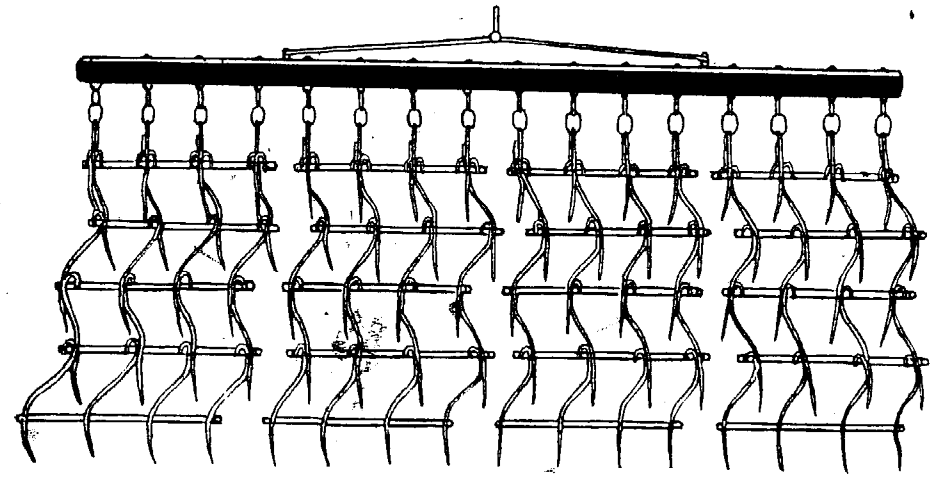


Fig. 20. A Set of Tine Harrows

main types, rigid tine, spring tooth and disc. These may be mounted on wheeled tractors or in small sizes pulled by an animal, e.g. the mule scuffler. These machines are not so far in heavy demand as hand labour is still employed to a considerable extent (see Fig. 21).

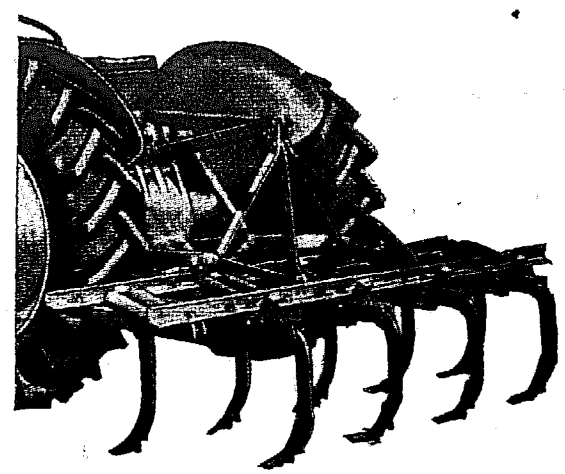


Fig. 21. Tiller

Rotary Cultivators

These are machines driven by a tractor or self propelled which cultivate the soil by means of rotating blades mounted on a shaft which is set at right angles to the direction of motion. Ploughing, weeding, and harrowing are possible in one operation, as well as the incorporation of crop residues or lime into the soil. These machines known as rotary hoes are used extensively in market gardens abroad but their use in Jamaica has so far been limited. There are several reasons for this, one of which is that they require knowledgeable operation and attention, which they seldom

receive. The power requirement except for the smallest models, which are useful for weeding only, is relatively high. This puts the price beyond the range of the farmer they most likely could assist.

Land Clearing and Soil Shaping Machinery

Various implements are available for

(*a*) Cutting trenches and drains
(*b*) Erection of mounds or 'bunds'
(*c*) Levelling
(*d*) Land clearing.

The most effective types of soil moving equipment are very heavy and expensive and include **bulldozers, front-end loaders, rippers** and **land planes.** Such equipment would not be required by the farmer except for capital development of the land when it would normally be made available by a contractor.

On a smaller scale useful work in clearing trees may be done by **winches** which may be hand or tractor operated. Wheeled tractors may be fitted with **tool bars** to which are fitted **'middle busters'** or **double mouldboard ridging ploughs,** for the purpose of cutting small trench for irrigation or drainage or furrows for the planting of crops. The **bunding disc harrow** is a similar implement in which the two disc gangs are tilted for the purpose of heaping soil into a continuous ridge or bund. These ridges may be used for planting crops, e.g. sweet potatoes or more frequently for the impounding of water in contours for rice cultivation.

A small land levelling implement is the **blade terracer** which can be mounted on the rear of the tractor and used for filling depressions or shaping roads. For removing loose earth rear mounted **scoups** are available also small versions of bulldozer and front-end loaders.

Planting and Manure spreading Machines

The maize/bean planter drawn by a mule is the seed planter most commonly used in Jamaica. A few larger machines for drilling rice are also used. Seed is very seldom broadcast in Jamaica.

Machines are used in other countries for planting an extensive variety of crops including the transplantation of seedlings but their application has not so far been adapted to Jamaica to any significant extent. Similarly there is little use made of machines which broadcast fertilizer, lime, or farmyard manure. Modern technique in fertilizer application is turning away from broadcasting, and more emphasis is being placed on machines which place the fertilizer in close proximity to the crop usually below the level of the ground and simultaneously to planting. It may be expected that machines of this type may eventually be used here.

Fig. 22. Mounted furrower (Middle buster) with two bodies

Fig. 23. Mounted disc harrow set to form ridge beds

Grass Management Machinery

Mowers are available in three types all of which depend on tractor draft.

The first is the reciprocal mower which has small knife sections on a bar driven backwards and forwards with scissors like action by the tractor. This is the least expensive type of mower and is suitable for grasses the stem of which offer some resistance. Unless however the pasture is clear of stones, stumps, holes and other depressions this type of mower has limitations and the **Rotary Brush Cutter** which is also driven from the power shaft of the tractor is more popular. In this case the cutting knife is a pair of blades rotated horizontally like a fan. This machine can stand rougher conditions then the reciprocal mower but tends to smash the grass into short pieces rather than cut it into lengths.

The third and latest type of mower is the **forage harvester** in which a reel bearing beaters is made to rotate rapidly while passing over the grass. This type of machine also breaks the grass into small pieces but can be made to throw them into a trailer drawn alongside the machine. It is thus a very convenient implement for the making of silage and may find useful application in the drier sections of the Island engaged in livestock husbandry.

Small self-propelled mowers of both the reciprocating and the rotary type are available.

Barn Machinery

Chaff Cutters are made in various sizes and may be hand operated or power driven. With increasing application of electricity more use may be made of these and similar types of barn machinery such as crop processers, hullers, shellers, fanners, and mills than is at present made.

Spraying Machinery

Many different varieties of pumps are in use in Jamaica for the spraying of crops, weed control, and overhead irrigation. Information on this equipment is too extensive for a survey of this nature and the farmer should seek guidance from the extension services on the type of equipment most suitable for his needs.

Care of Tractors and Farm Machinery

It is not possible to deal exhaustively with this subject in this article, but it is desirable to draw attention to certain aspects which particularly affect the pockets of farmers of this country.

1. Far too little attention is paid as a rule to training drivers how to operate efficiently and to service the equipment as recommended in the operator's handbooks.

2. Lubrication, which is the fundamental basis of maintenance, is often shockingly neglected.

3. Records are seldom kept—the result is that maintenance is haphazard, and casual. For long life and low depreciation, constant maintenance is essential, and it is impossible to be economical and thorough when no records are kept.

4. Often, equipment is expected to do work for which it was never designed. A boy should never be expected to do a man's work.

5. Insufficient attention is paid to housing, particularly that of fuels and lubricants.

6. There is a tendency to over-capitalize: that is to say, to purchase equipment which is too expensive for the size farm on which it is required. In some cases, farmers hope to offset the purchase price of a tractor unit by hirage to others but this often does not prove economical. A better plan is to leave contracting to those who make a whole time business of it and can afford suitable equipment. As a rule, a farmer cannot devote the time needed to supervise equipment when it is away from his farm.

7. Co-operative ownership of equipment in Jamaica has so far not proved a success. Lack of management may be blamed as the chief stumbling block.

8. Too often, in estimating the cost of maintenance of equipment, insufficient attention is paid to the need for repairs and ultimate replacement. Both repairs and depreciation are very heavy items of the cost of maintenance of tractors.

From the above it would appear that the farmer engaging in the use of tractors and other mechanical units should stop to think and ask himself the following questions.

(1) What is the type of equipment that my farm needs? Can I hire, or should I buy my own?

(2) What may it cost per year for operation, repair and depreciation?

(3) Do I have, or can I employ anyone who has sufficient knack with machinery to operate it efficiently?

(4) Do I have, or can I afford to put up adequate storage for the tractor and its fuel and lubricants?

(5) Do I have enough work to justify the purchase of this machinery for my own use, or am I depending on hiring it out? If so, do I really have a reliable estimate of what portion of its cost can be recovered by hirage? Can I undertake the supervision which such a system requires?

CHAPTER 11

Irrigation and Drainage

INTRODUCTION

Water and air are essential for plant growth. If at any stage of the growth of plants water or root aeration is insufficient, yields and consequently financial returns are diminished. The object of irrigation is to supply the plant with sufficient water whenever natural sources are deficient. On the other hand, the object of drainage is to remove excess water and provide the plant with suitable aeration. The correct relationship between water and air in the soil is a necessary although not a sufficient condition for optimum yields and returns. This relationship can only be achieved by practising good soil and water conservation.

The principal objective of this chapter is to set out the main features of irrigation and drainage practices consistent with good soil and water conservation. A minimum amount of discussion on soil, the behaviour of water in soils (its retention and movement) and the response of plants to the various conditions that obtain are included, being of practical importance and essential for a full understanding of the main objective.

Irrigation and Drainage in the Farm Business

Farming is a business and the farmer's aim is to obtain the optimum economic return over an indefinitely long period. He is not interested in maximum yield. His interest in higher yields extends only to the point that greater production adds more to return than to cost. He thus fails to adopt improved agronomic practices when its financial benefits have not been sufficiently stressed and/or realized.

The recommendations set out herein for improved irrigation and drainage efficiency must be kept in correct perspective. They must be adapted to the needs of the farm—not only its cropping programme but its financial condition. For this reason it must be borne constantly in mind that crop yield is determined by a host of other production factors besides irrigation (water) and drainage (aeration) and that the level of crop yield is determined by the value set by the lowest production factor. Thus, it does not pay to supply ample water or good drainage conditions and neglect fertilizer applications or pest control or any other cultivation requirement. Furthermore, because farming involves a diversity of activities, the farmer is not merely concerned whether a crop response will be obtained from further inputs of irrigation or drainage. It is essential for the farmer to know whether a shilling invested in irrigation will yield more returns than a shilling invested in drainage, or fertilizers or other lines within the farm.

THE SOIL

The earth's crust is made up of rocks and the so-called unconsolidated sediments. The unconsolidated sediments are composed chiefly of solid particles derived from the physical and chemical weathering of rocks, plus varying amounts of moisture, organic matter, air and gases. The modified outer portion capable of supporting crops is termed soil.

Soil is a three phase system. Individual particles (solids) occupy roughly one half of the total volume. The remaining space, the voids between particles, is filled with water and gases in reciprocal amounts. Proper proportions of the three phases—solids, liquids and gases—are necessary for plant growth.

WHOLE SOIL CONTAINS

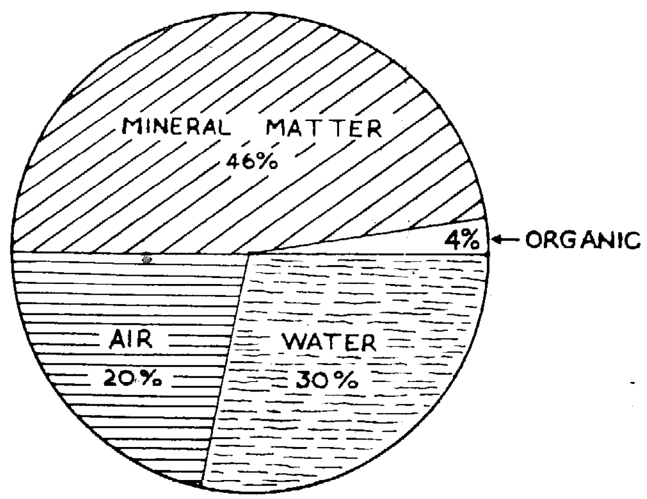


Fig. 1. U.S. Department of Agriculture, Soil

~~**The Soil Type.**~~ Soils ~~varying~~ widely in their physical and chemical properties and thus their ability to support crops are developed as a result of the interaction and variation of five genetic factors. These may be listed as: parent material (rocks), climate, topography and geologic time (age), and living organisms (plant, animal and micro-organisms).

From a morphological standpoint, soils are composed of a series of layers of varying degrees of distinctness. These layers are approximately parallel with the soil surface and are called 'horizons'. Collectively, the

Fig. 2. Soil Profile

horizons make up what is called the soil profile—simply a vertical cut from the surface through the various layers to the parent rock below.

Differences in soil type are clear in the soil profile which is the resultant of all the factors involved in its formation. Since plant roots may be found at great depths, accurate characterization of a soil as a substrate for plant growth requires an examination not only of the surface horizon but also of the portion of the soil that lies below.

Soil Properties important in Irrigation and Drainage. Two soil properties are particularly important. These are: (*a*) Soil Texture, and (*b*) Soil Structure.

Soil chemical conditions such as extremes in reaction (too acid or too alkaline) or salinity and the presence of toxic substances or absence of essential nutrients, may limit root growth. Root depth limitations are more commonly imposed by the physical condition of the soil. The most obvious of these is that the soil profile itself might be very shallow, the parent rock from which the soil is derived occurring at only a few inches below the soil surface. Another physical limitation commonly known to farmers is the occurrence of a hardpan or an impervious layer called a plough-sole caused by repeated cultivation at one depth. Poor drainage or aeration conditions resulting from poor structure of the sub-soil of a soil profile is the usual factor limiting root development. Below are set out the various drainage classes:

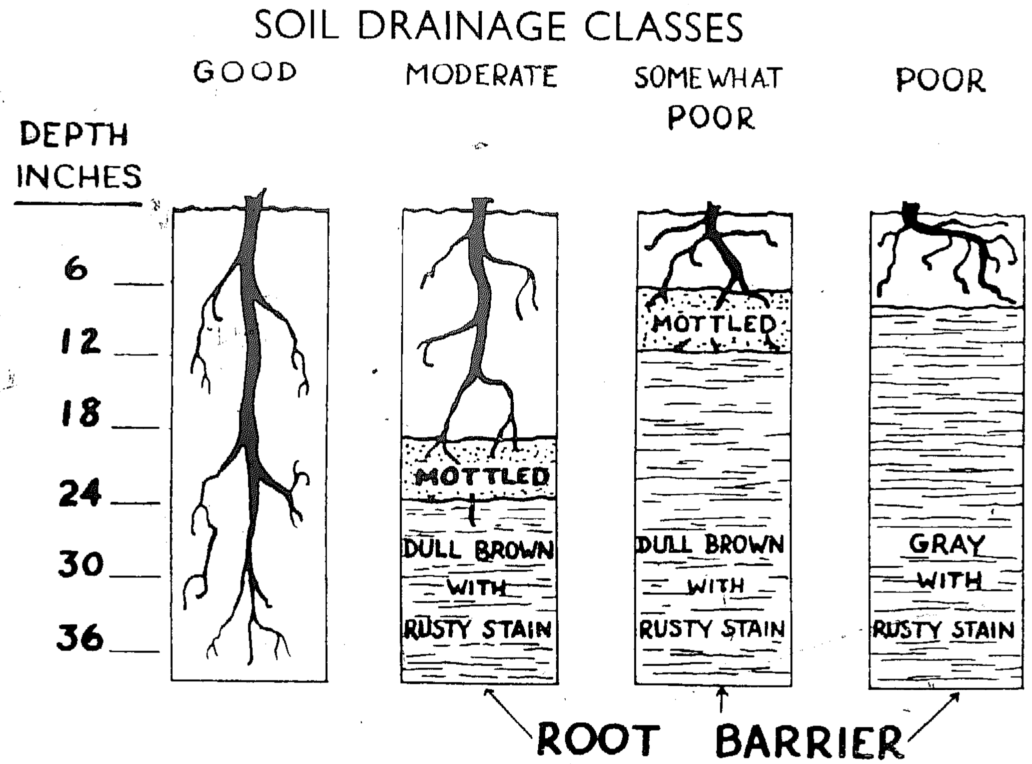


Fig. 8. Cornell Recommends for Field Crops, 1958

It can be readily seen that a crop grown on soil with poor drainage conditions will have a much smaller root room or volume from which to draw its nutrients and moisture, than the said crop grown on a soil with good drainage. It is for this reason that it is pointless speaking of the rooting depth of a crop without specifying the soil condition. As a matter of fact the rooting depth of crops in a particular soil type is the best measure or index of its physical condition.

The depths to which various mature crops will extend their root systems in the soil when grown in deep, permeable well-drained soil under average conditions are shown in the following table:

Table 2

Root Depth for Crops

Crop	*Depth in Feet*	*Crop*	*Depth in Feet*
Alfalfa	10–15	Grain Sorghum	6
Bananas*	3	Onions	1
Beans (Dry)	3·5	Peas	3·5
Beans (Green)	3	Potatoes (Irish)	3
Beans (Lima)	4	Potatoes (Sweet)	4–6
Cabbage	2	Pumpkins	6
Citrus	4–6	Radishes	1·5
Corn	6	Spinach	2
Cotton	4	Squash	3
Eggplant	3	Sugar Cane†	3
Grapes	8	Tomatoes	6–10
Lettuce	1·5	Watermelons	6

* Estimated. † Based on data from Puerto Rico.

Farmers can do a lot to improve the root room of their crops. In preparing their seed beds or fields, farmers can give the soil a good tilth by carrying out ploughing operations at the correct moisture condition. The turning of trash in the subsoil will aid to improve its structure and hence its drainage condition. Subsoiling or deep-knifing of sandy soils will prevent the development of a compacted layer. Planting on banks or mounds will increase the depth to which roots can penetrate before reaching the poorly aerated subsoil. Drains suitably placed will also encourage deeper rooting of crops.

The importance of the depth and habits of rooting of crops to irrigation practices is brought out under the heading Root Zone Water Storage Capacity.

Soil as a Water Reservoir. On rain or irrigation, water enters the soils and is retained in its finer pores and around its particles in the form of films. Excess water percolates through the larger pores to lower depths in response to the pull of gravity.

Field Capacity. The water content of the moistened portion of the soil, after the excess water has drained away and the rate of downward movement has decreased materially, is defined as the field capacity. This moisture content is reached 1 to 3 days after water intake ceases depending on whether the soil is a sand or clay.

Permanent Wilting Point. All the water thus retained by the soil is not available to the plant. As the soil dries out the films of water surrounding the particles become thinner and thinner and much more energy or stress is required to withdraw it. A moisture content is finally reached

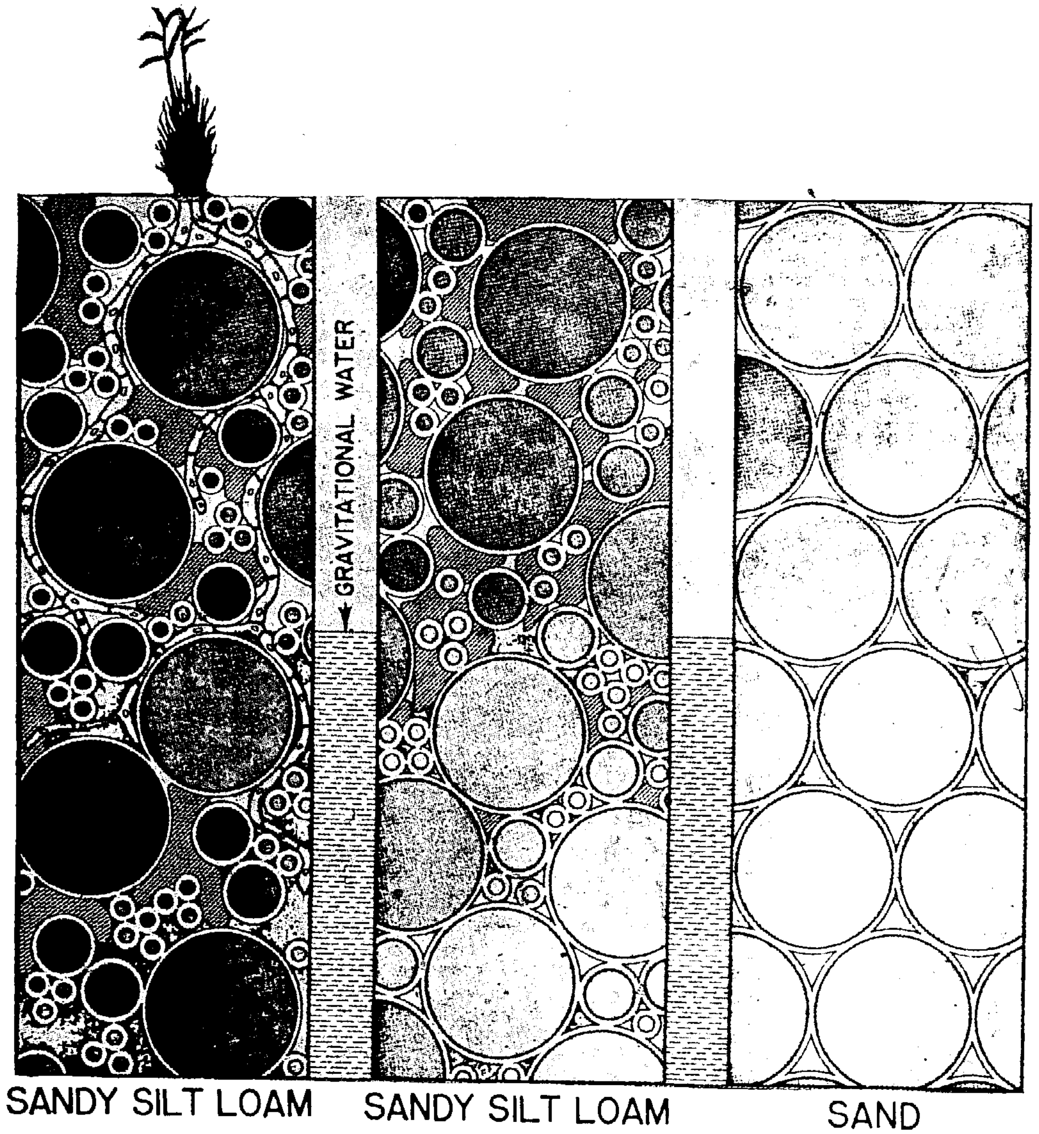


Fig. 9. Water Holding Capacity of Soils

where the rate of water absorption by the roots of plants is so low that they are unable to supply the water losses from their leaves (transpiration). The result is that the plants wilt. The moisture content of the soil at which plants permanently wilt has been called the permanent wilting point.

Available Moisture. The quantity of water held by soils in the range between the field capacity and the permanent wilting point is said to represent the available water capacity of the soils (where 'available water' means water that is subject to utilisation by plants in support of growth).

The amount of water stored in the soil in the available state depends largely on its texture. Below is set out the available moisture capacity in inches of water per foot depth of soil under average conditions:

Soil	*Available Moisture Capacity (inches of water per ft. depth)*
Very Heavy (high in clay)	2·00
Heavy	2·20
Medium	2·00
Light	1·25
Very Light	0·75

The table below serves as a guide for judging what percentage of this moisture is retained in the soil.

For some years, however, the question of the availability of water to plants in the range between the field capacity and the permanent wilting point has been a subject of controversy. One group of investigators argue that plants either do or do not have available water. That is to say, as long as the water content of the soil is in excess of the permanent wilting point, the quantity and quality of the water are not important. Another group of investigators argue that the transition from the available to the unavailable state is gradual and that plant response may be affected to a measurable degree by this transition before the water content of the soil has been reduced to the permanent wilting point. To date, the most desirable moisture levels at which irrigation is to be carried out have not been adequately determined for all crops.

Root Zone Water Storage Capacity. In irrigation, sufficient water should be applied to moisten the entire zone in which crops will find it possible to root. Water in excess of this amount is wasted because the roots cannot get to it. Too little water will result in shallow rooting of the crop and in the need of more frequent irrigation.

Fig. 10 shows the depth of penetration of water in various soils from a 4-inch irrigation.

The depth of irrigation water penetration should be adjusted to the rooting habits of plants.

Crop roots are never evenly distributed throughout its rooting depth (see Figs. 11 and 12) but are usually more concentrated near the soil surface. The extraction of moisture from the entire root zone is therefore not uniform.

Bananas take as much or more than 75 per cent of its water from the first foot depth and sugar cane probably over 60 per cent.

Irrigation engineers in assessing the net moisture to be replaced each irrigation, consider both the available moisture holding capacity of the

Table 3

Practical Interpretation Chart for Soil Moisture

Percent of Available Moisture Remaining	Feel or appearance of soils: Coarse	Light	Medium	Heavy and very heavy
0	Dry, loose, single-grained, flows through fingers	Dry, loose, flows through fingers	Powdery, dry, sometimes slightly crusted but easily breaks down into powdery condition	Hard, baked, cracked, sometimes has loose crumbs on surface
50 or less	Still appears to be dry; will not form a ball with pressure*	Still appears to be dry; will not form a ball*	Somewhat crumbly, but will hold together from pressure	Somewhat pliable, will ball under pressure*
50 to 75	Same as Coarse Texture under 50 or less	Tends to ball under pressure but seldom will hold together	Forms a ball,* somewhat plastic; will sometimes slick slightly with pressure	Forms a ball; will ribbon out between thumb and forefinger
75 to field capacity	Tends to stick together slightly, sometimes forms a very weak ball under pressure	Forms weak ball, breaks easily, will not slick	Forms a ball and is very pliable; slicks readily if relatively high in clay	Easily ribbons out between fingers; has a slick feeling
At field capacity	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand	Same as Coarse	Same as coarse	Same as Coarse
Above field capacity	Free water appears when soil is bounced in hand	Free water will be released with kneading	Can squeeze out free water	Puddles and free water forms on surface

* Ball is formed by squeezing a handful of soil very firmly with fingers.

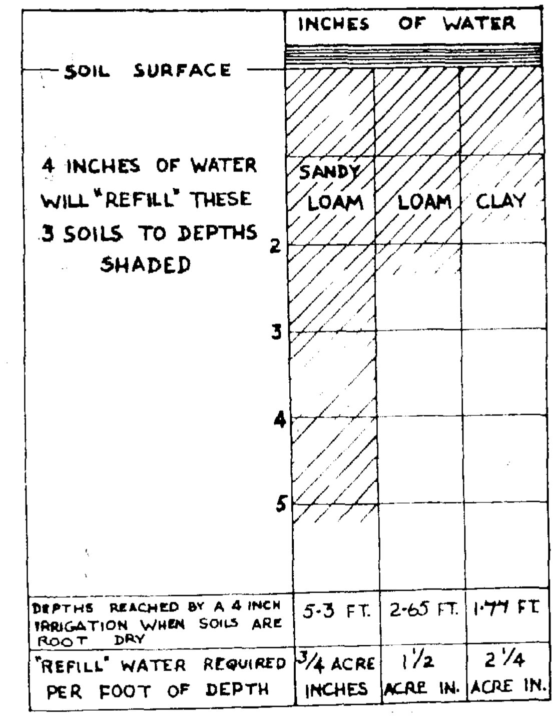


Fig. 10

Depth of penetration of water in various soils from a 4-inch irrigation. (Redrawn after Turville and Hitch, Univ. Ariz. Agr. Ext. Serv. Circ., 1944.)

entire rooting depth and the normal moisture extraction pattern of the irrigated crop. They assume that the available moisture holding capacity of the top fourth (¼) of the root zone is 50 per cent of the total readily available moisture held in the entire root zone at sufficiently low stress to maintain rapid vigorous crop growth.

The following example illustrates the procedure followed in estimating the net moisture to be replaced:

Assume a soil has an available moisture holding capacity of 1·75 inches in the top foot and a capacity of 2 inches for the second, third, fourth and fifth foot of depth. Also, assume a crop root zone depth of 5 feet.

One quarter of the root zone depth will be 1·25 feet. The available moisture holding capacity of the top quarter of the root zone will be 2·25 inches (1·75 + ¼ of 2·0). The net moisture to be replaced will be 4·5 inches (2·25 × 2).

In this example, 50 per cent of the crop root zone available moisture, as considered usually safe by irrigation engineers, has been used as the most desirable moisture level at which irrigation is to be carried out. Some special crops such as potatoes and lettuce are reported to require relatively high moisture levels to maintain crop quality, while, in the

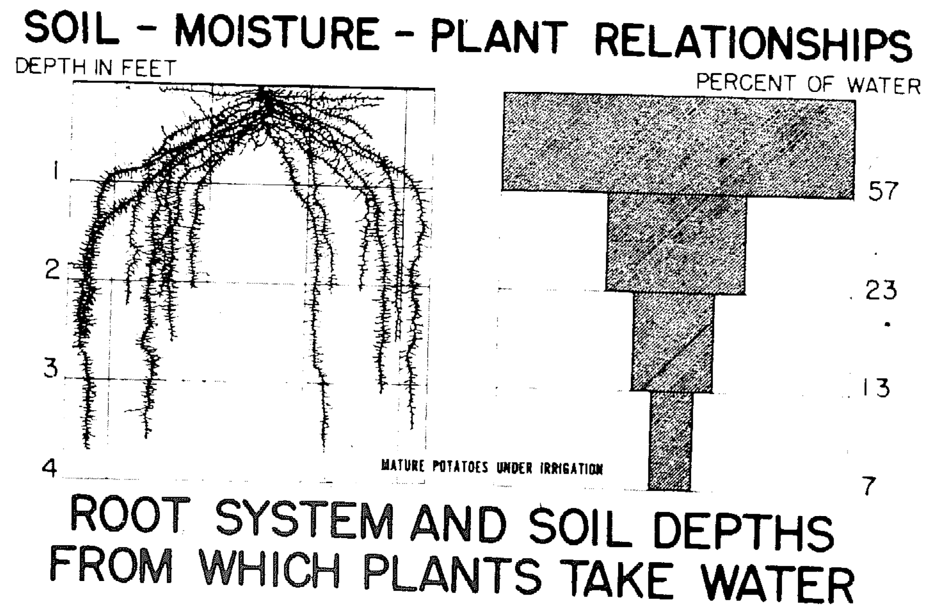


Fig. 11

economic production of sugar cane where the interest is recoverable sugar much lower levels are advantageous. Also, shortage of water might make it necessary for farmers to use a low moisture level, but it is important to note that the danger of severe crop losses (sometimes over 25 per cent) resulting from wilting even for short midday or afternoon periods is so great that it is usually unwise to allow the available moisture to be reduced to less than 25 per cent before re-wetting.

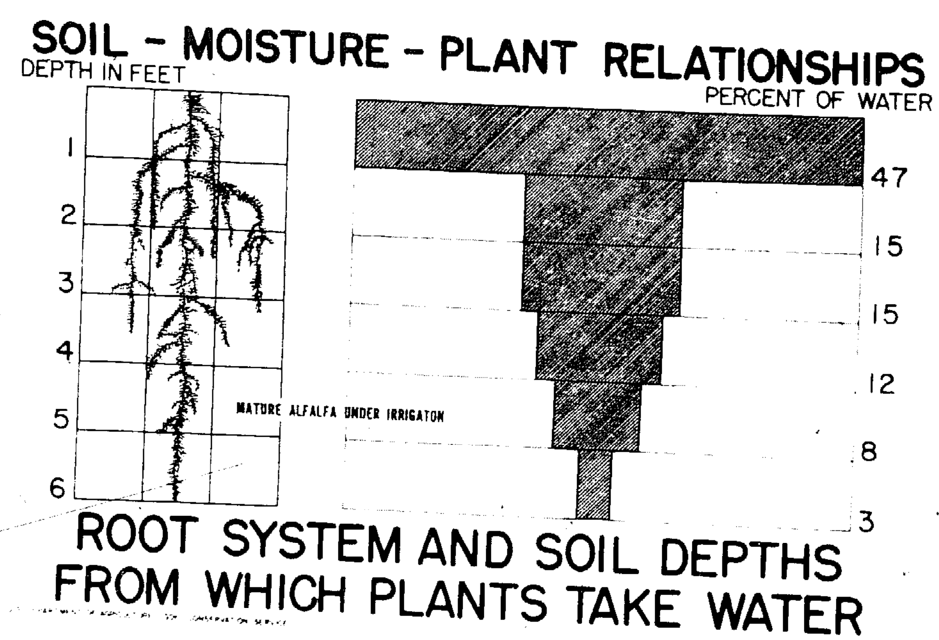


Fig. 12

The Movement of Water in Soils. Soil is a porous medium containing various sizes of pores. The rate of flow of water through these pores decreases rapidly as their pores become smaller. The texture and structure of the soil affect the rate of flow of water as they influence the number, size and continuity of the pores. Clay soils possess a large number of small pores in contrast with a smaller number of larger pores in sands.

The movement of water through these pores is brought about by the action of gravity or capillary pull, either alone or in combination. The type of water movement may be discussed from two points of view:

(1) Relatively rapid movement in a saturated soil—water moved in the larger pores primarily through the action of gravity. This force acts in a downward direction.

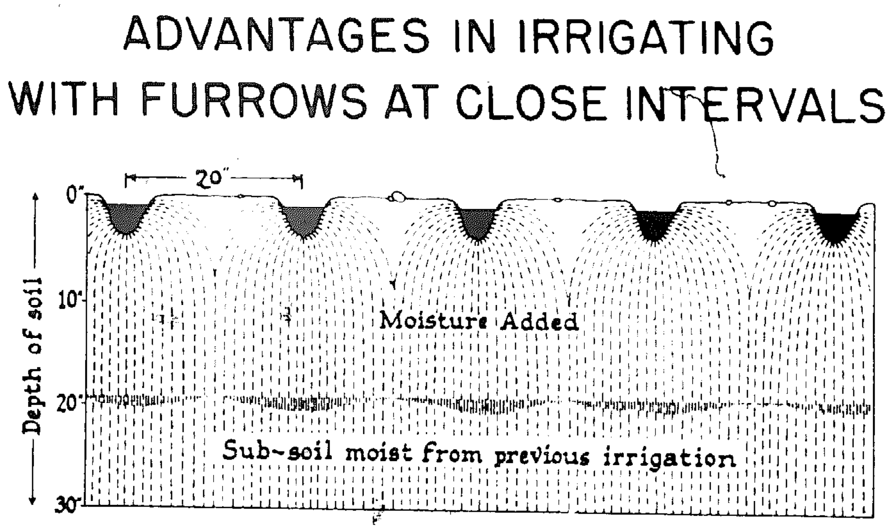
(2) Much slower movement in an unsaturated soil—water moves in the smaller pores primarily through the action of capillary forces. These forces may act laterally, vertically upwards, vertically downwards or at any angle between the vertical and horizontal. Capillary movement downward is assisted by gravity and is therefore slightly faster than in other directions.

The flow of water in saturated sand or gravel is rapid because such soils contain a high proportion of large pores. However, in unsaturated or partially wet soils in which the large pores are air filled water transport is faster in fine textured soils or clays because they contain a larger effective transmitting cross section than the coarse textured or sandy soils.

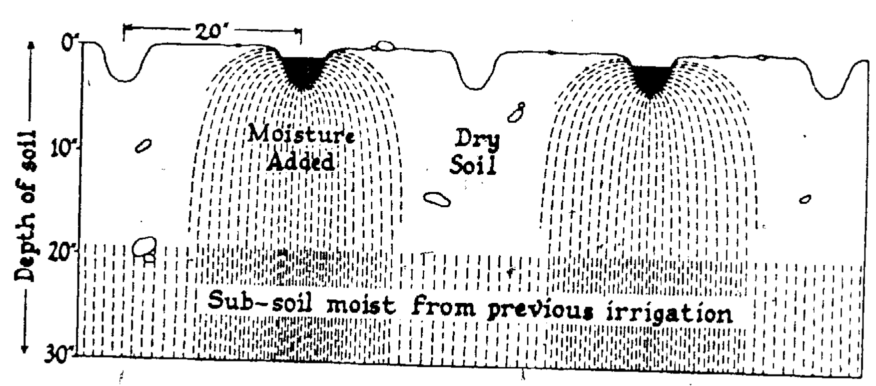
Basic Intake Rate. The rate at which water moves into the soil usually decreases rather rapidly for a time after the start of a rain or an irrigation. The initial entry or infiltration of water is quite rapid because the top layer is usually the driest layer and is in the best state of aggregation. Further entry of water is limited by the rate at which it can be absorbed and percolate through the subsoil. Entrapped air and the plugging of pores by moving particles also reduce the rate of subsequent entry. After several hours, however, the entry usually becomes nearly constant. The basic intake rate is the final, nearly constant rate at which water will enter the soil after several hours of irrigation. It is an important factor in irrigation system design and water management practice. In all methods of irrigation it determines the time required to refill the soil moisture reservoir. With other factors such as slope and erodability of the soil it determines the size of streams and the maximum length of run for border and furrow irrigation.

The Wetting Pattern of Soils. During entry of water in a dry soil the water moves downwards in the form of a 'front'. Beyond this front the soil remains apparently dry and immediately at and behind the front the soil is apparently completely wetted. Advance of the front causes the development of wetting patterns because there is a sharp line of demarcation between the obviously wet soil and the obviously dry soil.

The wetting pattern of furrow irrigation is very interesting for in this case water is applied directly only to a portion of the soil and consequently the wetting front also advances laterally. Generally, soil profiles are not homogenous and lateral movement is influenced by the relative permeability of successive layers. A layer of slowly permeable soil within or near the root zone, as in the marine clays of the Clarendon and St. Catherine plains of Jamaica, may cause a temporary parched water table and wide horizontal movement of the water. In contrast, an extremely permeable under layer may curtail horizontal movement. Furrow spacings must be so adjusted as to ensure horizontal overlap of the wetting patterns of individual furrows.



Water in every furrow for three hours



Water in every other furrow for six hours

Fig. 13

CROP WATER REQUIREMENTS

The parts of the plant that are exposed to the air are subject to drying by the evaporation (loss) of water from the cells. The evaporation loss of

water from plants is called transpiration. By far the greatest portion of water taken up by roots of a plant is lost by transpiration.

For every pound of dry matter in a plant we commonly find about 5 or 10 lbs. of water, but for each pound of dry matter produced, the plant must absorb several hundred pounds of water; the difference between the 5 or 10 lbs. and the several hundred pounds represent water lost by transpiration.

Transpiration is a most essential process for plant growth. It keeps the plants cool and prevents them from burning up in the heat of the sun. It also hastens the transport of nutrients absorbed in solution by the roots to the leaves—see Fig. 6.

Continued transpiration is possible only if the plant has a continuing supply of available moisture. If the supply becomes depleted or if loss of water exceeds the rate of water uptake the plant eventually wilts and transpiration is curtailed. A severely wilted plant, which has closed stomata or leaf openings, cannot carry on photosynthesis effectively because the necessary exchange of gases with the surrounding air is impaired. Photosynthesis is the process whereby the green plant tissue manufactures sugars from the carbon dioxide absorbed from the air and water obtained from the soil. This process also produces oxygen.

Although excessive transpiration may injure plants and reduce yields, very little can be done to control it under field conditions. Weather condition governs almost entirely the transpiration losses for turgid plants as well as the evaporation losses from soil or free water surfaces.

Evapo-transpiration is the term used to denote the combined total loss of water to the atmosphere from evaporation from the soil and transpiration from plants.

Investigators have established that the daily rate of evapo-transpiration from a given land area is determined by climatic, soil moisture and plant conditions. For explanation, any plant will need more water on hot dry windy days than on humid cool or calm days. Again, areas of high solar radiation have much higher temperatures and lower average relative humidities and thus require more soil water for a given plant than areas of lower solar radiation.

Under conditions of wet soil surface and complete crop cover, the crop intercepts nearly all the heat from the sun and the wind and direct evaporation from the soil surface will only be a small fraction of the total evapo-transpiration losses from the soil water. If, however, the crop cover is incomplete, the crop will only intercept a fraction of the heat from the sun and wind. The remainder will be absorbed by the soil and used for evaporating surface soil water.

The ratio of transpiration to total evapo-transpiration will depend upon the fraction of the heat intercepted by the crop. Lastly, as to be expected, a large banana tree will use more water than a small one, and a field of cane will require more water than one of grass. However, differences of water use due to the type of crop and their stage of development will not be great as long as the climatic conditions do not differ. It is the climate that largely determines the quantity of water used. Table 4 is included merely to illustrate the magnitude and variation of evapo-transpiration or consumptive use of water by crops during different periods of the year. They have little or no application to Jamaican conditions where the climate is different.

Climatic Data and Irrigation Planning. A simple and powerful tool for determining irrigation requirements by using climatological data is afforded by acceptance of the concept of potential evapo-transpiration and its application for the calculation of soil moisture deficit.

The Concept of Soil Moisture Budget. Starting with a field under humid conditions in which the only source of water is that applied from above in the form of either rain or irrigation and the only loss is through evaporation from the soil and transpiration from the crop, it is a simple matter to calculate day-to-day changes in the soil moisture content.

In terms of the deficit of soil moisture below field capacity, the deficit at the end of today equals yesterday's deficit plus today's evaporation and transpiration minus today's rainfall and irrigation. In other words, evaporation from the soil and transpiration from plants use up water and so increase the soil moisture deficit. Rainfall and irrigation add water and thus decrease the deficit, that is to say return the state of the soil moisture towards field capacity. The soil acts simply as a reservoir for the moisture.

Part of this soil moisture budget equation can be readily evaluated. Rainfall is easily measured and the amount of irrigation water applied to a crop can be determined. The other part, evaporation and transpiration, is more difficult to determine but it can be estimated by direct or indirect measurement or calculation.

The direct method consists of enclosing a mass of soil in a tank to which water is added daily. Various means may be provided for measuring the water consumed daily by a crop growing in such a tank.

Several instruments for indirectly determining evapo-transpiration have been used. Commonly used are: the 4-foot diameter open water tank, the Piche atmometer and the Livingston porous spherical bulb atmometer.

Innes and Cowan have established a relationship between evapo-transpiration from sugar cane and open pan evaporation for Jamaica. Their investigations suggest that sugar cane daily water use amounts to 0·6 of a standard open pan.

Once the relation between climatic factors of an area or easily measured open pan evaporation and evapo-transpiration from a particular crop has been established, the frequency and quantity of irrigation applications become a simple matter of book-keeping.

Table 4

Consumptive Use of Water for Principal Irrigated Crops in Inches

Crop	*Jan.*	*Feb.*	*March*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Total*
Beans	1·4	3·48	3·20									0·76	8·84
Bananas	4·96	4·6	5·64	6·2	6·12	6·56	6·80	6·04	6·0	5·64	4·28	4·00	66·84
Corn (1)					0·84	3·00	3·60	1·68	0·68				9·80
(2)							0·96	2·76	3·00	1·76	0·48		8·96
(3)	2·48	1·28	0·62								0·60	1·80	6·78
Grain Sorghum (1)					0·48	2·28	3·08	2·20	1·04				9·08
(2)							0·56	2·12	2·72	2·04	0·68		8·12
(3)	2·24	1·68	1·00								0·36	1·40	6·88
Cotton Annual (1)					0·80	1·16	3·88	5·36	4·04	2·44	1·68		19·14
(2)								1·04	3·4	5·0	2·88	1·72	14·04
Sugar Cane	4·44	3·72	3·80	3·68	3·80	4·28	4·68	5·68	5·80	5·52	5·20	4·44	55·04
Rice (1)					2·28	10·00	10·96	10·00	10·32	3·20			46·76
(2)	7·96	7·60	9·72	3·56							1·60	6·08	36·52
(3)	6·64	8·12	4·32									0·80	19·88
Tomatoes	4·20	3·36	3·28								1·60	1·92	14·36

A sample soil moisture budget calculation is shown in Table 5. In this table 'Deficit' is considered as the deficiency in stored soil moisture. In other words, it is the amount of irrigation water required to bring the soil moisture to field capacity.

In calculating the budget it must be remembered that potential evapo-transpiration is water used by the crop and tends to increase the deficit. Therefore P.E. values must be added to the deficit. On the other hand, rain and irrigation replenish the soil moisture and decrease the deficit. If rain and irrigation exceed the deficit, there will be a surplus and this amount is entered in the surplus column. This either runs off or percolates to below the root zone and is lost to the crop. The relative amount of deep percolation to surface runoff losses will depend on the infiltration rate of the soil at the particular moisture content, its slope and crop cover. This however is not important as far as irrigation schedules are concerned but are of interest to flood control, underground water supplies, etc. Fig. 14 shows the water cycle.

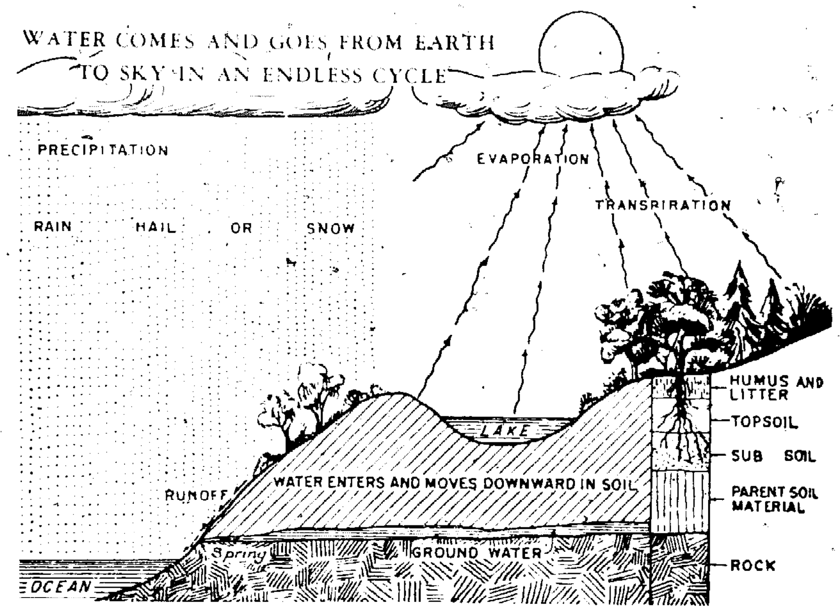


Fig. 14

Climatic data and a quantitative knowledge of the rate of water movement from soil and plant upwards into the atmosphere (evapo-transpiration) provide a more fundamental understanding of problems in many fields of endeavour.

We have seen its importance in irrigation Schedules but it is equally important in engineering design and other agronomic practices. For example, engineers design irrigation systems to take care of the water needs of crops during their peak evapo-transpiration or consumptive use periods. Referring to the example cited under Root Zone Water Storage Capacity

Table 5
Soil Moisture Budget

Date	Latent Evaporation	Potential Evapo-transpiration L.E. × 0·0034	Rain	Irrigation	Soil Moisture Deficit	Soil Moisture Surplus
	c.c.	ins.	ins.	ins.	ins.	ins.
1					2·17	
2	74	0·25		1·00	1·42	
3	67	0·23			1·65	
4	50	0·17	0·37	1·00	0·45	
5	40	0·14	0·08		0·51	
6	53	0·18	0·40		0·29	
7	43	0·15			0·44	
8	41	0·14			0·58	
9	64	0·22			0·80	
10	24	0·08	0·65		0·23	
11	27	0·09			0·32	
12	57	0·19			0·51	
13	12	0·04	0·89		0·00	0·34
14	47	0·16	0·02		0·14	
15	47	0·16	0·11		0·19	
16	13	0·04			0·23	
17	28	0·10			0·33	
18	36	0·12			0·45	
19	58	0·20			0·65	
20	46	0·16	0·37		0·44	
21	70	0·24			0·68	
22	49	0·17			0·85	
23	39	0·13			0·98	
24	48	0·16			1·14	
25	44	0·15			1·29	
26	46	0·16			1·45	
27	56	0·19	0·02	1·00	0·62	
28	46	0·16			0·78	
29	54	0·18			0·96	
30	26	0·09	0·37		0·68	
31	60	0·20			0·88	

From Publication, 1045 Canada Dept. of Agriculture.

in which the net moisture to be replaced on irrigation was 4·5 inches and assuming that in the Mid-Clarendon Irrigation Area of Jamaica investigations established that sugar cane uses 0·30 acre inches of water per acre per day during the month of June and that water use during other months were less, all irrigation installations would be planned to make it possible to re-wet cane fields on the soil type in question every 15 days—

$$\frac{4{\cdot}5}{0{\cdot}3} = 15.$$

For a long period it was thought that the creation of a dust mulch was a moisture conservation measure of considerable value. Evapo-transpiration studies indicate that it is of little consequence and that trash, dry grass, bagasse or other mulches are not very effective in reducing stored soil moisture losses unless of appreciable depth (over 4 inches); a fact which dry farmers in St. Elizabeth, Jamaica, are fully aware.

Climatic and Evapo-transpiration data are essential in the planning of water supplies, flood control, drainage, mechanical operations and indeed in the consideration of almost every aspect of soil and water conservation. Its importance cannot be over-rated.

METHODS OF IRRIGATION

The four basic methods of applying water to soil are by:

(1) flood irrigation;
(2) furrow irrigation;
(3) sprinkler irrigation; and
(4) sub-irrigation.

Flood irrigation includes wild flooding, border, and basin methods. Furrow irrigation is generally assumed to include contour furrow systems. Sprinkler irrigation includes any system whereby water under pressure is sprayed on the soil surface. Sub-irrigation can be practically carried on in very limited areas by controlling the water table. Soil moisture is replenished by water moving up through capillary action from the water table when it is raised for short periods.

Border irrigation is the most widely used adaptation of the flood methods. Water is turned into the upper end of a field between parallel ridges or borders. The strips of land between these borders have little or no cross slope but will have a grade in the direction of water flow. Fig. 15 illustrates the main features of a border irrigation layout.

The border method of irrigation is used for irrigating close growing crops such as grasses and small grains. The borders are usually of the wide type as shown in Fig. 16. Wide borders are liked for permanent installations in fields since they are easily crossed with farm machinery and are capable of being wet to support crop growth over the entire surface. The narrow type of border is usually used only for temporary border irrigation where land requires a wetting before further land preparation is carried out or in orchards where no cover crop is used. Permanent narrow borders may be used on land having considerable cross slope if the fields will not require the use of much machinery.

Since most fields will have some cross slope there will be a drop between successive border strips. Drop between border strips in excess of 6 inches may cause difficulty in wetting the border and also makes the border more difficult to cross with machinery. For best results the width of the border strip should be adjusted so the drop does not exceed this amount. If the field cross slope is too great to allow this, an occasional

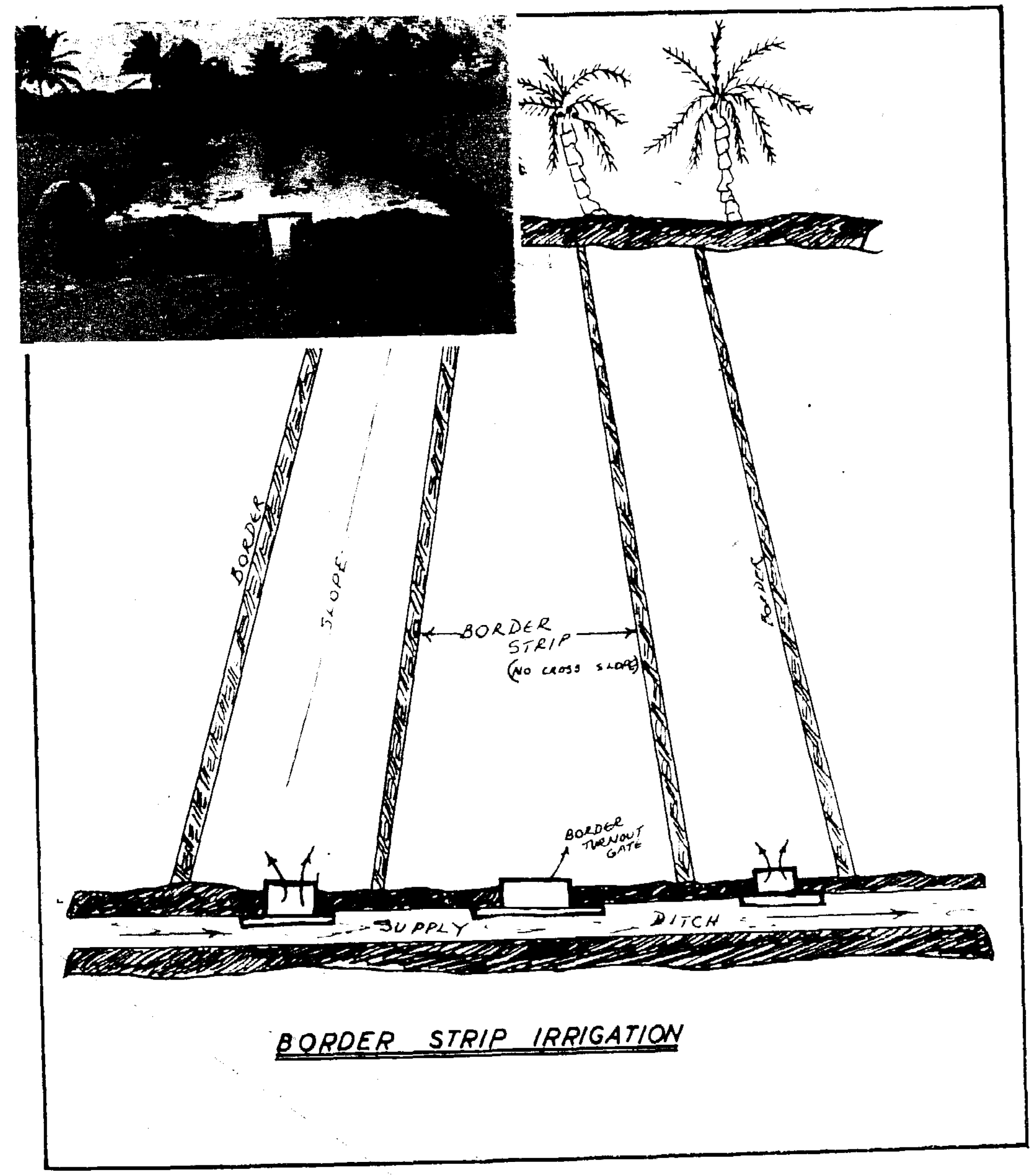


Fig. 15

major terrace can be used. Border strips under 15 feet in width are generally considered to be quite narrow, however they may have to be used at times. The width of strips used between borders also depends upon the size of irrigation stream available, and on the steepness of the slope in the direction of flow.

The irrigation slope, whether the natural slope of the field or a resultant of land levelling, must be considered in choosing the width between borders. A slope of 0·15 per cent (0·15 feet per 100 feet) is usually considered minimum and a slope of 2 to 3 per cent maximum depending somewhat upon the soil type and the erosion preventive characteristics of the crop being grown. The steeper slopes require narrow border strips and the flat slopes may have border strip spacing to 60 feet widths.

The length of border strips should be such that a near uniform depth of water can be applied. If the run is long and the water intake rate of the soil is high, the upper end of the strip will receive more water than the

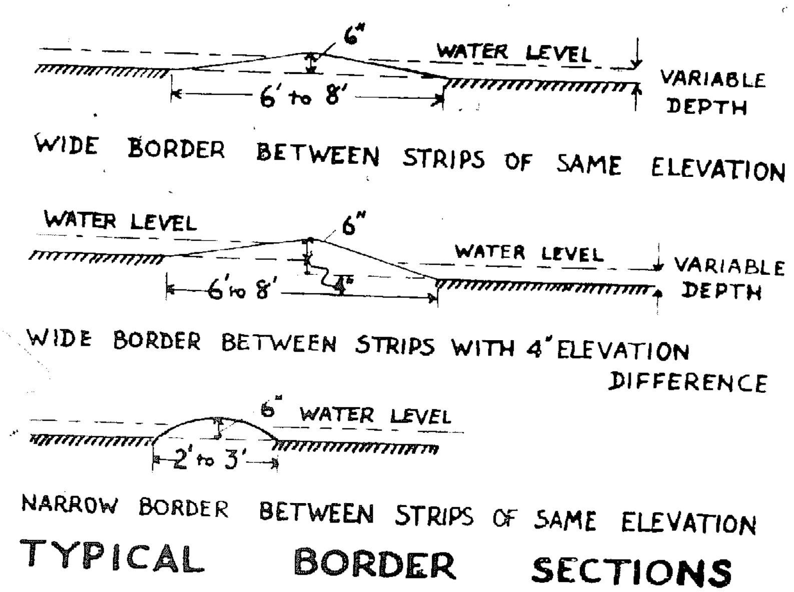


Fig. 16

ower end. Fig. 17 illustrates a typical advance and recession curve for water flowing in a border strip. These curves would indicate the border should be only about 600 feet long in this case. The length of time water has the opportunity to enter the soil at various distances along the strip length must be nearly equal for uniform applications of water. This

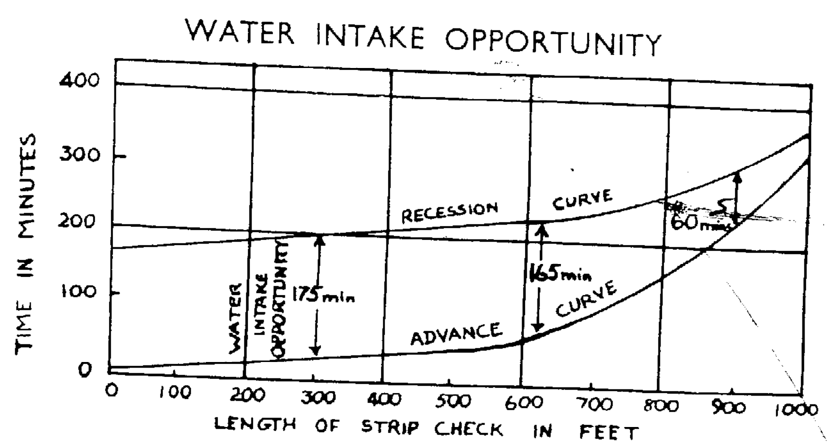


Fig. 17

The opportunity time for water to enter the soil on a border strip is shown above. Note that the first 600 feet of the 1000 foot strip is nearly equal.

'opportunity time' is the time elapsed from when the initial flow reaches some point until the flow recedes or disappears at that point.

The water-intake rate of a soil can be determined by using a metal cylinder at least 12 inches long and 9 to 12 inches in diameter. The cylinder is pressed or driven into the soil about 4 inches deep and water is added to determine the rate of absorption by the soil. Most soils will take water quite rapidly at first and settle down to a 'basic intake rate' after several hours. Tests made when the soil is moist may show a slower intake rate than when the soil is dry.

The size of the border stream required depends upon the width and length of border strip, the depth of application of water, the slope of the

Table 6

Factors for use in adjusting border strip streams from Fig. 18 for slopes other than 0·5 per cent

Slope %	*Slope Factor*	*Slope* %	*Slope Factor*
Level	2·00	0·8	0·90
0·1	1·43	0·9	0·88
0·2	1·23	1·0	0·86
0·3	1·13	1·5	0·78
0·4	1·04	2·0	0·74
0·5	1·00	2·5	0·70
0·6	0·96	3·0	0·67
0·7	0·93	4·0	0·63

strip and the intake rate of the soil. If only a limited water supply is available the border size must be adjusted accordingly. Fig. 18 gives a method of estimating border stream size. The following example will serve to illustrate the method:

Assume a border strip 30 feet wide and 600 feet long has a slope of 1 per cent or one foot in a hundred feet and the basic intake rate of the soil has been found to be 0·5 inches per hour. Assume also that 3 inches of water is to be applied for an irrigation. Fig. 18 would indicate the desirable unit flow would be 0·005 cubic feet per second. The slope factor from Table 6 is 0·86. The corrected unit flow then will be 0·005 × 0·86 = 0·0043 cubic feet per second. Since the unit flow is given for a strip one foot wide and 100 feet long it must be multiplied by the width and by the length in hundred foot units. In this case the border stream requirement would be 0·0043 × 30 × 6·00 = 0·77 cubic feet per second or 288 Imperial gallons per minute. (See conversion Table 8). The following formula can be used to determine the number of hours required to apply a 3-inch depth of water:

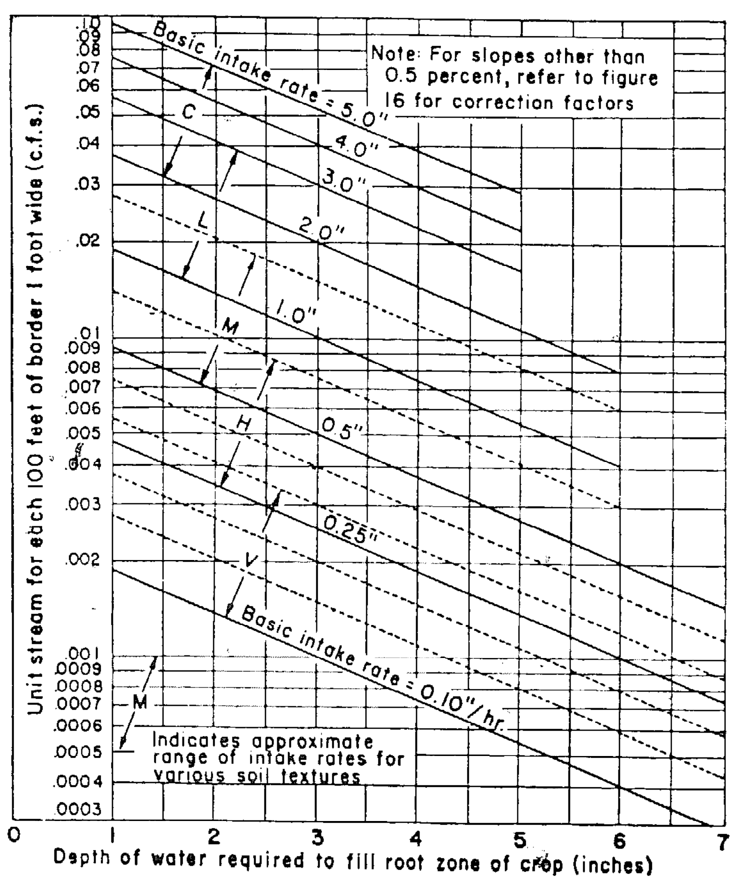


Fig. 18. Curves for estimating unit-border streams on slopes of 0·5 per cent.

$$\text{Hours of irrigation} = \frac{\text{Depth in inches} \times \text{acres in strip}}{\text{flow in cu. ft. per second}}$$

A border strip 30 ft. × 600 ft. is 0·415 acres and substituting in the formula we find:

$$\text{Hours required} = \frac{3 \text{ inches} \times 0{\cdot}415 \text{ acres}}{0{\cdot}77 \text{ cu. ft. per sec.}} = 16{\cdot}2$$

Then 16·2 hours will be required to deliver a quantity of water that if evenly applied would cover the border strip 3 inches deep. Since losses to deep percolation, runoff and evaporation will occur only about 60 per cent of this is actually able to be stored for crop use.

Table 7 gives some suggested *maximum* safe irrigation streams per foot border strip width* (*U.S. Department of Agriculture Soil Conservation Service Handbook No. 82*). These values can be used as guides and probably should not be exceeded.

* For border strips without sod protection. Larger streams may be used with sod cover. Table based on Imperial gallons.)

*** Table 7**

Slope %	*Max. stream g.p.m.*	*Slope* %	*Max. stream g.p.m.*
0·3	56	1·0	22
0·4	45	1·5	16
0·5	38	2·0	13
0·6	32	2·5	11
0·7	29	3·0	10
0·8	26	4·0	8
0·9	24	5·0	7

The irrigation stream should ordinarily be reduced when water reaches 100 feet from the lower end. This will help in avoiding ponding. Oftentimes the flow can be reduced by one-fourth or even more.

Basin irrigation (also called contour-check irrigation) is accomplished by building dikes or levees around an area that may be of irregular shape and flooding with the desired depth of water. Dikes are usually built on contour lines with the interval of elevation of the ground surface between dikes only two or three inches. Two inches difference in elevation will allow six dikes to be built for every foot of slope of the land. The location of the cross dikes will be determined by the topography of the land, the size of stream to be used and the soil type. On slopes that may erode easily, water may be carried to small basins by portable or permanent pipe lines. Fig. 19 illustrates such an arrangement using field ditches. Field ditches are most commonly used to convey water to interior basins.

The amount of water to be applied must be determined by the crop water requirements and soil water holding capacity as discussed earlier in this chapter. The following formula will enable the irrigator to apply the proper amount of water if the size of the stream and the area of the basin is known. (See Table 8 converting cu. ft./sec. to g.p.m.)

$$\text{Inches depth} = \frac{\text{number of cu. ft./sec.} \times \text{hours run}}{\text{number of acres in basin}}$$

Example: A stream of $\frac{1}{2}$ cu. ft. per second is used to flood a basin 50 feet wide and 300 feet long. How many inches of water will be applied in 2 hours?

$$\text{Area in acres} = \frac{50 \text{ ft.} \times 300 \text{ ft.}}{43{,}560} = 0{\cdot}35 \text{ acres}$$

$$\text{Inches depth} = \frac{\frac{1}{2} \times 2 \text{ hours}}{0{\cdot}35} = 2{\cdot}85 \text{ inches}$$

A well laid out basin system can be very efficient in the use of irrigation water. Since the basins are often of different sizes it is more difficult for the irrigator to determine the proper time of application and some

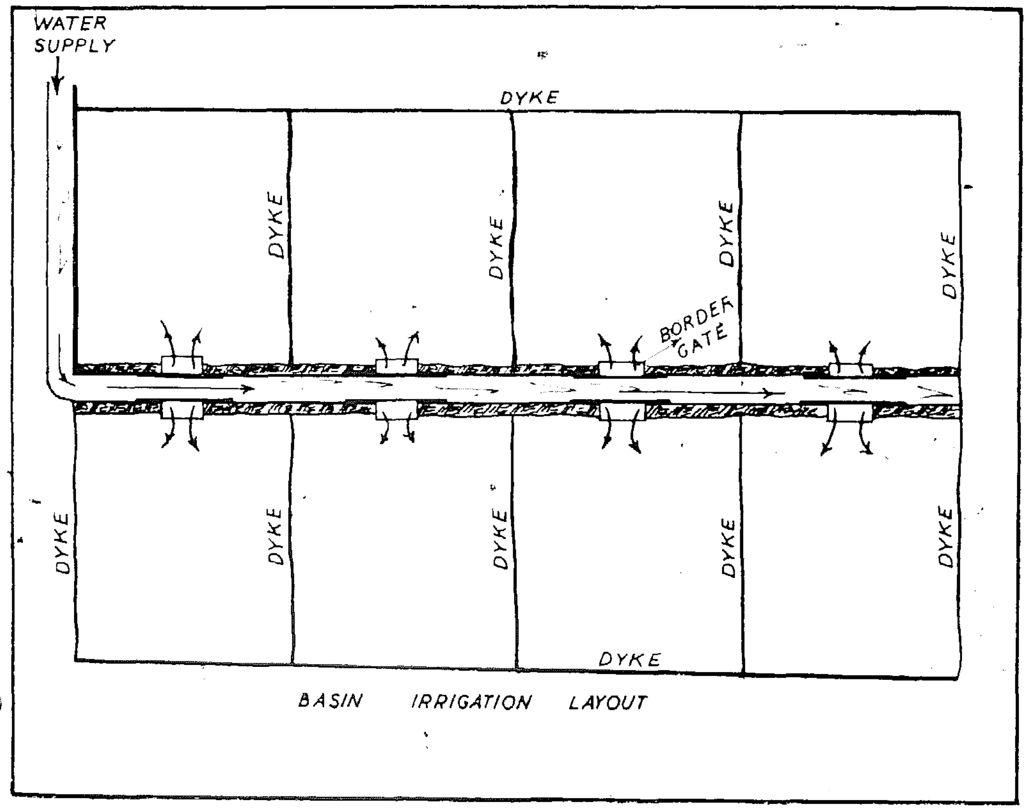


Fig. 19

guesswork is apt to be used. Less land levelling may be required than for furrow or border strip irrigation methods. The uniformity of water application will not be too good however unless the slope between contour dikes is removed since the amount of water entering the soil will be greater on the low side of the basin.

Furrow irrigation can be used for most row crops and orchards. Water is delivered to a pipe, flume or head ditch along the upper edge of a field and part of the flow is distributed to furrows running down the slope. Furrows should be of such a length that an even irrigation will result and with a stream size that will minimize the possibilities of erosion. The smallest practical irrigation streams will usually enable the irrigator to save labour, soil and water.

When furrows are used for hay and grain crops the term applied is usually 'corrugation or rill method of irrigation' instead of furrow method. Corrugations or rills are small shallow ditches and usually spaced 18 inches to 36 inches apart in the field. Sometimes these corrugations are used between border ridges to conduct water down the border strip. This is especially advantageous if the levelling has not been done uniformly.

Fig. 20 shows two methods used to raise the water level in a head ditch for furrow distribution. Fig. 21 shows water being distributed to furrows

Table 8

Conversion Tables. Cubic feet per second to Imperial gallons per minute

Tens	Units									
	0	1	2	3	4	5	6	7	8	9
0		373·93	747·85	1,121·78	1,495·70	1,869·63	2,243·56	2,617·48	2,991·41	3,365·33
1	3,739·26	4,113·19	4,487·11	4,861·04	5,234·96	5,608·89	5,982·82	6,356·74	6,730·67	7,104·59
2	7,478·52	7,852·45	8,226·37	8,600·30	8,974·22	9,348·15	9,722·08	10,096·00	10,469·93	10,843·85
3	11,217·78	11,591·71	11,965·63	12,339·56	12,713·48	13,087·41	13,461·34	13,835·26	14,209·19	14,583·11
4	14,957·04	15,330·97	15,704·89	16,078·82	16,452·74	16,826·67	17,200·60	17,574·52	17,948·45	18,322·37
5	18,696·30	19,070·23	19,444·15	19,818·08	20,192·00	20,565·93	20,939·86	21,313·78	21,687·71	22,061·63
6	22,435·56	22,809·49	23,183·41	23,557·34	23,931·26	24,305·19	24,679·12	25,053·04	25,426·97	25,800·89
7	26,174·82	26,548·75	26,922·67	27,296·60	27,670·52	28,044·45	28,418,38	28,792·30	29,166·23	29,540·15
8	29,914·08	30,288·01	30,661·93	31,035·86	31,409·78	31,783·71	32,157·64	32,531·56	32,905·49	33,279·41
9	33,653·34	34,027·27	34,401·19	34,775·12	35,149·04	35,522·97	35,896·90	36,270·82	36,644·75	37,018·67

using 'spiles'. Spiles are tubes placed in the bank of the ditch and are made of steel pipe, wood lath or short lengths of hose. Fig. 22 illustrates the distribution of water to row crops by means of siphon tubes and using checks in the head ditch to maintain the water level. Fig. 23 illustrates the use of gated surface pipe to distribute water to furrows. The gates are

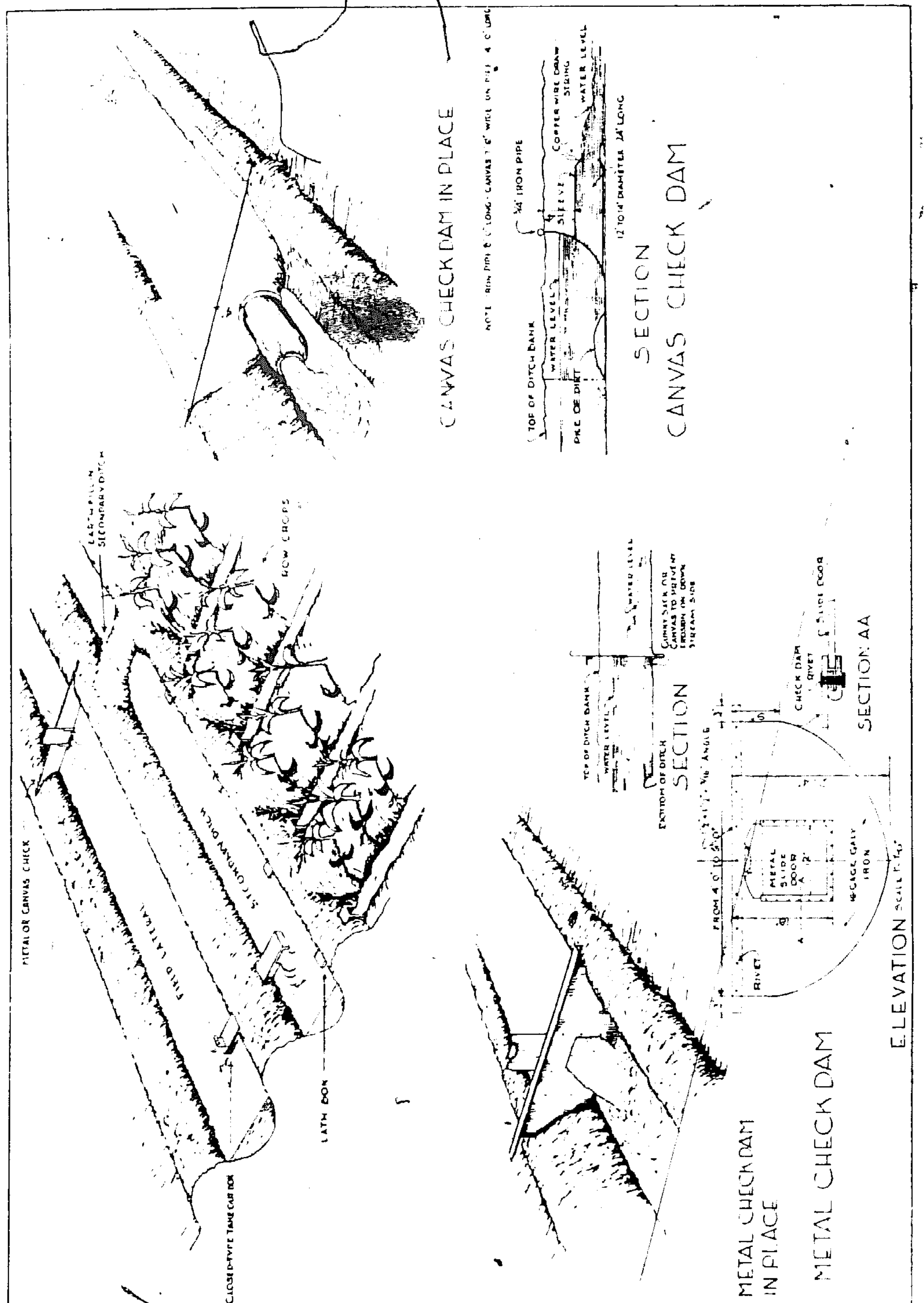


Fig. 20

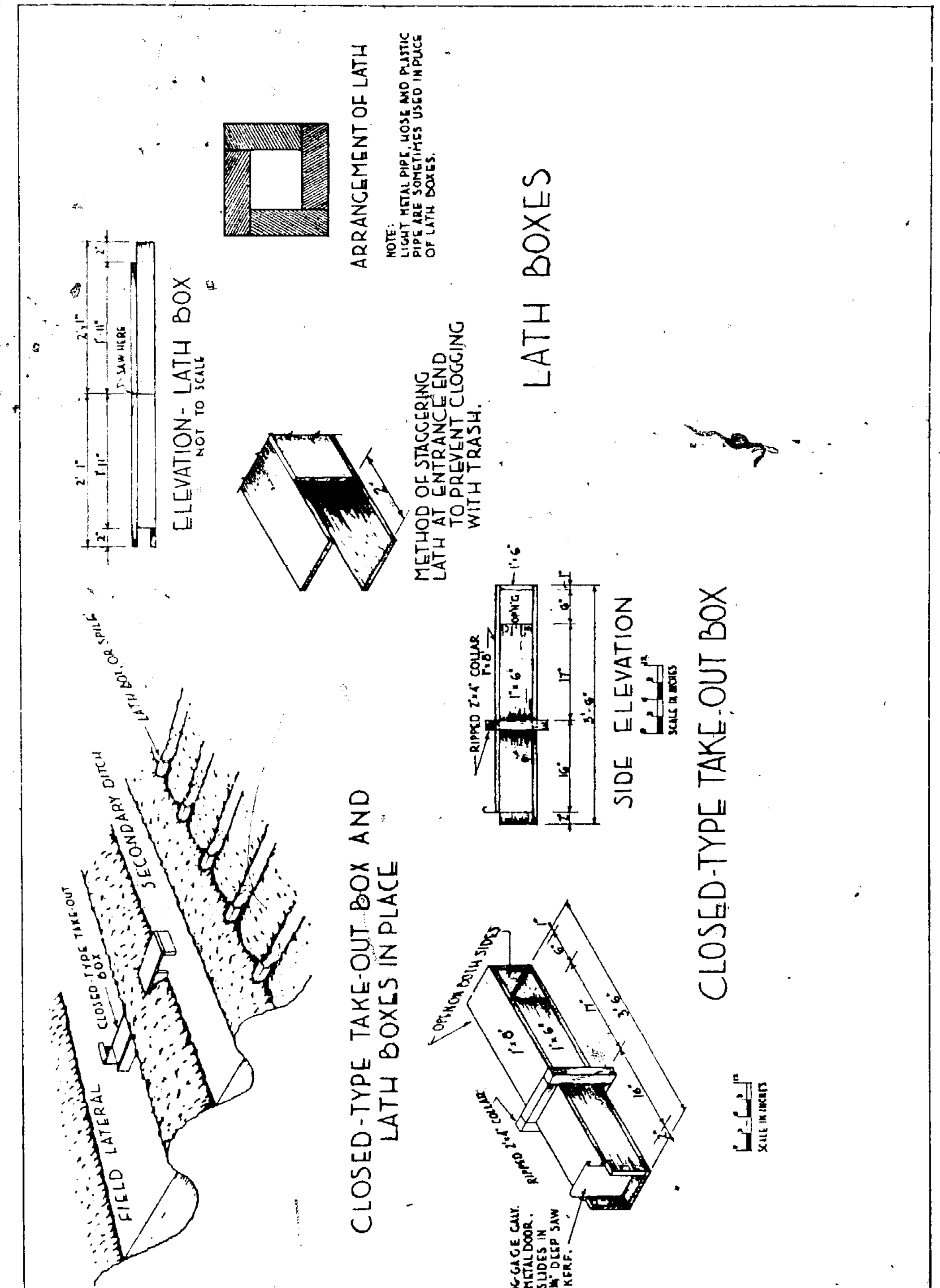


Fig. 21

ordinarily spaced the same distance apart as the crop rows and are adjustable. This gated pipe distribution method is sometimes used in conjunction with concrete pipe. Hydrants as shown are used for connection to the gated pipe. Fig. 24 shows irrigation water being supplied to furrows by hydrants requiring no valves but using slide gate outlets.

Furrow spacing in row crops is usually the same as the crop row spacing. The width of the area wet from a furrow will be roughly the same as the depth in soils of medium texture. Sandy soils that have high water intake rates may allow a much faster movement down than horizontal. Heavy slowly permeable soils with impermeable subsoils may have a

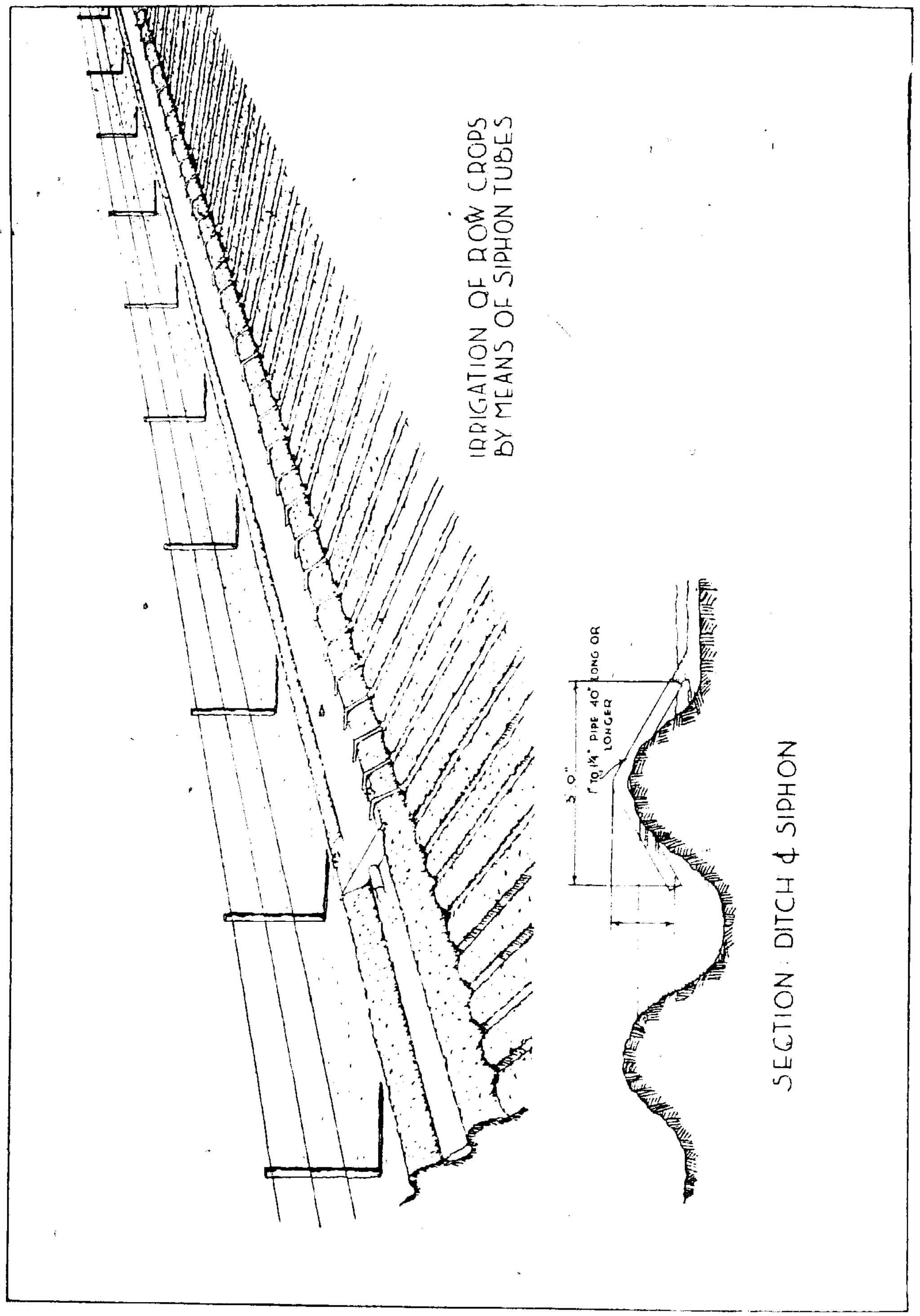


Fig. 22

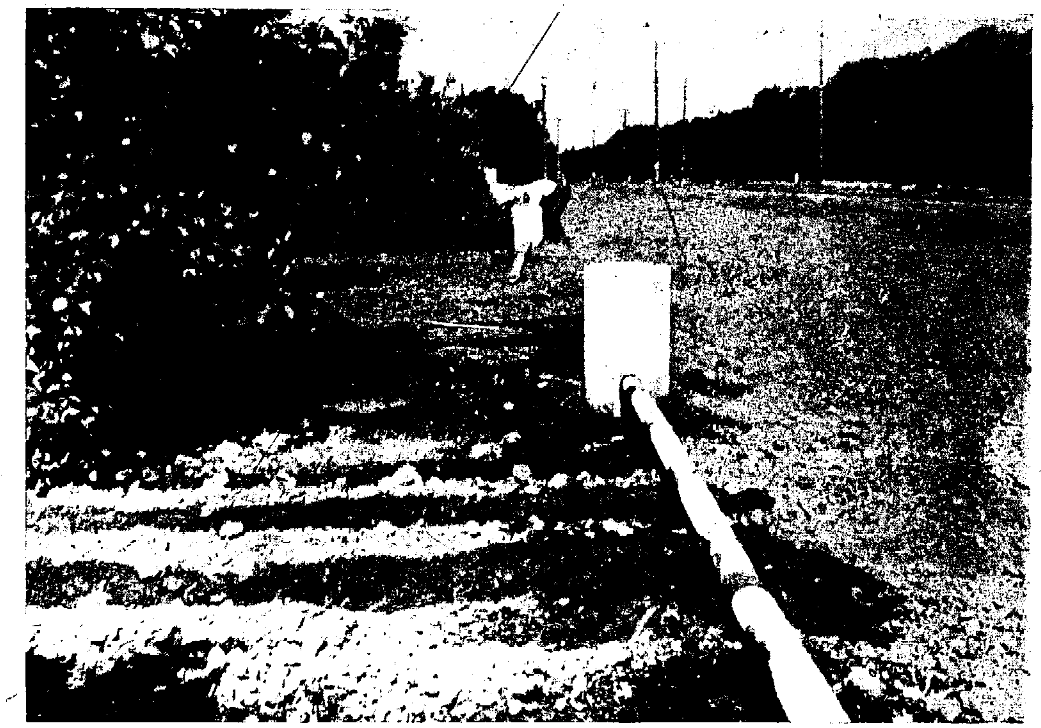


Fig. 23. Furrow Irrigation using gated pipe

Fig. 24. Irrigation Water supplied to furrows by hydrants using slide gate outlets

faster movement horizontally than downward and allow a wide spacing between furrows.

In practically all soils water will be in contact longest on the upper end of a furrow. A rule-of-thumb often used for uniform irrigation is that the stream should reach the end of the furrow within one-fourth of the total time needed to apply the required moisture to a soil. Table 9 gives some maximum furrow lengths generally found satisfactory for average soil conditions. This table is based on the assumption that water intake rate will be somewhere in the range of the rates indicated in Table 10.

It is necessary to make an initial determination of the approximate size of the furrow stream that will be desirable. This stream size is dependent upon the intake rate of the soil, the length of the furrow run and the maximum non-erosive furrow stream.

The intake rate of a soil during the irrigation will change as illustrated in Fig. 25. It is important to know this intake rate (use an average value) in order to determine how long the water must flow in the furrow to apply the required application. The best way to obtain this information is by field trial. A gallon container, a watch, and a short length of pipe can be

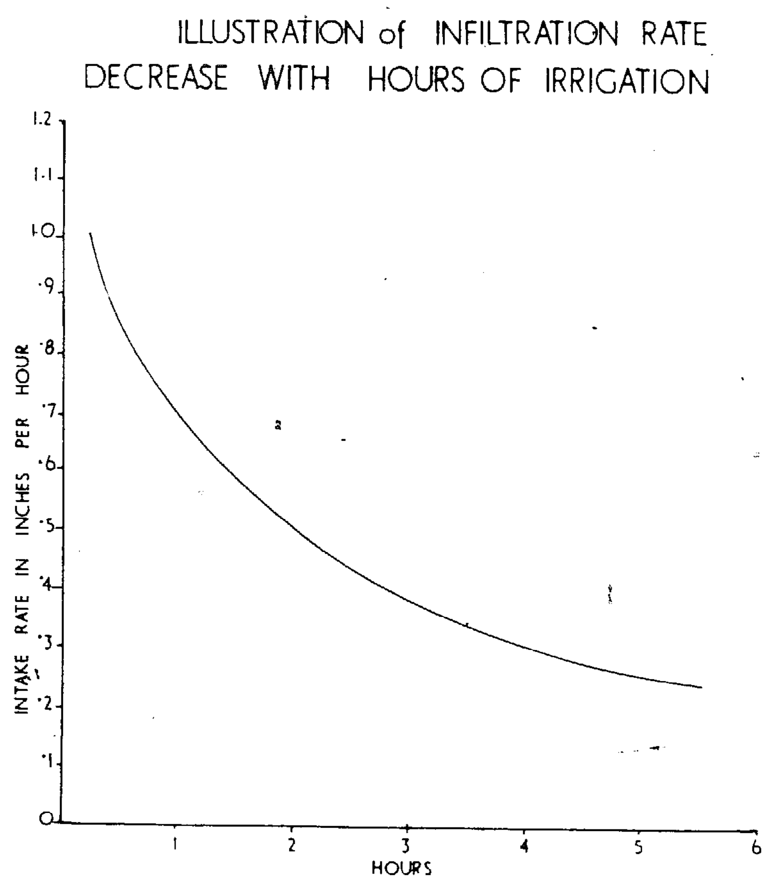


Fig. 25

Table 9

Some Maximum Irrigation Runs for Furrows with basic intake rates for soils assumed to be in the range shown in Table 10

Slope %	K Appl. In. 4	K 3	K 2	F Appl. In. 4	F 3	F 2	M Appl. In. 4	M 3	M 2	S Appl. In. 4	S 3	S 2	L Appl. In. 4	L 3	L 2	C Appl. In. 4	C 3	C 2
0·25	1500	1275	1050	1300	1150	950	1150	975	825	925	800	650	700	600	500	325	275	225
0·50	1000	875	725	900	800	650	775	675	550	625	550	450	475	400	325	225	175	150
0·75	800	700	575	700	600	500	625	525	425	500	425	350	375	325	275	175	150	125
1·00	675	600	475	600	525	425	525	450	375	425	350	300	325	275	225	150	125	100
1·50	550	475	375	500	425	350	425	375	300	350	300	250	250	225	175	125	100	
2·00	475	400	325	400	350	300	350	300	250	300	250	200	225	200	150	100	100	
2·50	425	350	300	375	300	250	325	275	225	250	225	175	200	175	125	100		
3·00	375	325	275	350	275	225	300	250	200	225	200	150	175	150	125			
4·00	325	275	225	300	250	200	250	200	175	200	175	150	150	125	100			

Explanation of Soil Texture Designation in Table

C —Very coarse textured sands and fine sands.
L —Coarse textured loamy sands and loamy fine sands.
S —Moderately coarse textured sandy loams and fine sandy loams.
M—Medium textured very fine sandy loams, loam, and silt loams.
F —Moderately fine textured sandy clay loams, clay loams and silty clay loams.
H —Fine textured sandy clays, silty clays and clay.

Table 10

Estimated Basic Intake Rates as related to soil texture and slope

Slope (Percent)	*Soil Texture* H	F	M	S	L	C
Furrows—Basic intake rate—Gallons per minute per 100 feet U.S. G.P.M.						
0·00–0·25	0·25–0·55	0·35–0·80	0·55–1·20	0·80–1·90	1·20–2·80	2·0 plus
0·25–0·50	0·20–0·45	0·30–0·65	0·45–1·00	0·70–1·50	1·00–2·30	1·7 plus
0·50–1·00	0·20–0·40	0·30–0·60	0·40–0·80	0·60–1·40	0·90–2·00	1·5 plus
1·00–2·00	0·15–0·35	0·20–0·50	0·35–0·70	0·50–1·20	0·80–1·70	1·3 plus
2·00–4·00	0·10–0·30	0·20–0·40	0·30–0·60	0·40–1·00	0·60–1·40	1·0 plus

1 U.S. Gallon = 0·84 Imperial Gallons

(See notes at bottom of Table 9 for description of soil texture.)

used to determine the rate of flow at the head of a furrow and also at the end of a furrow. The short pipe imbedded in the ditch should direct the flow of the furrow into the gallon can which is placed in a shallow dug pit below the end of the pipe. The difference in flow between the two measurements is the amount of water being absorbed by the soil. This intake rate is generally stated in gallons per minute per 100 feet or in inches per hour. Fig. 26 is a conversion chart from gallons per minute per 100 feet to inches per hour for various furrow spacings. For other spacings the following formula will apply:

$$\text{Inches per hour} = \frac{\text{Imperial g.p.m. per 100 ft.} \times 1{\cdot}16}{\text{furrow spacing in feet}}$$

The required minimum furrow stream will be the average intake rate in gallons per minute per 100 feet multiplied by the number of 100 foot units in the furrow length plus a 10 to 15 per cent allowance made for runoff. An example of this calculation is given:

Assume a field has 600 feet long furrows and an average intake rate of 0·5 inches per hour. The furrows will be spaced 3 feet apart. Fig. 26 shows this would amount to 1·25 gallons per minute per 100 feet. The requirement for 600 feet would then be 6 × 1·25 gallons per minute plus 15 per cent runoff allowance or 8·63 gallons per minute per furrow.

The average intake rate in the foregoing example was assumed to be 0·5 inches per hour. If a 3-inch irrigation were to be applied it would be necessary for the stream to remain in each furrow $\frac{3}{0{\cdot}5}$ or 6 hours plus whatever time it takes for water to travel the length of the furrow. It is obvious that in order to properly irrigate the lower end of a field some over-irrigation will result in the upper end. Since the infiltration rate decreases with time in most soils the difference in application between the

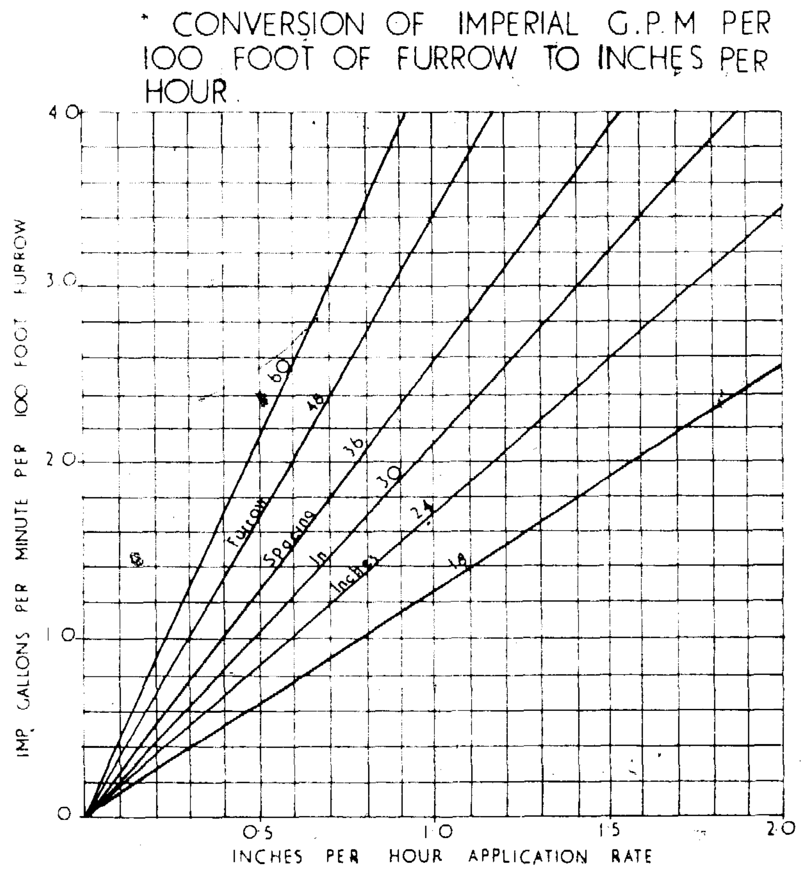


Fig. 26

upper and lower end of a field might not be too great. It is usually desirable to adjust the flow of a stream to the minimum after the stream has reached the end of the furrow to reduce runoff losses.

The U.S. Department of Agriculture Soil Conservation Service gives the following formulas for determining maximum non-erosive streams in their 'Instructions and Criteria for Preparation of Irrigation Guides':

$$\text{Maximum flow in g.p.m. (Imperial) for furrows} = \frac{8{\cdot}3}{S}$$

$$\text{Maximum flow in g.p.m. (Imperial) for corrugations} = \frac{10{\cdot}4}{S}$$

(S is the irrigation grade in per cent.)

Contour planting makes possible the use of fairly steep slopes for furrow irrigation. Irrigation water can be allowed to flow in furrows that are given only a slight grade. The field slope may be as much as 20 per cent depending upon the crops to be grown. In areas where rains of high intensity may occur considerable damage may occur by flood runoff overtopping furrows and causing field gulleys. Grass waterways are sometimes planned at intervals in a field to care for this runoff. Fig. 27 illustrates a

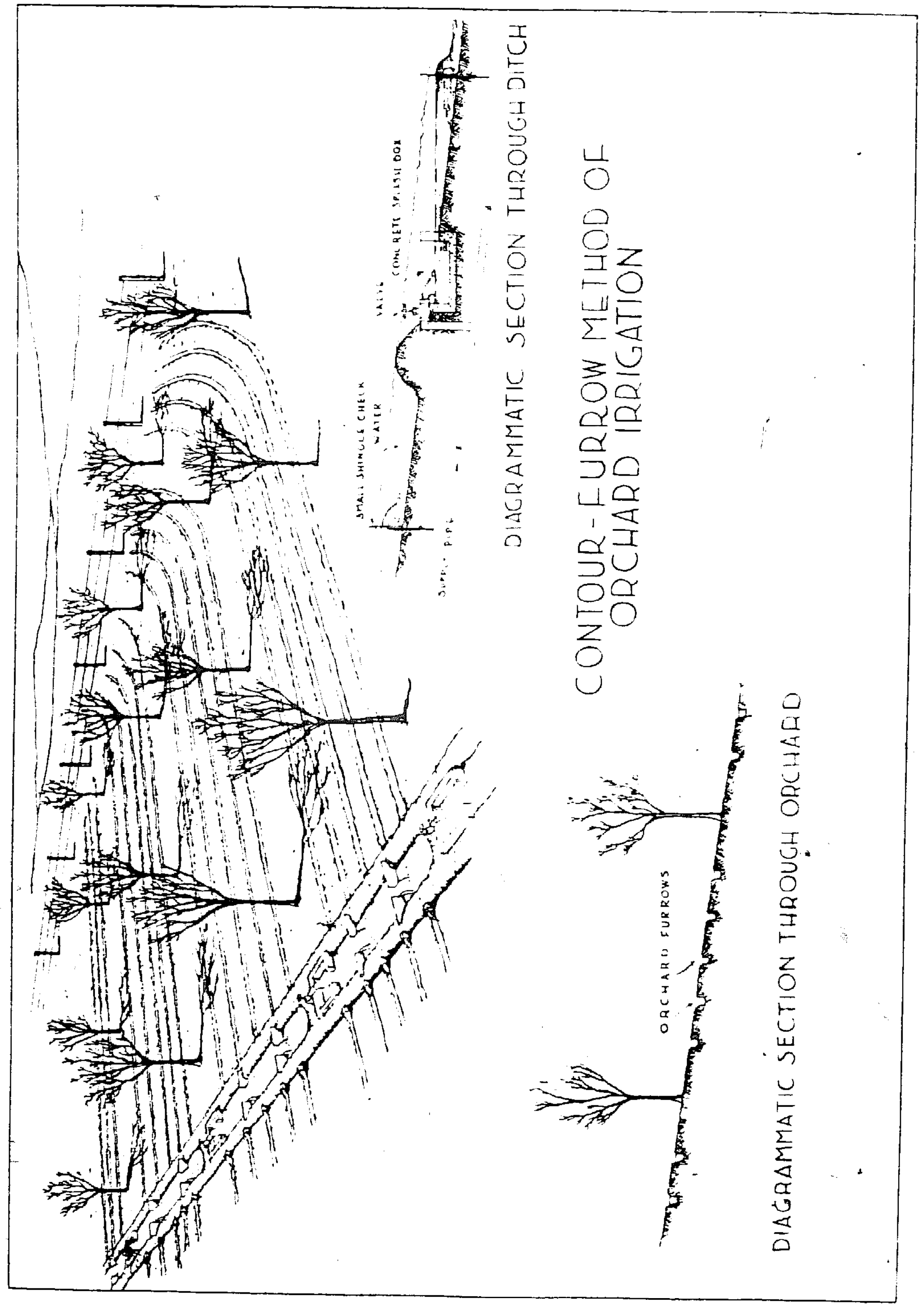


Fig. 27

contour planting and irrigation system. Note that a series of drops must be used since water in the supply ditch is brought down the slope.

Bench terraces are oftentimes used for small acreages on steep hillsides. The width of the terraces will depend on the slope, the depth of the soil and, in the case of orchard crops, the row spacing of trees. It is impor-

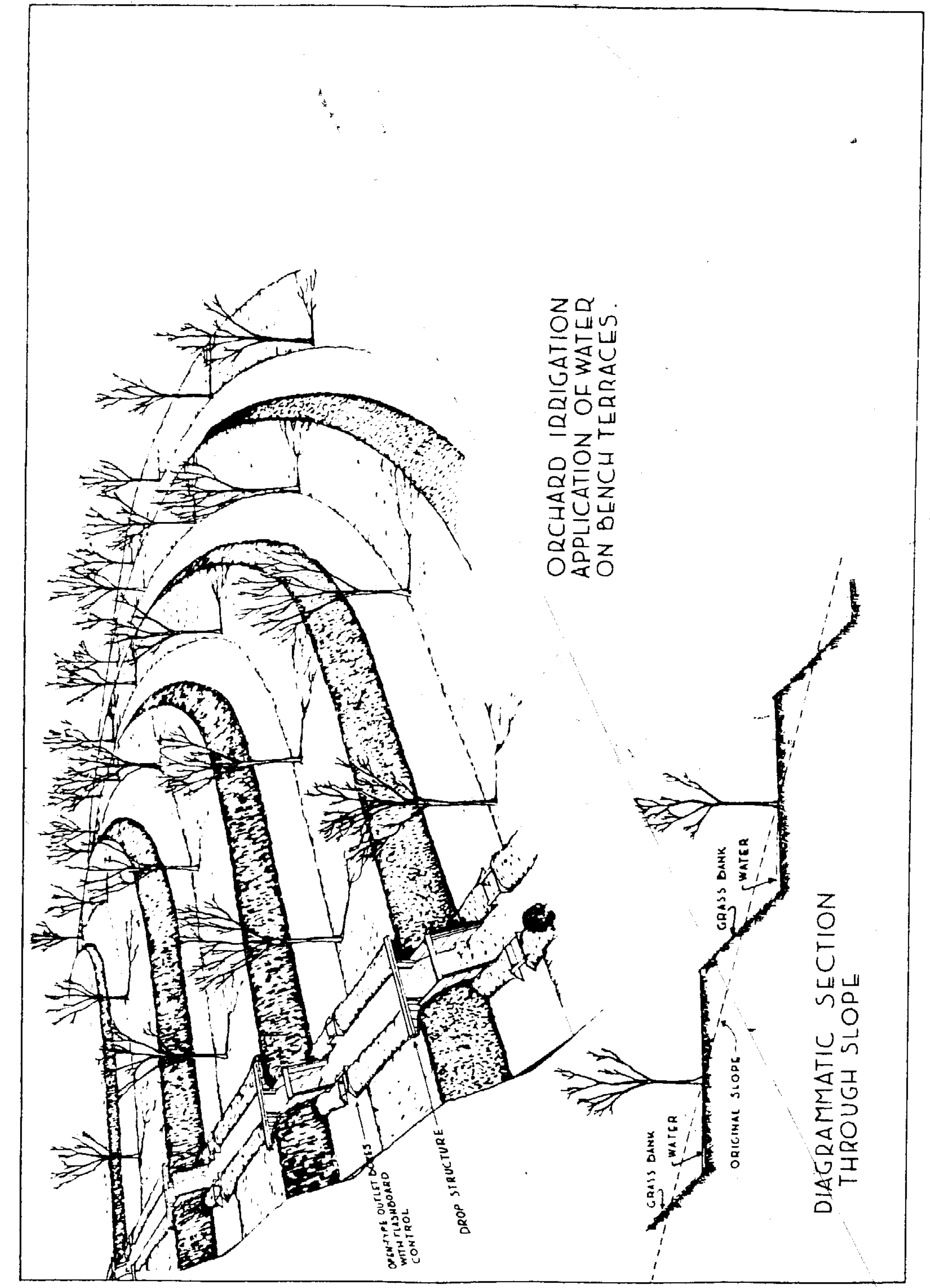


Fig. 28

tant here also to make provision for rains of high intensity. Benches are usually sloped back toward the hill and runoff channels provided at intervals from the field. See Fig. 28. Here again a series of drops must be used in the water supply channel since it runs down the slope. Outlet boxes with flash boards can be used to admit water to terraces.

The sprinkler or overhead method of irrigation has gained wide acceptance in the last 15 years due to the development of lightweight aluminium pipe and 'quick couplings'. This method of irrigation has proved to be particularly well adapted to irrigating steep hillsides and sandy or gravelly soils with fast percolation rates. Water can usually be distributed more uniformly on the field by using this method of irrigation. Frequently phenomenal gains in production are reported when a change is made to sprinkling from one of the other methods. This is probably due to the better irrigation coverage and the improved soil moisture conditions resulting. Crops require the same amount of moisture regardless of the method of irrigation. Water application efficiency with a sprinkler system may be higher than most surface irrigation systems since there will ordinarily be no runoff and little deep percolation loss.

Since a properly designed sprinkler system will have no runoff, it is the ideal method of irrigation for soils that are easily eroded. On steep slopes a combination of permanent cover crop and sprinkling reduces erosion to a minimum. On bare land in areas subject to high intensity rainfalls caution must still be exercised in planting cultivated crops on sloping land even if they are to be sprinkler irrigated.

One of the chief disadvantages of sprinkler irrigation is the high initial cost of installation. This may be partially offset by the fact that less land forming or land levelling is required than with other methods. The annual cost of water is higher with sprinkling since pressure must be developed by pumping and equipment costs must be depreciated. Savings in the amount of water applied may more than offset this disadvantage in some instances.

Since the uniformity of water distribution is dependent upon the pattern of the stream from the sprinkler nozzle, wind creates a definite distribution problem. Plenty of overlap must be allowed if strong winds are common in an area. Over-tree sprinkling in orchards is subject to wind distortion much more than under-tree sprinkling. There has also been some concern in regard to wetting of leaves and fruit for prolonged periods. There is some danger of washing spray from leaves and fruit, maintaining more humid conditions, increasing disease and in some cases splitting ripening fruit. It would be wise to investigate these things thoroughly for an area before practising over-tree watering.

Usually it is best to use almost continuously the stream of water that satisfies the crop requirements during the peak use period. This may be a disadvantage if water deliveries are made on a rotation basis with large volumes available for only a very short period.

By far the largest percentage of sprinkler systems in use today are the 'rotating-sprinkler' type. Only this type will be discussed here. These systems can be permanent, semi-portable or portable. In a 'portable'

system the pump, main line and sprinkler laterals can be moved from field to field. In a 'semi-portable' system only the sprinkler laterals are moved and the pump and main line are permanently installed. A 'permanent' system is seldom practical for agricultural purposes as it usually requires a large capital expenditure. Lateral lines and main lines for permanent systems are usually buried to allow field operations to proceed normally.

Fig. 29 shows the required components for a sprinkler irrigation system. The design of a sprinkler system is an engineering problem and should be designed for the particular field to be irrigated. The designer must have data on the soil water holding capacity, depth, infiltration rate and information regarding the peak water use of the crop to be grown Fig. 30 illustrates a typical design for a 10-acre square field using medium

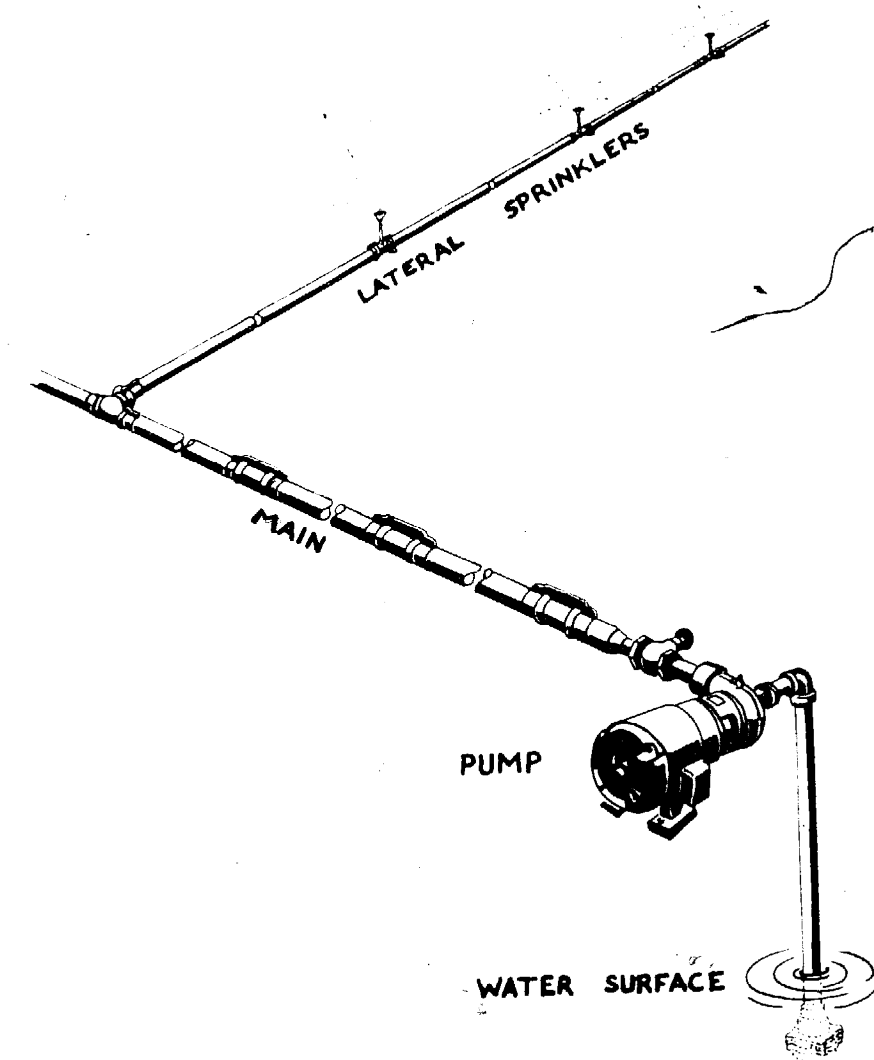
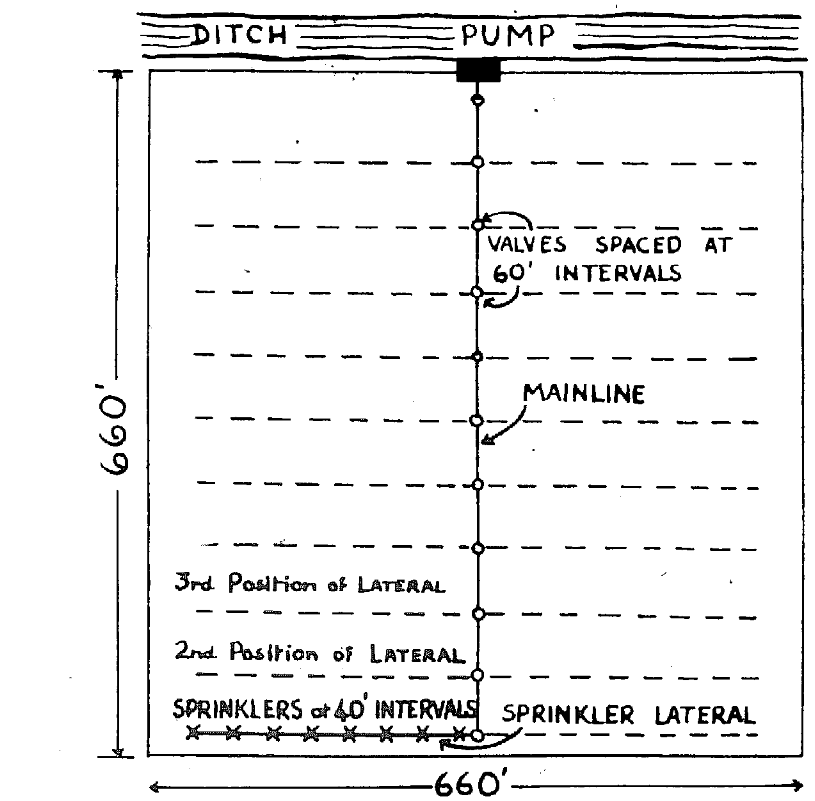


Fig. 29. Sprinkler Irrigation Components



A SPRINKLER IRRIGATION LAYOUT FOR 10 ACRE FIELD

Fig. 30

pressure sprinklers. The sprinklers used here are spaced 40 feet apart in the lateral and the lateral is moved along the main line 60 feet each move. The sprinklers deliver 7·2 (U.S.) g.p.m. and will apply 0·29 inches of water per hour. Over 3 inches of water will be applied each irrigation if the lateral is moved twice each day. The lateral will ordinarily require less than ½ hour to move to the next position. Since there are only 22 possible lateral settings in the field, one operating lateral moved twice each day could irrigate the 10-acre field in eleven days.

Giant sprinklers using very high pressures (80–120 pounds per square inch) have been used to quite some extent in irrigating sugar cane, bananas, corn and other dense growing crops that make pipe moving difficult. These sprinklers discharge 100 to 500 gallons per minute and have a wetted diameter up to 400 feet. Great care must be taken in choosing a proper spacing since wind effect can be a serious problem.

More uniform distribution of water can usually be obtained from longer sets. Since the giant sprinklers apply water quite rapidly sets must be changed quite often. Staggering the spacing of the sprinklers on the lateral and alternating the lateral position with respect to the previous move will tend to keep a more uniform moisture level in the field.

New equipment being tried in the field today includes large rotating booms mounted on waggons, wheel-roll laterals and tractor drawn laterals. Under certain conditions these developments may be well adapted but they should be studied carefully before being used.

The diameter of the circle covered by a sprinkler and the wind conditions that may exist will govern the spacing that can be used. Fig. 31 illustrates the precipitation pattern from a single sprinkler and also the pattern from the combined precipitation of the overlapping sprinklers. The higher the wind velocity the closer must be the sprinkler spacing both on the lateral lines and between the lateral lines.

Medium pressure sprinklers are used for most field crops since the cost of operation is not as great as the high pressure sprinklers and the spacing between sprinklers will not require the large number of settings in the field as the low pressure sprinklers. The following spacing is recommended by the *Sprinkler Irrigation Association Handbook*:

Wind Condition	*Lateral Spacing*
None	65% of wetted diameter
5 m.p.h. or less	60% of wetted diameter
5–10 m.p.h.	50% of wetted diameter
Over 10 m.p.h.	22–30% of wetted diameter

The cost of equipment for a sprinkler irrigation system is variable since there are so many kinds of layouts and so much depends upon the shape of the field and the proximity to a water supply. A well and turbine type pump will add a considerable amount of cost above that of a system requiring only a centrifugal pump to operate from a river or lake. The per acre cost on a small farm will be higher than that on a large farm.

The annual cost of sprinkler irrigation can be divided into three parts First, the fixed costs made up of interest on the investment, depreciation, taxes and insurance; second, the fuel costs, repairs and pump attendants; and third, the cost of labour to operate the system.

Three estates on the north coast of Jamaica which are sprinkler irrigating sugar cane with large sprinklers, using 80 to 100 pounds per square inch pressure at the nozzle, estimated the annual cost of sprinkling at about 12/- per acre inch of water applied. It was estimated that nearly half of this cost was for labour in attending the pump and moving the equipment. One of these estates estimated that water applied by surface irrigation methods cost 6/- per acre and another estimated that labour only cost 7/6 per acre for the area irrigated by surface methods. Since this particular area has very sandy soil and undulating topography the sprinkler irrigation method can make more efficient use of the water. While the cost of application may appear high, the available water can be

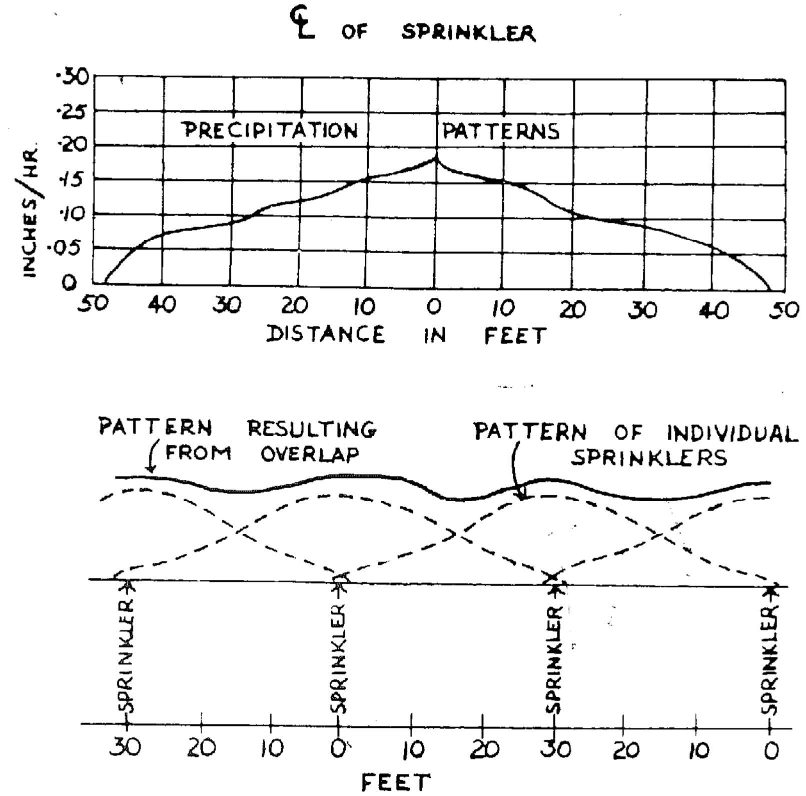


Fig. 31

Sprinkler Precipitation Pattern with sprinklers spaced 30 feet apart in a lateral. The four sprinklers are assumed to have the ideal distribution shown in the pattern for an individual sprinkler at the top.

used on a larger area. Our estate used the sprinkler irrigation method when difficulty was encountered in covering the area by the furrow irrigation method.

Sub-irrigation can only be practised effectively when the right conditions are present. There must be an impervious layer below the root zone of the crop and the topography must be smooth and relatively flat. Sandy soils are most likely to be successfully irrigated by sub-surface methods. Moisture is added to the soil by raising the water table in an area for a short time and then lowering it again. Excess soil water must not be retained for long periods as this would tend to be harmful to roots and restrict their development. Control of the water level in an area can ordinarily be handled best by ditches spaced at intervals that can be filled for some period of time.

PREPARATION OF LAND FOR IRRIGATION

Most land that is to be irrigated will require some preparation. The method of irrigation to be used will determine the kind and amount of preparation required. Row crops will require furrow or sprinkler irriga-

tion, hay and grain crops may be best suited to border irrigation methods, and orchard crops on steep slopes will probably require contour irrigation methods, bench terracing, or sprinkler irrigation.

After the method of irrigation has been chosen it is necessary to have the field surveyed. This may not be necessary if the sprinkler method of irrigation is to be used and if it has been decided no land forming will be required. Land planing is often done to remove knolls and fill swales and no particular grade is required since there is no intention of changing the general topography.

Most fields that are to be irrigated by furrow or flood methods will require a topographic map to properly evaluate the irrigation layout. Stakes will ordinarily be set at 100-foot intervals forming a grid in the field. Elevations are taken at these stakes and a topographic map made from information obtained. Fig. 32 shows a small field staked in this manner with the contour lines drawn in. It may be too expensive or cuts may be too deep to grade a field to one plane. It is very necessary to know the soil profile to be able to determine cuts that will not permanently affect agricultural production. The depth of soil removed or added from a particular location is termed cut or fill. The volume of cut or fill is the average depth multiplied by the area of cut or fill. Experience has shown that with modern earth moving equipment more cut than fill will be

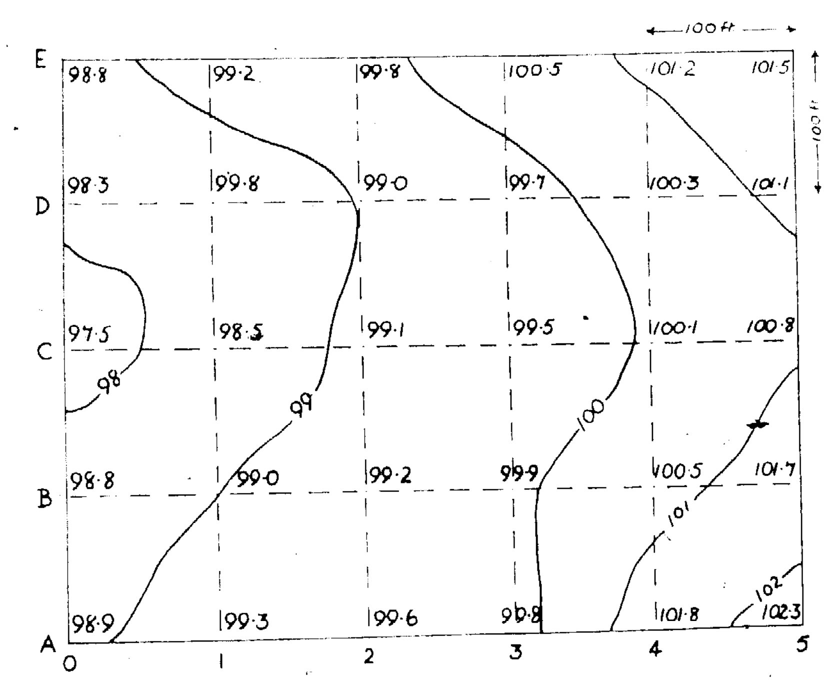


Fig. 32

Topographic Map of field showing contour lines at one foot intervals. Stakes are placed at corners of squares showing cut or fill to be made when grade has been determined.

required. The usual allowance is 20 to 40 per cent more cut than fill, however when cuts are shallow (0·2 feet to 0·3 feet) it may be necessary to allow 75 to 100 per cent excess cut.

There are four basic methods of land levelling design. These are:

1. **The plane method** that results in a true plane surface for the entire field. The centroid of the area to be levelled is first found. Cuts and fills will be exactly balanced if the plane passes through the centroid at the average elevation of the field. Since more cut than fill is required it will be necessary to lower the plane to obtain the ratio desired.

2. **The profile method** where the profiles of the grid lines are drawn and the grades are chosen on somewhat of a trial and error basis making sure however to get the proper balance between cuts and fills. This method is described in more detail below.

3. **The plan inspection method** where the elevations are placed on the grid map and desirable slopes are selected by observing cuts, fills, and haul distances as affected by various trial grades.

4. **The contour adjustment method** is a trial and error procedure of adjusting contours on a map. It is particularly useful in levelling if the field is to be irrigated by contour furrows.

The profile method is used quite widely since it is usually thought easier to choose grades on a plotted profile. Profiles can be plotted across or down the slope. Trial grade lines are then plotted on the profiles. The elevation of the trial grade lines should be plotted in the opposite direction also to determine if the grade in that direction is suitable for the system being planned. Several trials will be needed to make a final determination. From the profile and grade line chosen the cut or fill at each grid station can now be found. The volume of earth work can be calculated by determining the volume for each grid square and finding the totals. An example of the calculation method used quite often is shown on page 223.

After the cuts or fills are determined they are marked on the stakes. Blue paint is often used on the top of the stakes to indicate fill and red paint to indicate a cut. A mark on the stake will indicate the level of the fill. A mark may also be used on the cut stakes exactly one foot above the desired grade. These reference stakes are preserved as much as possible during the levelling operation by working in between them until those areas are brought to the desired grade.

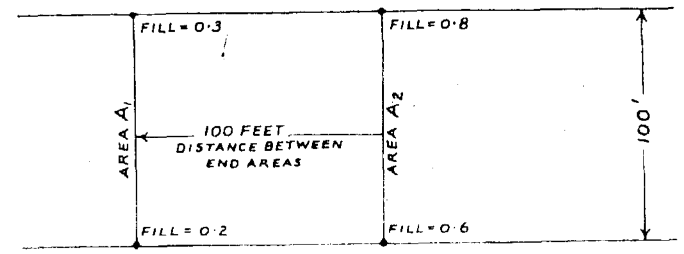
Fig. 33 shows a tractor and scraper being used to move earth on a land grading job. Small scrapers up to 2 cubic yards can be used with wheel type tractors while the larger units require crawler type tractors.

Chisels and rippers may be required to loosen the soil before land grading can take place. This may also be desirable to improve water intake rates or to break up an existing hardpan. Fig. 34 shows this kind of equipment being used.

$$\text{Volume (cut or fill) in cu. yds.} = \frac{L(A_1 + A)_2}{54}.$$

L = Distance between end area in feet.
A_1 = Area of cut or fill at one end in square feet.
A_2 = Area of cut or fill at other end in square feet.

The fill in the grid below would be computed as follows:



$$A_1 = \frac{0\cdot3 + 0\cdot2}{2} \times 100 = 25 \text{ sq. ft.}$$

$$A_2 = \frac{0\cdot8 + 0\cdot6}{2} \times 100 = 70 \text{ sq. ft.}$$

$$V = \frac{100\,(25 + 70)}{54} = 176 \text{ cu. yds.}$$

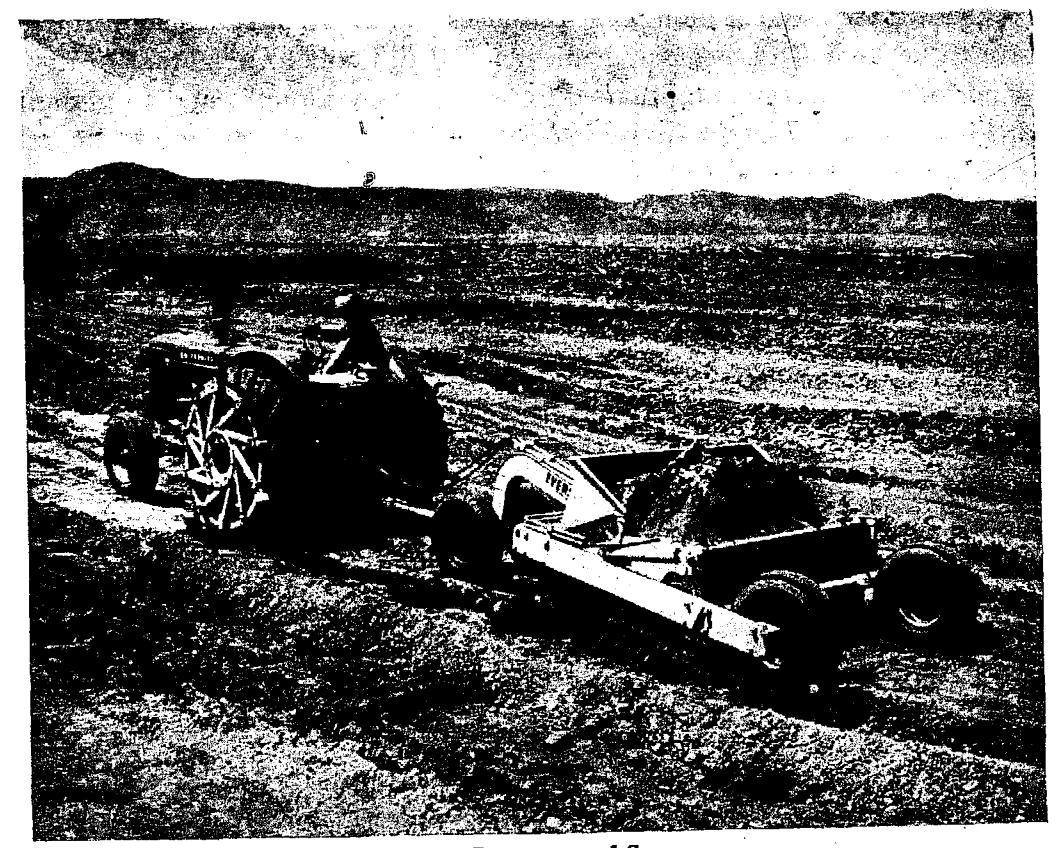


Fig. 33. Tractor and Scraper

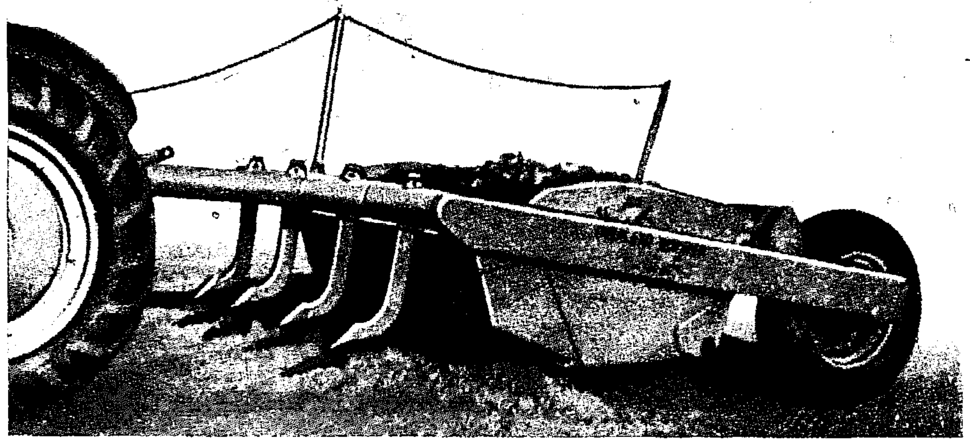


Fig. 34. Scraper and Ripper combination

Land planes of the type shown in Fig. 35 are used to move small quantities of earth for short distances and to perform the finishing operation where scrapers have been used for the heavy cuts. The accuracy of the finished grade depends upon the operator since considerable training is required in the handling of one of these land planes.

Ploughs. Correct ploughing practices are important if field surfaces are to be kept from becoming uneven and difficult to irrigate. On dry-land farms it is common practice to use ordinary ploughs and to plough fields in lands, as shown in the left-hand corner of Fig. 36. Soil is moved outward from the dead furrow each season, resulting in development of high and low areas.

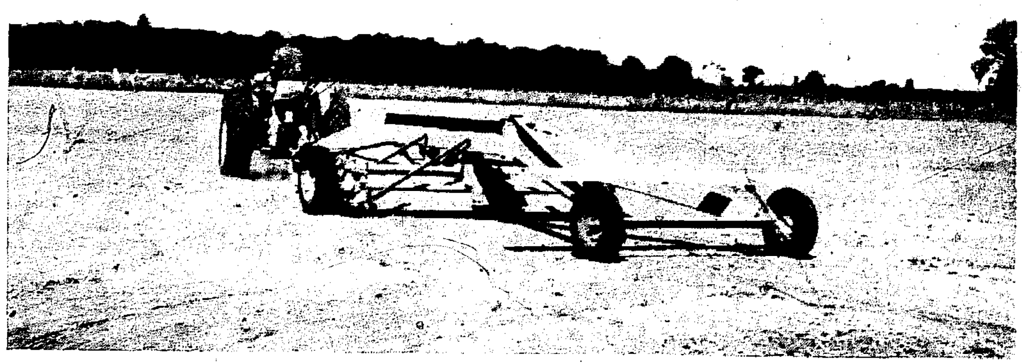


Fig. 35. Land Levelling Plane

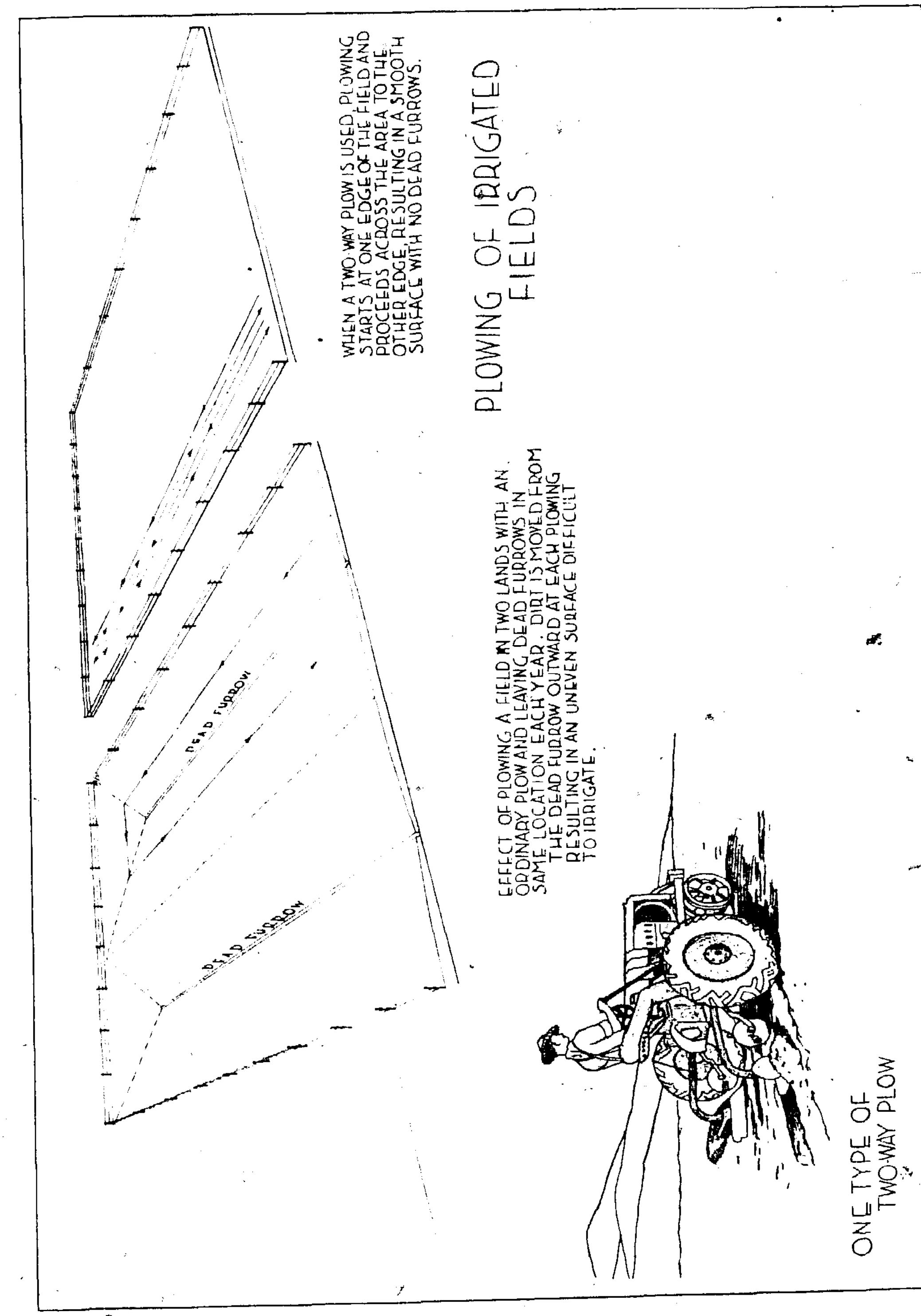


Fig. 36

Experienced irrigation farmers prefer a two-way plough, which it is possible to use without producing a dead furrow and without leaving an uneven surface, as shown in the right-hand corner of Fig. 36. In using the two-way plough one is lowered for operation and one is raised as shown in the lower left corner of Fig. 36. When once across the field, the other plough is lowered and the first plough raised for the return trip. The irrigation leveller float should be used occasionally to remove minor irregularities.

Ditcher. Canals and large ditches are made with special ditching equipment. But smaller ditches and field laterals can be made by ditchers

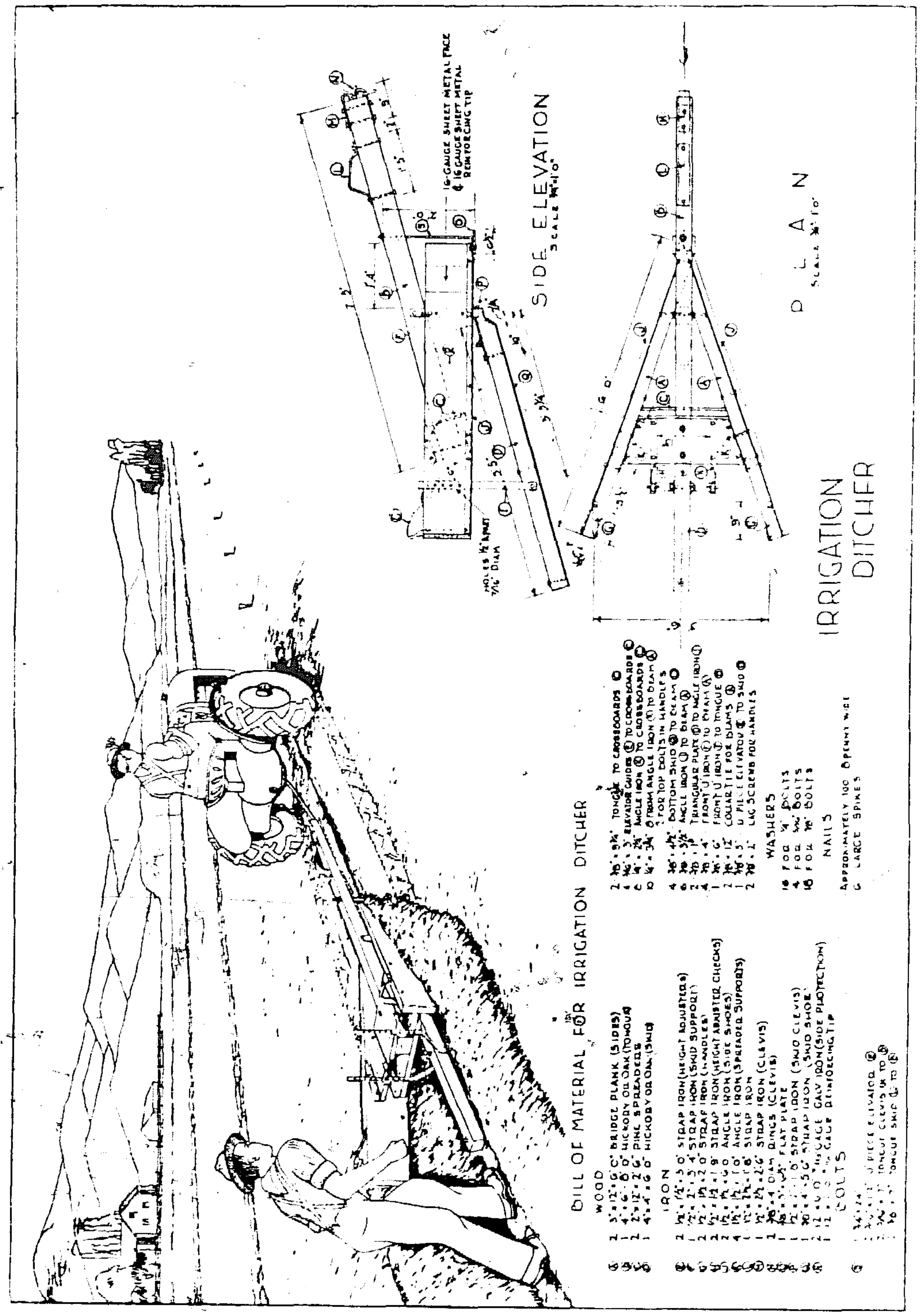


Fig. 37

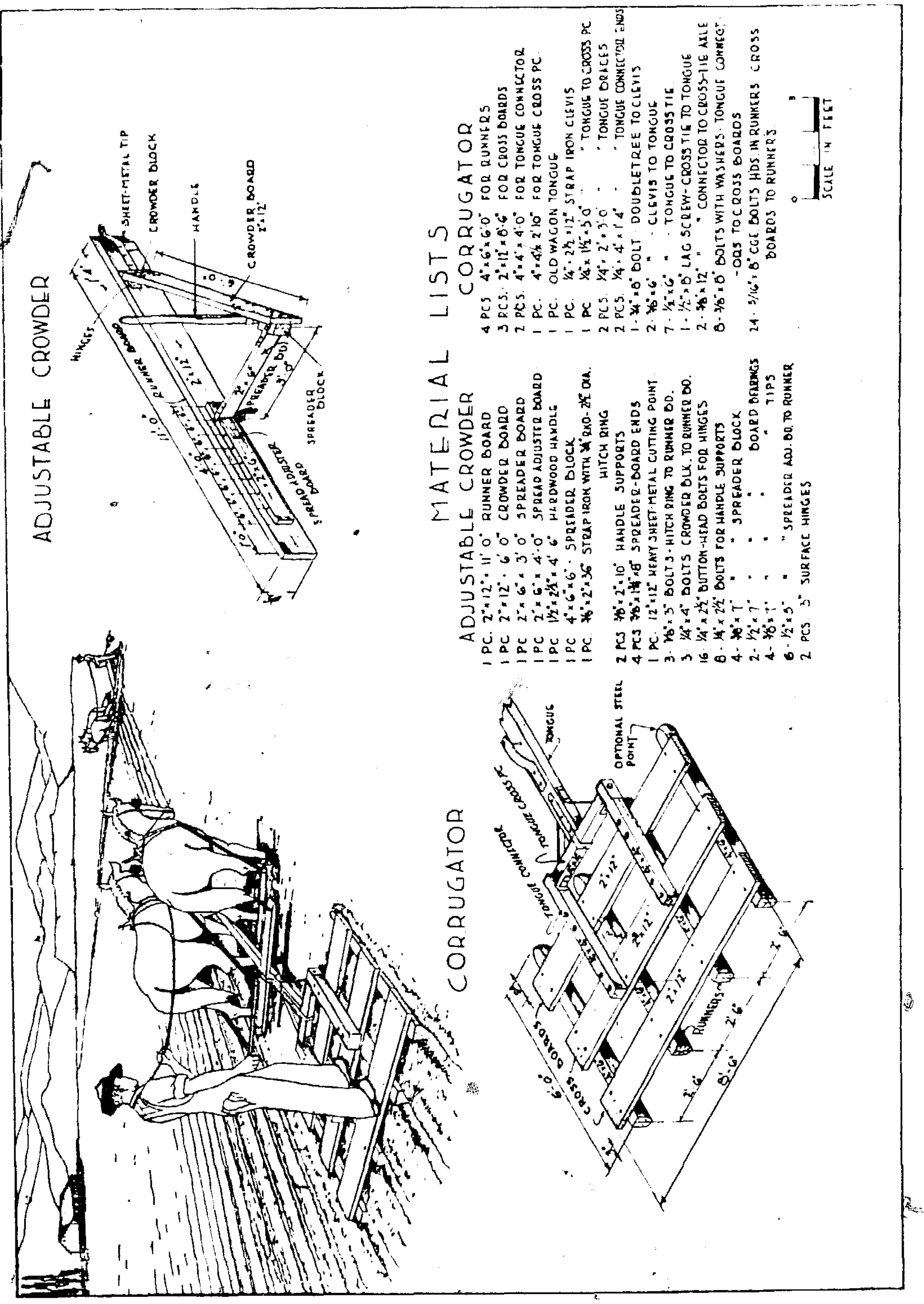


Fig. 38

such as that shown in Fig. 37. This ditcher is easily and cheaply made at home. Its design and operation are self-explanatory.

Adjustable Crowder. The adjustable crowder (Fig. 38) is essentially a one-way ditcher, adapted to making various-width ditches by adjusting the spreader board between the runner and the crowder. Several furrows are first ploughed to loosen the dirt. Then the crowder with the crowder board leaning upward and outward crowds the dirt to one side to form the ditchbank. This operation is then repeated in the opposite direction to form the bank on the other side.

The Corrugator. The corrugator (Fig. 38) is used to make small furrows or corrugations for conducting irrigation water over the ground surface. Corrugations are particularly adapted to watering grain or hay crops on irregular fields, or for new fields which have not been thoroughly levelled and floated. The runners are commonly made of 4-inch by 6-inch material, spaced 30 inches apart. This spacing may vary, however, depending on the soil and slope of the land.

Border Drag. The border drag shown in Fig. 39 is used to build border dikes like those shown in Fig. 15. There are other types of implements used for building the border dikes, depending on the size of the borders, the slope of the land, etc. The type shown in Fig. 39 is a home-made wooden drag.

Pumping Irrigation Water from Wells, Lakes, or Streams. Several illustrations which follow show pump installations for raising water from wells, lakes or streams. In order that the proper pump and power plant may be selected, it is necessary to have information regarding the rate of flow required, the distance the water must be lifted, and other factors such as the friction head in the pipe and the friction loss in elbows, foot valves, etc. Unless the proper pump is selected, the efficiency may be low and the cost of operation higher than necessary.

Many types of pumps and power plants are now available. There is a marked tendency, however, to use high-speed Diesel engines or electricity on the greater lifts.

Turbine- and Propeller-type Irrigation Pumps: The turbine-type irrigation pump (Fig. 40) is adapted to lifting water from wells of various diameters and through various heads, from a few feet to several hundred feet. The characteristics of the pump are determined largely by the design of the bowl assembly and the speed of the impeller shaft.

In order to determine the type of pump and design of bowl assembly required for the best efficiency under given conditions, the manufacturers should have the following information:

1. The discharge of the well at various stages of draw-down. This is determined by a pump test of the well.
2. The diameter of the well casing.
3. The type of power to be used for driving the pump.

Where three-phase electrical energy is available, the direct-connected motor drive may be used. Other types of drives for the turbine pump are shown.

The propeller-type pump is adapted to lifting large volumes of water through low heads. In irrigation practices it is used to deliver water from a stream or lake to a canal at higher level, or from a low-level canal to one at a higher level. The same types of drives as shown for the turbine are adapted to the propeller pump. In order to determine the type of pump

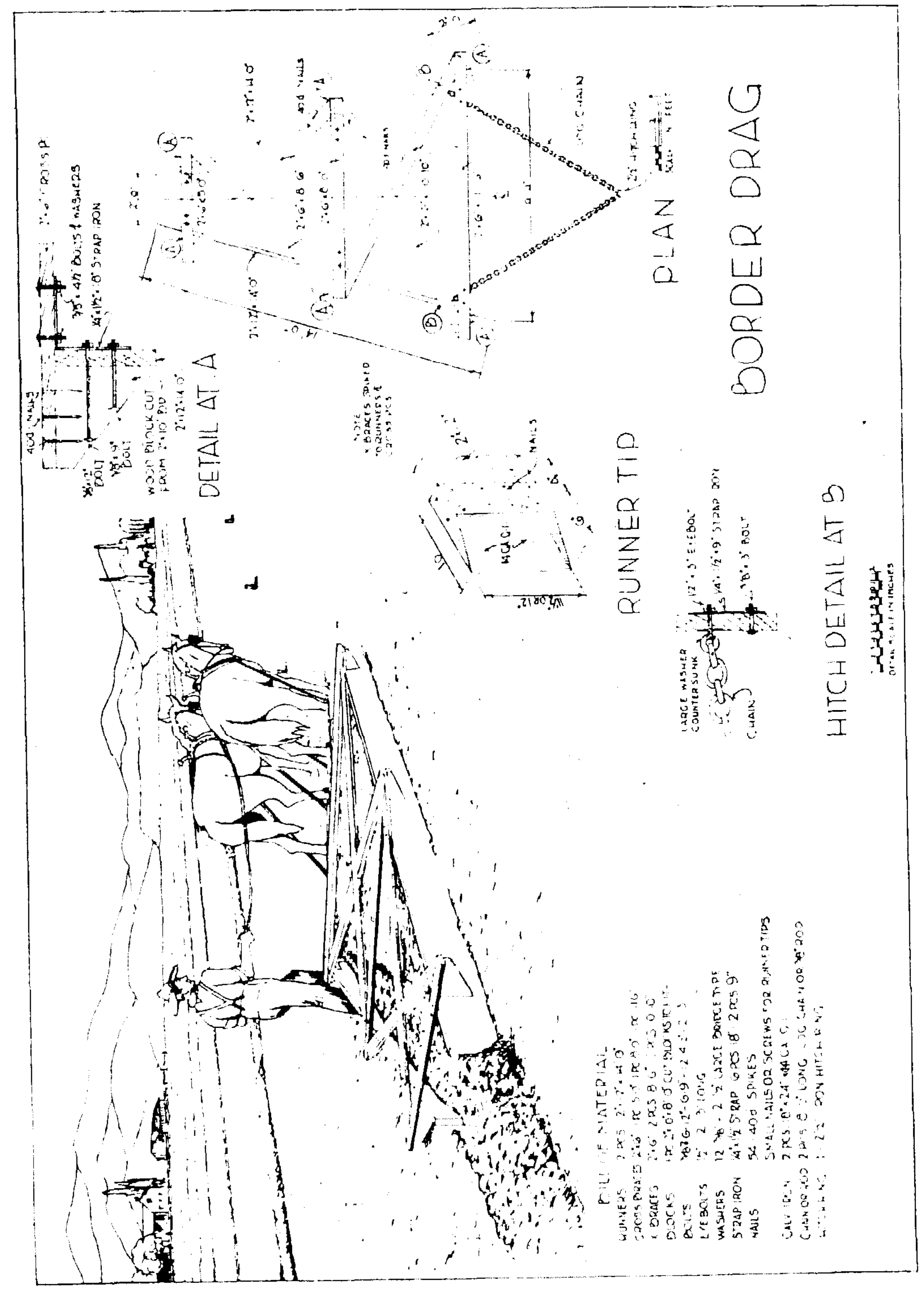


Fig. 39

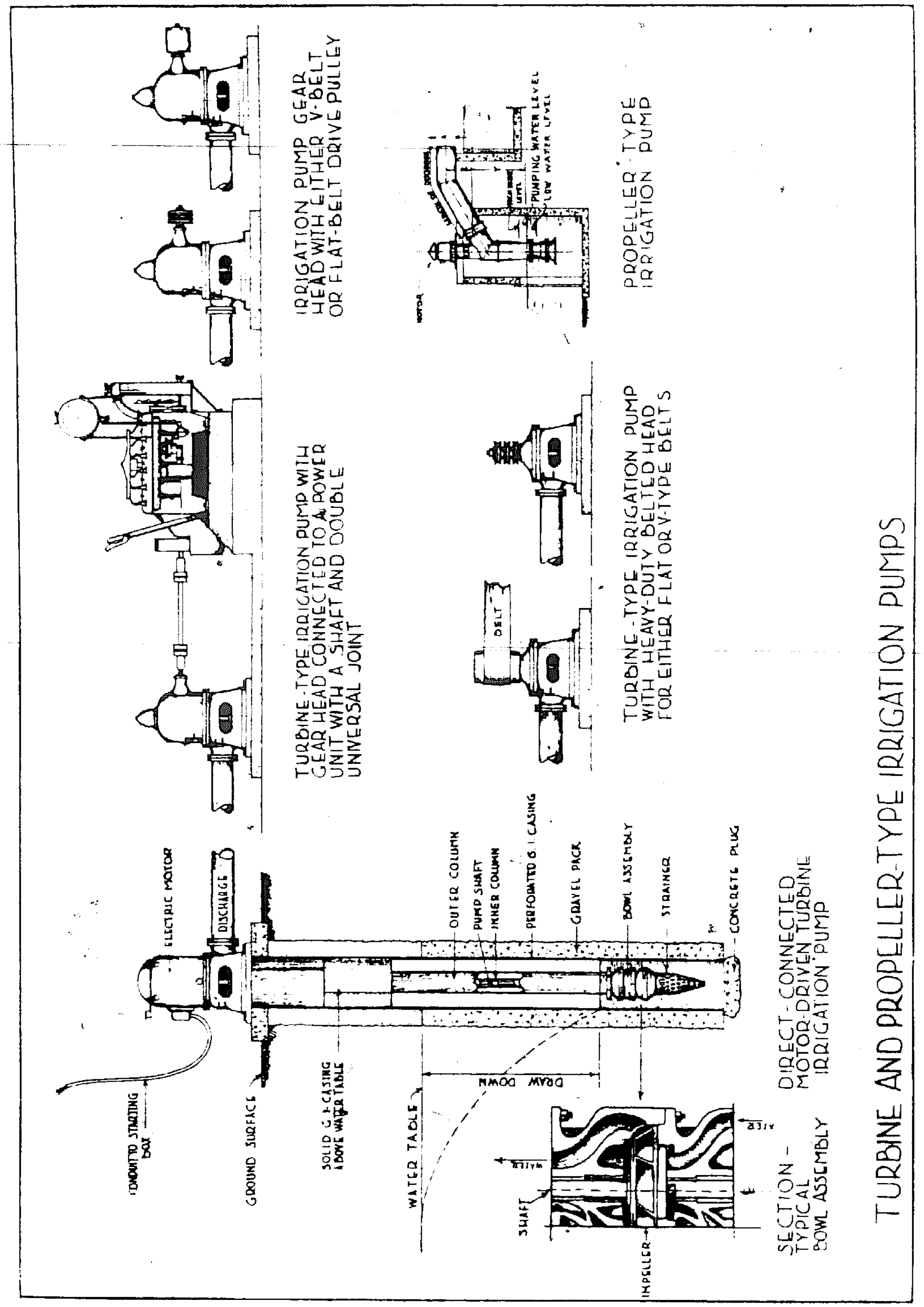


Fig. 40

required for the best efficiency under given conditions, the manufacturers should be given the following information:

1. The discharge required in gallons per minute or cubic feet per second.

2. The total head or lift in feet.
3. The type of power available.

Installation of a Horizontal Centrifugal Pump. The horizontal centrifugal pump (Fig. 41) is well adapted to pumping from streams or lakes or from one canal to another. The characteristics of this type of

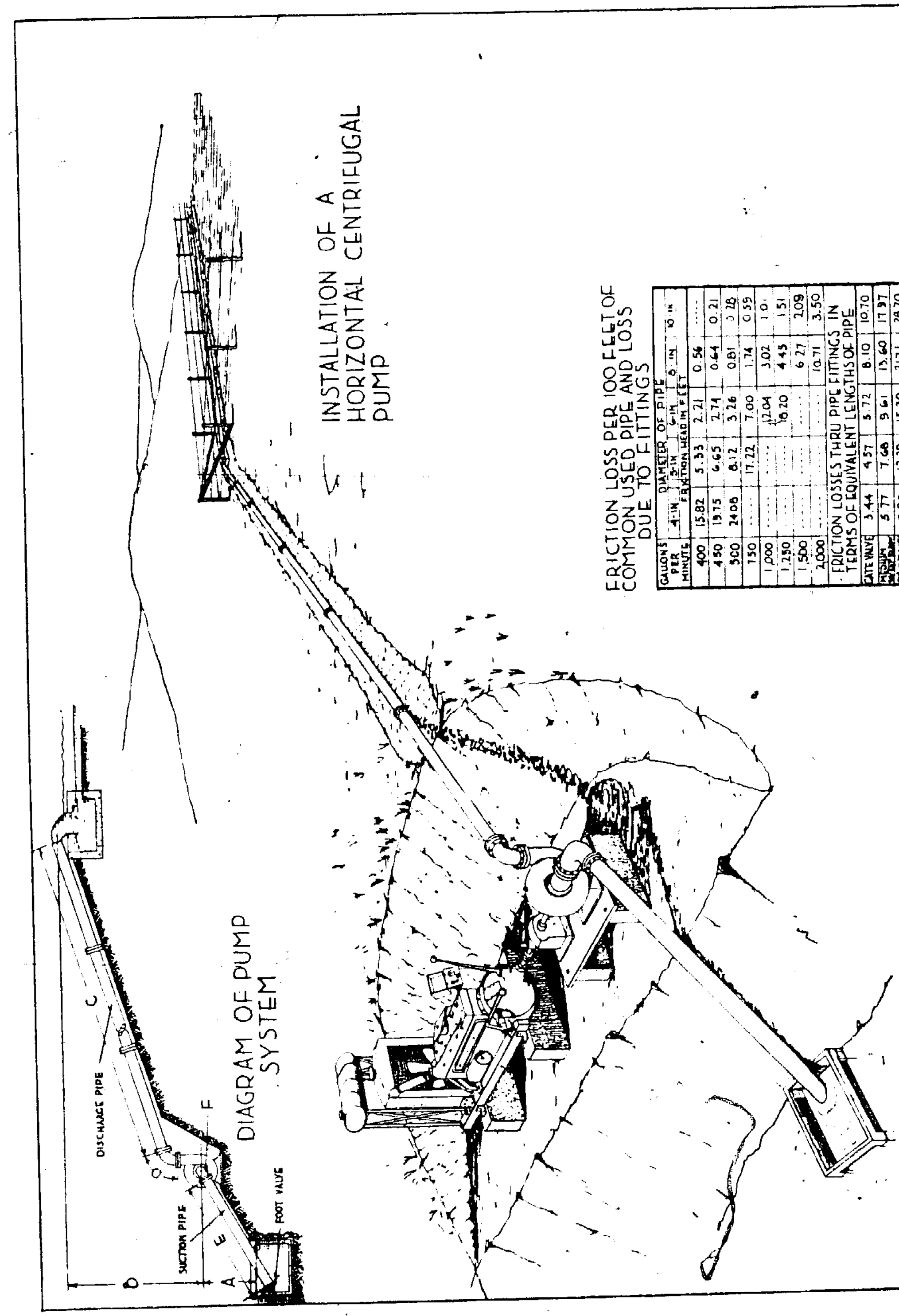


Fig. 41

pump are determined largely by the design and speed of the impeller. The manufacturers should have the following information in order to furnish a pump which will give the best efficiency under given conditions.

1. The quantity of water to be derived in gallons per minute or cubic feet per second.

2. The total head, or lift, in feet.

3. The type of power available and the probable speed at which the pump will operate.

The total lift, or head, includes not only the actual vertical distance in feet to which water will be lifted as A plus B in Fig. 41, but also the friction head in the pipe and pipe fittings.

The size of the suction and discharge pipe must be adapted to the quantity of water to be pumped. The table shown in Fig. 41 indicates the lost head due to friction per 100 feet of pipe length, as well as the losses through pipe fittings in terms of equivalent length of pipe.

An example—see sketch in upper left corner of Fig. 41:

Let $A + B = 20$ feet actual head.

Let $C + E = 200$ feet actual length of 8-inch discharge and suction pipe.

D = Medium-sweep elbow, equivalent to 13·6 feet of 8-inch pipe.

F = Standard elbow, equivalent to 21·7 feet of 8-inch pipe.

Compute total head when pump is delivering 1,000 gallons per minute.

An 8-inch pipe has 3·02 feet of friction head for 100 feet of pipe length when carrying 1,000 gallons per minute. The total head is calculated on the basis of total length of pipe plus the equivalent length for fittings. In the example it is 200 + 13·6 + 21·7 or 235·3 feet of 8-inch pipe. Since the friction head is given per 100 feet of pipe, it is necessary to divide 235·3 by 100, giving 2·353. This, multiplied by 3·02, gives 7·05, the friction head for 235·3 feet of 8-inch pipe. The total head is then 7·05 friction head plus 20 feet actual head or 27·05 feet.

There is a slight additional loss due to the foot-valve resistance and other factors.

The friction-loss table is based on commonly-used pipe.

Pumping from a Stream or Pond. Water for garden irrigation can be pumped from ponds and streams if the lift is not too great. A small horizontal centrifugal pump set not higher than 10 feet above the water and powered by a gasoline engine is the equipment ordinarily used. Pumps of the type may be had in sizes which will deliver from 30 to 1,000 gallons or more per minute. See Fig. 42 for illustration of pumping system for streams or ponds.

Pumping from Shallow Irrigation Wells. Along river bottoms where the ground water level is always within 10 feet or less of the surface, small irrigation wells may be successfully used for the irrigation of farm

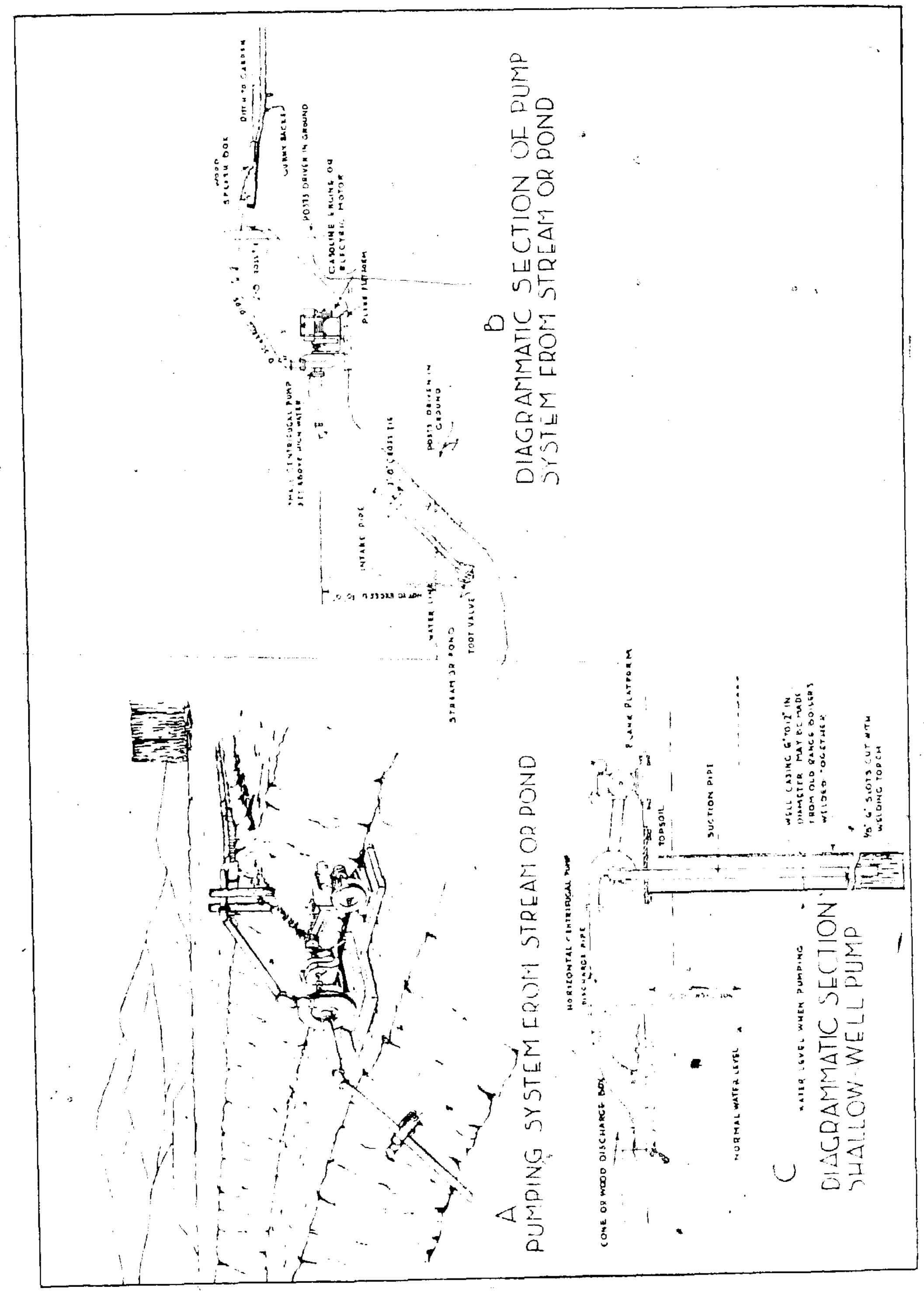
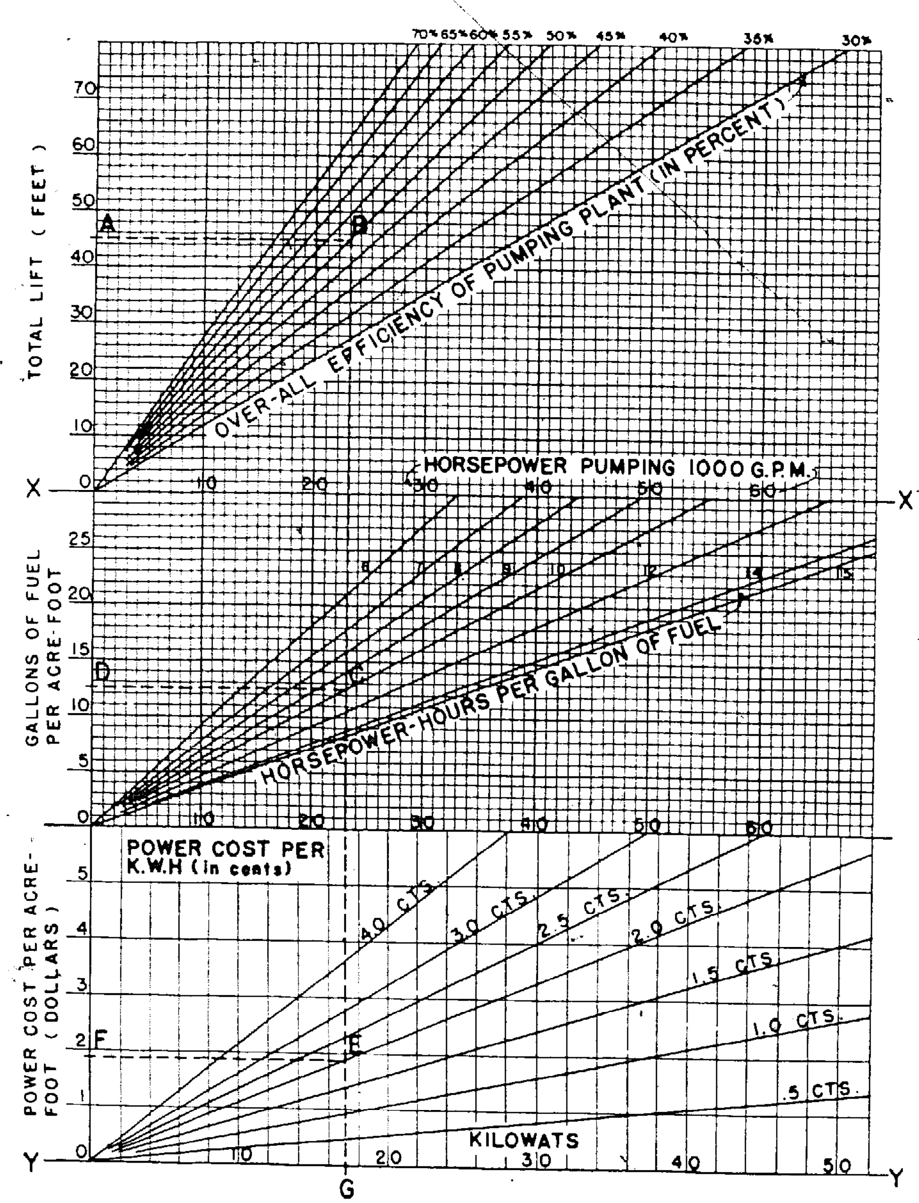


Fig. 42

gardens. Casings for such wells are ordinarily made from sheet metal slotted to permit water to enter. In some instances old range oilers with the ends cut out are welded together and slotted with a welding torch. Small centrifugal pumps set at ground surface are quite satisfactory. A diagrammatic section of a shallow-well pump is shown in Fig. 42.



POWER REQUIREMENTS - FUEL CONSUMPTION AND ELECTRICAL ENERGY COSTS AT VARIOUS PUMPING PLANT EFFICIENCIES.

Fig. 43

A Power-requirement Chart for Pumping. By means of the chart shown in Fig. 43 it is possible to determine power requirements, fuel consumption and electrical energy costs at various pumping-plant efficiencies and at various lifts.

At *A* at the upper left is the scale of lifts from 0 to 80 feet. The lift must include not only static head, but friction and velocity heads as well.

At *B*, upper centre, over-all plant efficiencies are represented. Over-all efficiencies in small irrigation pumping plants run from 40 to 60 per cent.

On the line *XX* is shown horsepower values when pumping 1,000 gallons per minute.

In the centre of the chart, at *C*, the fuel consumption of various types of engines is represented.

The approximation number of horsepower-hours developed per gallon of fuel for various types of engines is given below:

Type of engine	*Horsepower-hours per gallon of fuel*
Gasoline engines in poor repair	6 to 7
Gasoline engines in good repair	8 to 9·5
Engines using fuel oil, semi-Diesel, etc.	9 to 11
High-speed Diesel	11 to 14·5

At the lower part of the chart, at *E*, is given the power cost in dollars per acre-foot of water pumped at various rates in cents per kilowatt-hour.

The line *YY* at the bottom of the chart represents the power required in kilowatts when pumping 1,000 gallons per minute.

Use of the Chart. The use of the chart is shown by the following example:

The lift of a given irrigation pump is 45 feet; the over-all efficiency of the plant is estimated at 50 per cent. What will be the horsepower required to pump 1,000 gallons per minute? How many gallons of fuel will be required to pump an acre-foot of water, using fuel oil in an engine other than Diesel? What would be the cost in dollars per acre-foot, using electricity at 2 cents per kilowatt-hour?

Starting at the upper left-hand margin locate the lift: 45 feet is at point *A*. Follow to the right until the 50 per cent efficiency line is intersected at point *B*.

From point *B* follow downward until the line *XX* is intersected. It will be noted that 23 horsepower is required to pump 1,000 gallons per minute. Continue downward until the line representing 10 horsepower-hours per gallon is intersected at *C*. From the point *C* follow to the left to the point *D*, which shows that 12·5 gallons of fuel will be required to pump an acre-foot of water.

If the cost in dollars per acre-foot is required, with electrical energy costing 2 cents per kilowatt-hour, follow downward from point *C* to point *E* on the diagonal line showing 2 cents cost. From point *E* follow to the left to point *F*, which shows the cost of pumping 1 acre-foot of water under the given conditions to be $1.90.

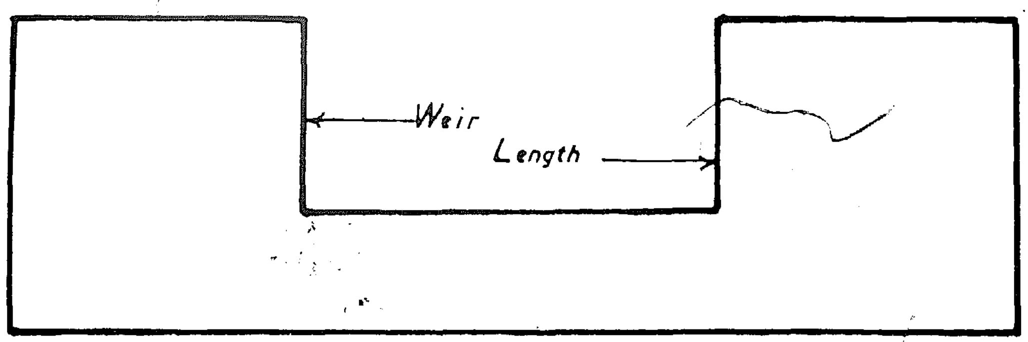
If the electrical load is required, follow downward from E to point G, which shows a value of 17.

If lifts other than those shown are to be used, certain allowances must be made. If values for a 100-foot lift are desired, those given for a 50-foot lift may be doubled, etc.

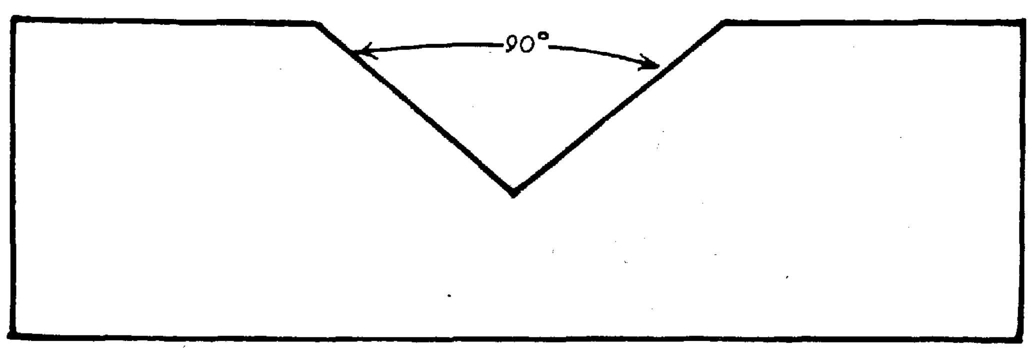
IRRIGATION STRUCTURES

A wide variety of structures are required for handling or controlling irrigation water. These structures are required to measure water, divide flow of streams, check erosion of streams, carry water across or under roadways and gulleys, and to provide protection to mechanical equipment used in pumping or controlling water.

Weirs commonly used to measure irrigation water to the farm or on the farm are shown in Fig. 44. The triangular-notch weir is the most accurate for small flows, however the rectangular weir is used much more often because of the lower 'head' requirement for measuring the same flow. Head is the difference in elevation required between the water level above the weir and the water level below the weir. The flow of water over a weir will be influenced by the sharpness of the material forming the



RECTANGULAR WEIR

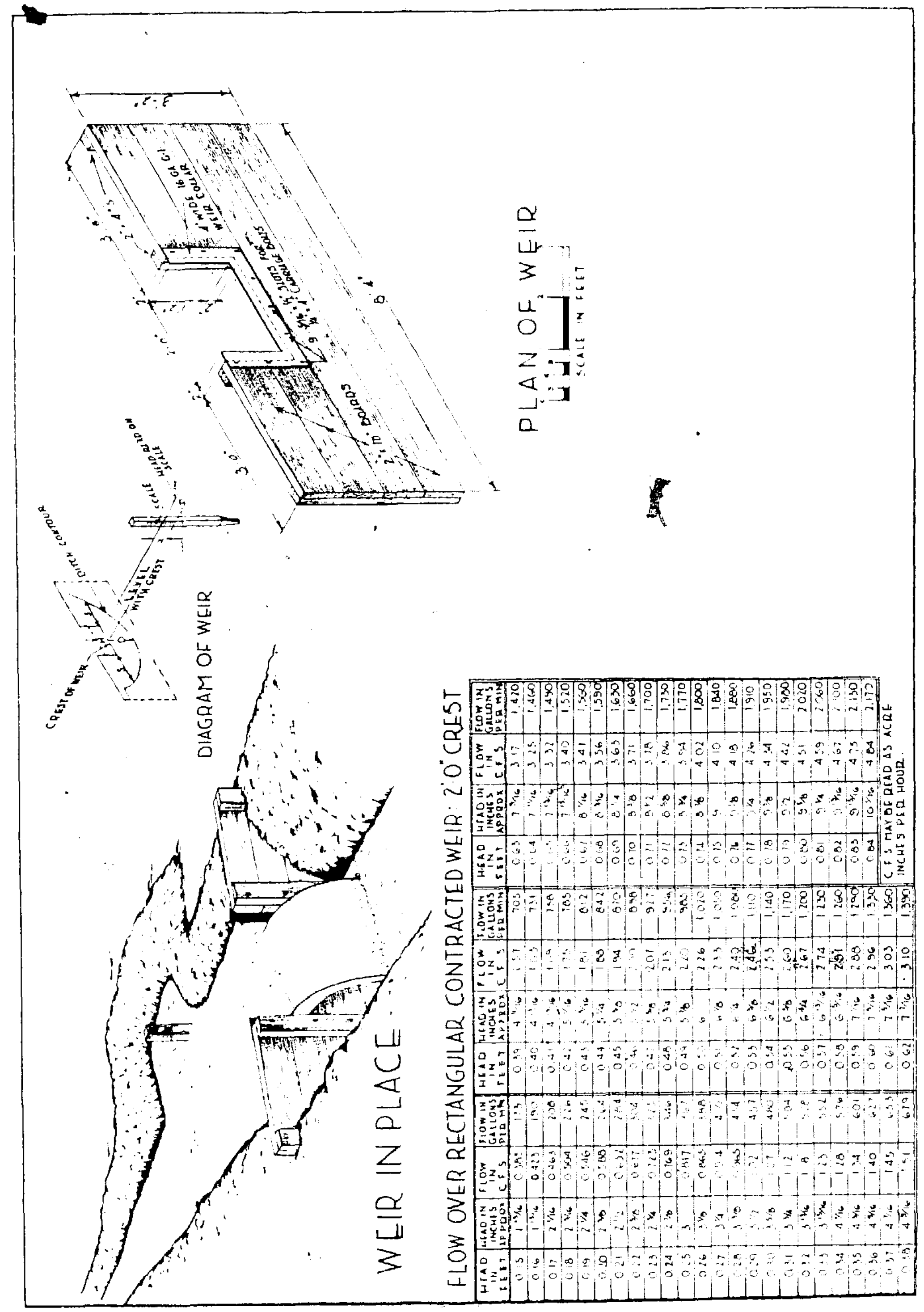


TRIANGULAR OR "V" NOTCH WEIR

Fig. 44. Two methods of weir used in measuring water

notch. Note that in Fig. 45 the notch in the illustration is made of steel and is bolted to the wooden structure. Tables 11 and 12 are computed for sharp crested weirs only.

Weirs can be portable when only an occasional measurement is required. Fig. 45 gives the essential measurements for a portable metal

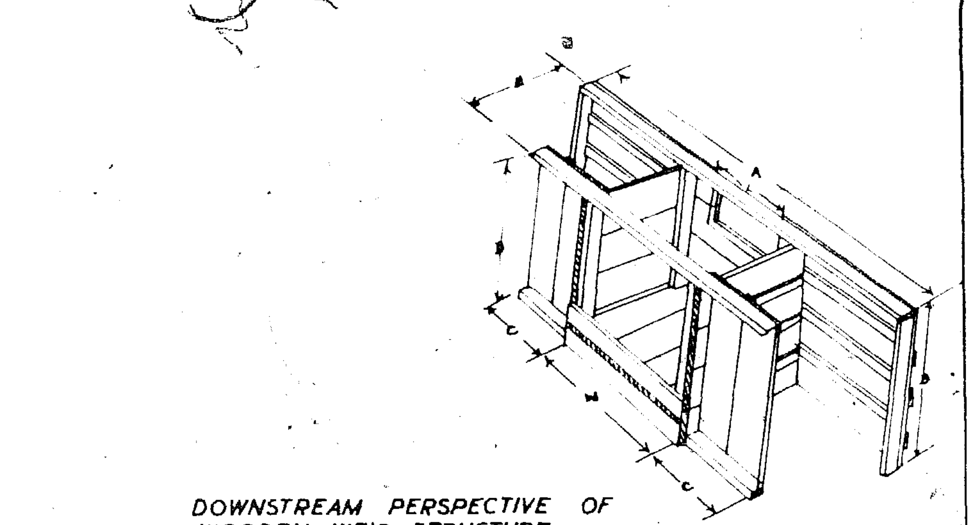


FLOW OVER RECTANGULAR CONTRACTED WEIR: 2'0" CREST

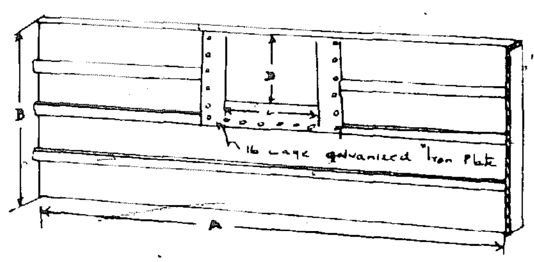
Head in feet	Head in inches approx	Flow in C.F.S.	Flow in gallons per min	Head in feet	Head in inches approx	Flow in C.F.S.	Flow in gallons per min	Head in feet	Head in inches approx	Flow in C.F.S.	Flow in gallons per min
0.15	1 13/16	0.381	171	0.39	4 11/16	1.57	705	0.63	7 9/16	3.17	1,420
0.16	1 15/16	0.423	190	0.40	4 13/16	1.63	731	0.64	7 11/16	3.25	1,460
0.17	2 1/16	0.463	208	0.41	4 15/16	1.69	758	0.65	7 13/16	3.32	1,490
0.18	2 3/16	0.504	226	0.42	5 1/16	1.75	785	0.66	7 15/16	3.40	1,520
0.19	2 1/4	0.546	245	0.43	5 3/16	1.81	812	0.67	8 1/16	3.47	1,550
0.20	2 3/8	0.588	264	0.44	5 1/4	1.88	842	0.68	8 3/16	3.56	1,590
0.21	2 1/2	0.632	284	0.45	5 3/8	1.94	870	0.69	8 1/4	3.63	1,630
0.22	2 5/8	0.677	304	0.46	5 1/2	2.00	898	0.70	8 3/8	3.71	1,660
0.23	2 3/4	0.723	324	0.47	5 5/8	2.07	927	0.71	8 1/2	3.78	1,700
0.24	2 7/8	0.769	346	0.48	5 3/4	2.13	956	0.72	8 5/8	3.86	1,730
0.25	3	0.817	367	0.49	5 7/8	2.20	985	0.73	8 3/4	3.94	1,770
0.26	3 1/8	0.865	388	0.50	6	2.26	1,020	0.74	8 7/8	4.02	1,800
0.27	3 1/4	0.914	410	0.51	6 1/8	2.33	1,050	0.75	9	4.10	1,840
0.28	3 3/8	0.963	434	0.52	6 1/4	2.40	1,080	0.76	9 1/8	4.18	1,880
0.29	3 1/2	1.02	457	0.53	6 3/8	2.46	1,110	0.77	9 1/4	4.26	1,910
0.30	3 5/8	1.07	480	0.54	6 1/2	2.53	1,140	0.78	9 3/8	4.34	1,950
0.31	3 3/4	1.12	504	0.55	6 5/8	2.60	1,170	0.79	9 1/2	4.42	1,980
0.32	3 13/16	1.18	528	0.56	6 3/4	2.67	1,200	0.80	9 5/8	4.51	2,020
0.33	3 15/16	1.23	552	0.57	6 13/16	2.74	1,230	0.81	9 3/4	4.59	2,060
0.34	4 1/16	1.28	576	0.58	6 15/16	2.81	1,260	0.82	9 13/16	4.67	2,100
0.35	4 3/16	1.34	601	0.59	7 1/16	2.88	1,290	0.83	9 15/16	4.75	2,130
0.36	4 5/16	1.40	627	0.60	7 3/16	2.96	1,330	0.84	10 1/16	4.84	2,170
0.37	4 7/16	1.45	653	0.61	7 5/16	3.03	1,360				
0.38	4 9/16	1.51	679	0.62	7 7/16	3.10	1,390				

C F S MAY BE READ AS ACRE INCHES PER HOUR.

Fig. 45



DOWNSTREAM PERSPECTIVE OF WOODEN WEIR STRUCTURE



UPSTREAM FACE OF WOODEN WEIR STRUCTURE

Approximate Range in Capacity Cubic Feet per Second	L Length of Weir Notch	D Depth of Weir Notch	A Length of Bulkhead	B Height of Structure	E Length of Side Wall	W Outside width of box below weir notch	C Length of downstream wing wall
0·3 to 1·5	1′ 0″	1′ 0″	8′ 0″	3′ 0″	2′ 6″	2′ 0″	1′ 6″
0·5 3·0	1′ 6″	1′ 3″	9′ 0″	3′ 6″	3′ 0″	3′ 0″	2′ 0″
0·6 6·0	2′ 0″	1′ 6″	10′ 0″	4′ 0″	3′ 0″	3′ 6″	2′ 0
1·0 10·0	3′ 0″	1′ 9″	12′ 0″	4′ 6″	3′ 6″	5′ 0″	2′ 6″
1·5 20·0	4′ 0″	2′ 0″	14′ 0″	5′ 0″	4′ 0″	6′ 0″	3′ 0″

Fig. 46

weir. Fig. 46 gives construction details for a rectangular weir that is to be installed permanently at a location. The following general rules are important and should be observed for accurate measurement of water:

(1) The weir should be set at right angles to the direction of flow of the stream.

(2) The pond behind the weir should be large enough so the water approaches the weir at a velocity under ½ foot per second. The crest of the weir must also be placed high enough so it will always be above the downstream water surface.

(3) The distance from the weir crest to the bottom of the ditch above the weir should be at least twice the maximum depth of water that will be flowing over it. The distance from the sides of the weir notch to the side of the channel above the weir should also be at least twice the maximum depth.

(4) The weir notch should be constructed of material (preferably steel) not over ¼ inch in thickness with sharp 90 degree edges.

(5) The head (vertical distance from weir crest to the upstream water level) should be measured away from the weir crest to avoid measurement on the curved water surface as it approaches the opening.

(6) For accurate measurement the length of weir crest should be chosen so the head going over it is at least 2 inches and not over ⅓ of its length. Table 12 gives the discharge of rectangular weirs for various crest lengths. Table 11 gives the discharge for a 90 degree triangular-notch weir.

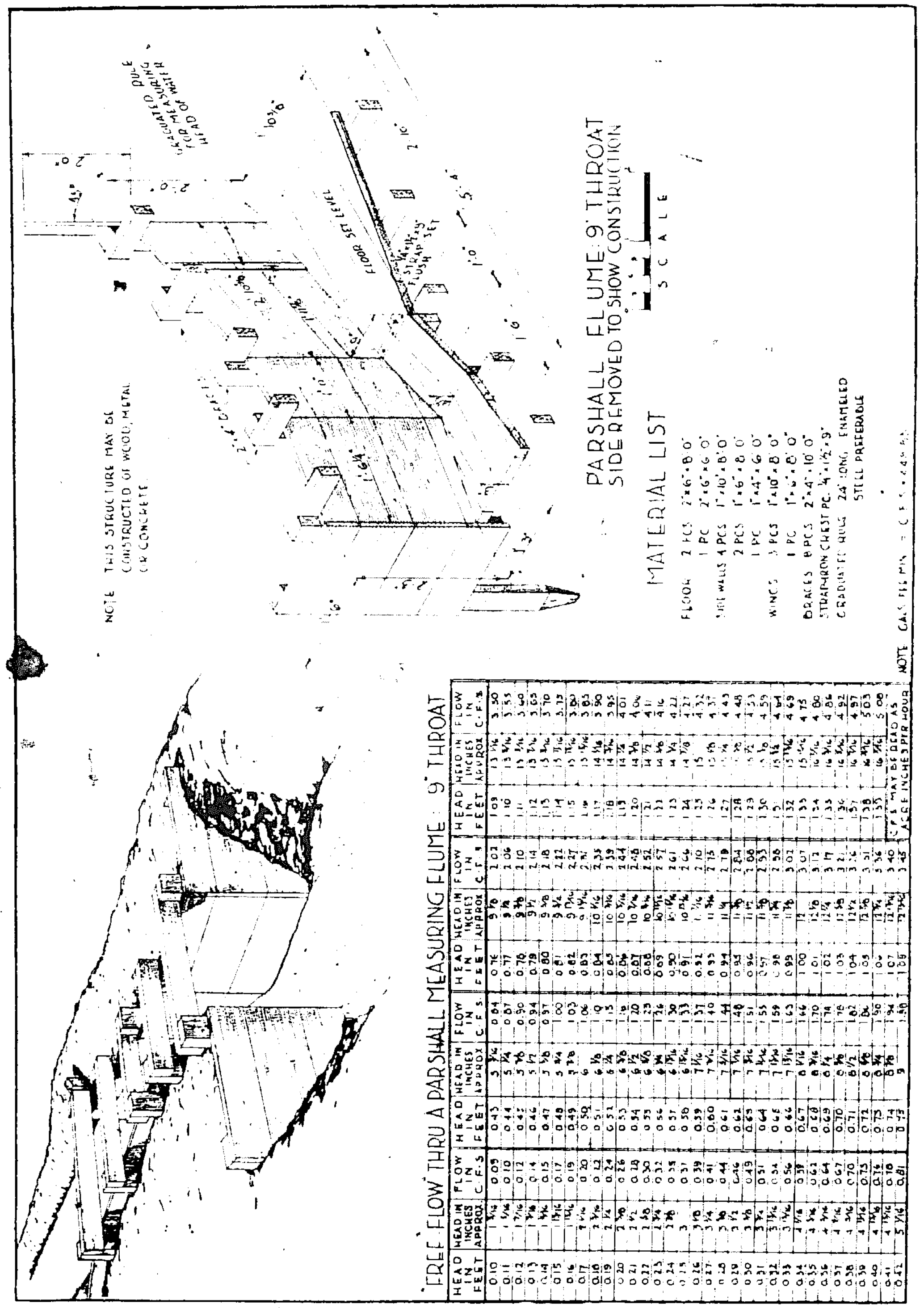
A Parshall measuring flume can operate with less head loss than that required for weirs. This is an important feature in many locations. The flume consists of a converging inlet, a narrow throat and a diverging outlet. A 'head' measuring gauge is located in the inlet section and another in the throat section. Only a single head reading is required when the flume is set so the lower gauge is less than 60 per cent of the upper gauge. When this condition exists the flume is said to be free flowing. If the lower gauge reads over 60 per cent then the upper gauge reading is affected and the flow is said to be submerged. Table 13 gives free flow discharge for Parshall measuring flumes with 3-inch to 3-foot throat widths. Fig. 47 shows construction details on a 9-inch Parshall flumes. Corrections must be made if the flow is submerged. These corrections will not be taken up here.*

The velocity of water from the flume is quite high under free flow conditions. Silt cannot deposit where it would affect the reading of the gauge, however some erosion protection of the channel may be required for a short distance downstream.

Parshall flumes are not adapted to combination with a turnout or division box and are more costly to build than a weir. They must be built accurately and installed properly for good water measurement.

A submerged orifice may be used to measure water. It also has the advantage of low head loss and can be combined with a turnout structure. Fig. 48 shows the construction of this type of orifice.

* *University of California Bulletin No. 588*, 'Measuring Water for Irrigation'.



FREE FLOW THRU A PARSHALL MEASURING FLUME: 9" THROAT

HEAD IN FEET	HEAD IN INCHES APPROX	FLOW IN C.F.S.	HEAD IN FEET	HEAD IN INCHES APPROX	FLOW IN C.F.S.	HEAD IN FEET	HEAD IN INCHES APPROX	FLOW IN C.F.S.	HEAD IN FEET	HEAD IN INCHES APPROX	FLOW IN C.F.S.
0.10	1 3/16	0.09	0.43	5 3/16	0.84	0.76	9 1/8	2.02	1.09	13 1/16	3.50
0.11	1 5/16	0.10	0.44	5 1/4	0.87	0.77	9 1/4	2.06	1.10	13 3/16	3.55
0.12	1 7/16	0.12	0.45	5 3/8	0.90	0.78	9 3/8	2.10	1.11	13 5/16	3.60
0.13	1 9/16	0.14	0.46	5 1/2	0.94	0.79	9 1/2	2.14	1.12	13 7/16	3.65
0.14	1 11/16	0.15	0.47	5 5/8	0.97	0.80	9 5/8	2.18	1.13	13 9/16	3.70
0.15	1 13/16	0.17	0.48	5 3/4	1.00	0.81	9 3/4	2.22	1.14	13 11/16	3.75
0.16	1 15/16	0.19	0.49	5 7/8	1.03	0.82	9 13/16	2.27	1.15	13 13/16	3.80
0.17	2 1/16	0.20	0.50	6	1.06	0.83	9 15/16	2.31	1.16	13 15/16	3.85
0.18	2 3/16	0.22	0.51	6 1/8	1.10	0.84	10 1/16	2.35	1.17	14 1/16	3.90
0.19	2 1/4	0.24	0.52	6 1/4	1.13	0.85	10 3/16	2.39	1.18	14 3/16	3.95
0.20	2 3/8	0.26	0.53	6 3/8	1.16	0.86	10 5/16	2.44	1.19	14 1/4	4.01
0.21	2 1/2	0.28	0.54	6 1/2	1.20	0.87	10 7/16	2.48	1.20	14 3/8	4.06
0.22	2 5/8	0.30	0.55	6 5/8	1.23	0.88	10 9/16	2.52	1.21	14 1/2	4.11
0.23	2 3/4	0.32	0.56	6 3/4	1.26	0.89	10 11/16	2.57	1.22	14 5/8	4.16
0.24	2 7/8	0.35	0.57	6 13/16	1.30	0.90	10 13/16	2.61	1.23	14 3/4	4.22
0.25	3	0.37	0.58	6 15/16	1.33	0.91	10 15/16	2.66	1.24	14 7/8	4.27
0.26	3 1/8	0.39	0.59	7 1/16	1.37	0.92	11 1/16	2.70	1.25	15	4.32
0.27	3 1/4	0.41	0.60	7 3/16	1.40	0.93	11 3/16	2.75	1.26	15 1/8	4.37
0.28	3 3/8	0.44	0.61	7 5/16	1.44	0.94	11 1/4	2.79	1.27	15 1/4	4.43
0.29	3 1/2	0.46	0.62	7 7/16	1.48	0.95	11 3/8	2.84	1.28	15 3/8	4.48
0.30	3 5/8	0.49	0.63	7 9/16	1.51	0.96	11 1/2	2.88	1.29	15 1/2	4.53
0.31	3 3/4	0.51	0.64	7 11/16	1.55	0.97	11 5/8	2.93	1.30	15 5/8	4.59
0.32	3 13/16	0.54	0.65	7 13/16	1.59	0.98	11 3/4	2.98	1.31	15 3/4	4.64
0.33	3 15/16	0.56	0.66	7 15/16	1.63	0.99	11 7/8	3.02	1.32	15 13/16	4.69
0.34	4 1/16	0.59	0.67	8 1/16	1.66	1.00	12	3.07	1.33	15 15/16	4.75
0.35	4 3/16	0.61	0.68	8 3/16	1.70	1.01	12 1/8	3.12	1.34	16 1/16	4.80
0.36	4 5/16	0.64	0.69	8 1/4	1.74	1.02	12 1/4	3.17	1.35	16 3/16	4.86
0.37	4 7/16	0.67	0.70	8 3/8	1.78	1.03	12 3/8	3.21	1.36	16 5/16	4.92
0.38	4 9/16	0.70	0.71	8 1/2	1.82	1.04	12 1/2	3.26	1.37	16 7/16	4.97
0.39	4 11/16	0.73	0.72	8 5/8	1.86	1.05	12 5/8	3.31	1.38	16 9/16	5.03
0.40	4 13/16	0.76	0.73	8 3/4	1.90	1.06	12 3/4	3.36	1.39	16 11/16	5.08
0.41	4 15/16	0.78	0.74	8 7/8	1.94	1.07	12 13/16	3.40	C.F.S. MAY BE READ AS		
0.42	5 1/16	0.81	0.75	9	1.98	1.08	12 15/16	3.45	ACRE INCHES PER HOUR		

Fig. 47

An orifice is an opening and as used here will refer only to an opening in thin material (12, 14 or 16 gauge steel). A submerged orifice then is one that discharges under water and the discharge can be measured by knowing the difference in water level above and below the orifice. Table 14 gives some recommended sizes for submerged orifice structures and Table

Table 11

Discharge Table for 90° Triangular-notch Weir with Complete Contractions Computed from the Formula $Q = 2{\cdot}49\,H^{2{\cdot}48}$

Head (H)		Discharge (Q)	Head (H)		Discharge (Q)
ft.	in.	sec.-ft.	ft.	ins.	sec.-ft.
0·20	2 3/8	0·046	0·73	8 3/4	1·14
0·21	2 1/2	0·052	0·74	8 7/8	1·18
0·22	2 5/8	0·058	0·75	9	1·22
0·23	2 3/4	0·065	0·76	9 1/8	1·26
0·24	2 7/8	0·072	0·77	9 1/4	1·30
0·25	3	0·080	0·78	9 3/8	1·34
0·26	3 1/8	0·088	0·79	9 1/2	1·39
0·27	3 1/4	0·096	0·80	9 5/8	1·43
0·28	3 3/8	0·106	0·81	9 3/4	1·48
0·29	3 1/2	0·115	0·82	9 13/16	1·52
0·30	3 5/8	0·125	0·83	9 15/16	1·57
0·31	3 3/4	0·136	0·84	10 1/16	1·61
0·32	3 13/16	0·147	0·85	10 3/16	1·66
0·33	3 15/16	0·159	0·86	10 5/16	1·71
0·34	4 1/16	0·171	0·87	10 7/16	1·76
0·35	4 3/16	0·184	0·88	10 9/16	1·81
0·36	4 5/16	0·197	0·89	10 11/16	1·86
0·37	4 7/16	0·211	0·90	10 13/16	1·92
0·38	4 9/16	0·225	0·91	10 15/16	1·97
0·39	4 11/16	0·240	0·92	11 1/16	2·02
0·40	4 13/16	0·256	0·93	11 3/16	2·08
0·41	4 15/16	0·272	0·94	11 1/4	2·13
0·42	5 1/16	0·289	0·95	11 3/8	2·19
0·43	5 3/16	0·306	0·96	11 1/2	2·25
0·44	5 1/4	0·324	0·97	11 5/8	2·31
0·45	5 3/8	0·343	0·98	11 3/4	2·37
0·46	5 1/2	0·362	0·99	11 7/8	2·43
0·47	5 5/8	0·382	1·00	12	2·49
0·48	5 3/4	0·403	1·01	12 1/8	2·55
0·49	5 7/8	0·424	1·02	12 1/4	2·61
0·50	6	0·445	1·03	12 3/8	2·68
0·51	6 1/8	0·468	1·04	12 1/2	2·74
0·52	6 1/4	0·491	1·05	12 5/8	2·81
0·53	6 3/8	0·515	1·06	12 3/4	2·87
0·54	6 1/2	0·539	1·07	12 13/16	2·94
0·55	6 5/8	0·564	1·08	12 15/16	3·01
0·56	6 3/4	0·590	1·09	13 1/16	3·08
0·57	6 13/16	0·617	1·10	13 3/16	3·15
0·58	6 15/16	0·644	1·11	13 5/16	3·22
0·59	7 1/16	0·672	1·12	13 7/16	3·30
0·60	7 3/16	0·700	1·13	13 9/16	3·37
0·61	7 5/16	0·730	1·14	13 11/16	3·44
0·62	7 7/16	0·760	1·15	13 13/16	3·52
0·63	7 9/16	0·790	1·16	13 15/16	3·59
0·64	7 11/16	0·822	1·17	14 1/16	3·67
0·65	7 13/16	0·854	1·18	14 3/16	3·75
0·66	7 15/16	0·887	1·19	14 1/4	3·83
0·67	8 1/16	0·921	1·20	14 3/8	3·91
0·68	8 3/16	0·955	1·21	14 1/2	3·99
0·69	8 1/4	0·991	1·22	14 5/8	4·07
0·70	8 3/8	1·03	1·23	14 3/4	4·16
0·71	8 1/2	1·06	1·24	14 7/8	4·24
0·72	8 5/8	1·10	1·25	15	4·33

Table 12

Discharge of Rectangular Weirs with Complete Contractions

Head (H)		Discharge (Q) for Crest Lengths (L) of—				Head (H)		Discharge (Q) for Crest Lengths (L) of—			
		1 foot	1·5 feet	2 feet	3 feet			1 foot	1·5 feet	2 feet	3 feet
ft.	in.	sec.-ft.	sec.-ft.	sec.-ft.	sec.-ft.	ft.	in.	sec.-ft.	sec.-ft.	sec.-ft.	sec.-ft.
0·10	1 3/16	0·11	0·16	0·22	0·33	0·56	6 3/4	1·31	1·99	2·67	4·04
0·11	1 5/16	0·12	0·18	0·25	0·37	0·57	6 13/16	1·35	2·04	2·74	4·15
0·12	1 7/16	0·14	0·20	0·28	0·42	0·58	6 15/16	1·38	2·09	2·81	4·26
0·13	1 9/16	0·15	0·22	0·32	0·47	0·59	7 1/16	1·42	2·15	2·88	4·36
0·14	1 11/16	0·17	0·25	0·35	0·53	0·60	7 3/16	1·45	2·20	2·96	4·47
0·15	1 13/16	0·19	0·28	0·39	0·58	0·61	7 5/16	1·49	2·25	3·03	4·58
0·16	1 15/16	0·21	0·31	0·43	0·64	0·62	7 7/16	1·52	2·31	3·10	4·69
0·17	2 1/16	0·23	0·34	0·47	0·70	0·63	7 9/16	1·56	2·36	3·17	4·81
0·18	2 3/16	0·25	0·37	0·51	0·75	0·64	7 11/16	1·60	2·42	3·25	4·92
0·19	2 1/4	0·27	0·40	0·55	0·83	0·65	7 13/16	1·63	2·47	3·32	5·03
0·20	2 3/8	0·29	0·44	0·59	0·89	0·66	7 15/16	1·67	2·53	3·40	5·15
0·21	2 1/2	0·31	0·47	0·63	0·95	0·67	8 1/16	1·71	2·59	3·47	5·26
0·22	2 5/8	0·34	0·50	0·68	1·02	0·68	8 3/16	1·74	2·64	3·56	5·38
0·23	2 3/4	0·36	0·54	0·72	1·09	0·69	8 1/4	1·78	2·70	3·63	5·49
0·24	2 7/8	0·38	0·57	0·77	1·16	0·70	8 3/8	1·82	2·76	3·71	5·61
0·25	3	0·40	0·61	0·82	1·23	0·71	8 1/2	1·86	2·81	2·78	5·73
0·26	3 1/8	0·43	0·65	0·86	1·31	0·72	8 5/8	1·90	2·87	3·86	5·85
0·27	3 1/4	0·45	0·68	0·91	1·38	0·73	8 3/4	1·93	2·93	3·94	5·97
0·28	3 3/8	0·48	0·72	0·96	1·46	0·74	8 7/8	1·97	2·99	4·02	6·09
0·29	3 1/2	0·50	0·76	1·02	1·53	0·75	9	2·01	3·05	4·10	6·21
0·30	3 5/8	0·53	0·80	1·07	1·61	0·76	9 1/8	2·05	3·11	4·18	6·33
0·31	3 3/4	0·55	0·84	1·12	1·69	0·77	9 1/4	2·09	3·17	4·26	6·45
0·32	3 13/16	0·58	0·88	1·18	1·77	0·78	9 3/8	2·13	3·23	4·34	6·58
0·33	3 15/16	0·61	0·92	1·23	1·86	0·79	9 1/2	2·17	3·29	4·42	6·70
0·34	4 1/16	0·63	0·96	1·28	1·94	0·80	9 5/8	2·21	3·35	4·51	6·83
0·35	4 3/16	0·66	1·00	1·34	2·02	0·81	9 3/4	2·25	3·41	4·59	6·95
0·36	4 5/16	0·69	1·04	1·40	2·11	0·82	9 13/16	2·29	3·47	4·67	7·08
0·37	4 7/16	0·72	1·08	1·45	2·20	0·83	9 15/16	2·33	3·54	4·75	7·21
0·38	4 9/16	0·74	1·13	1·51	2·28	0·84	10 1/16	2·37	3·60	4·84	7·33
0·39	4 11/16	0·77	1·17	1·57	2·37	0·85	10 3/16	2·41	3·66	4·92	7·46
0·40	4 13/16	0·80	1·21	1·63	2·46	0·86	10 5/16	2·46	3·72	5·01	7·59
0·41	4 15/16	0·83	1·26	1·69	2·55	0·87	10 7/16	2·50	3·79	5·10	7·72
0·42	5 1/16	0·86	1·30	1·75	2·65	0·88	10 9/16	2·54	3·85	5·18	7·85
0·43	5 3/16	0·89	1·35	1·81	2·74	0·89	10 11/16	2·58	3·92	5·27	7·99
0·44	5 1/4	0·92	1·40	1·88	2·83	0·90	10 13/16	2·62	3·98	5·35	8·12
0·45	5 3/8	0·96	1·44	1·94	2·93	0·91	10 15/16	2·67	4·05	5·44	8·25
0·46	5 1/2	0·99	1·49	2·00	3·03	0·92	11 1/16	2·71	4·11	5·53	8·38
0·47	5 5/8	1·02	1·54	2·07	3·12	0·93	11 3/16	2·75	4·18	5·62	8·52
0·48	5 3/4	1·05	1·59	2·13	3·22	0·94	11 1/4	2·79	4·24	5·71	8·65
0·49	5 7/8	1·08	1·64	2·20	3·23	0·95	11 3/8	2·84	4·31	5·80	8·79
0·50	6	1·11	1·68	2·26	3·42	0·96	11 1/2	2·88	4·37	5·89	8·93
0·51	6 1/8	1·15	1·73	2·33	3·52	0·97	11 5/8	2·93	4·44	5·98	9·06
0·52	6 1/4	1·18	1·78	2·40	3·62	0·98	11 3/4	2·97	4·51	6·07	9·20
0·53	6 3/8	1·21	1·84	2·46	3·73	0·99	11 7/8	3·01	4·57	6·15	9·34
0·54	6 1/2	1·25	1·89	2·53	3·83	1·00	12	3·06	4·64	6·25	9·48
0·55	6 5/8	1·28	1·94	2·60	3·94						

15 gives discharges for heads from 0·01 to 0·80 feet. Gauges may be attached to the upstream and downstream wall of the structure to find the difference in water level or head causing the flow through the orifice.

The submerged orifice has the disadvantage of becoming clogged easily with weeds or moss and if the water is muddy this condition is not apparent with casual inspection. Its ability to measure water accurately with low head loss makes it quite popular in many irrigated areas however.

An outlet box as shown in Fig. 49 may be used for turning water into a border strip. The gate in the box can be used to control the flow from the field lateral. Large siphon tubes to 12-inch diameter have been used for this purpose also. These large siphon tubes are usually primed with a

Table 13. Flow Through Parshall Measuring Flumes

Head, H (feet)	Discharge, Q, for throat widths, W, of—						
	3 inches	6 inches	9 inches	1 foot	1·5 feet	2 feet	3 feet
	sec.-ft.	sec.-ft.	sec.-ft.	sec.-ft.	sec.-ft.	sec.-ft.	sec.-ft.
0·10	0·028	0·05	0·09	—	—	—	—
0·11	0·033	0·06	0·10	—	—	—	—
0·12	0·037	0·07	0·12	—	—	—	—
0·13	0·042	0·08	0·14	—	—	—	—
0·14	0·047	0·09	0·15	—	—	—	—
0·15	0·053	0·10	0·17	—	—	—	—
0·16	0·058	0·11	0·19	—	—	—	—
0·17	0·064	0·12	0·20	—	—	—	—
0·18	0·070	0·14	0·22	—	—	—	—
0·19	0·076	0·15	0·24	—	—	—	—
0·20	0·082	0·16	0·26	0·35	0·51	0·66	0·97
0·21	0·089	0·18	0·28	0·37	0·55	0·71	1·04
0·22	0·095	0·19	0·30	0·40	0·59	0·77	1·12
0·23	0·102	0·20	0·32	0·43	0·63	0·82	1·20
0·24	0·109	0·22	0·35	0·46	0·67	0·88	1·28
0·25	0·117	0·23	0·37	0·49	0·71	0·93	1·37
0·26	0·124	0·25	0·39	0·51	0·76	0·99	1·46
0·27	0·131	0·26	0·41	0·54	0·80	1·05	1·55
0·28	0·138	0·28	0·44	0·58	0·85	1·11	1·64
0·29	0·146	0·29	0·46	0·61	0·90	1·18	1·73
0·30	0·154	0·31	0·49	0·64	0·94	1·24	1·82
0·31	0·162	0·32	0·51	0·68	0·99	1·30	1·92
0·32	0·170	0·34	0·54	0·71	1·04	1·37	2·02
0·33	0·179	0·36	0·56	0·74	1·09	1·44	2·12
0·34	0·187	0·38	0·59	0·77	1·14	1·50	2·22
0·35	0·196	0·39	0·62	0·80	1·19	1·57	2·32
0·36	0·205	0·41	0·64	0·84	1·25	1·64	2·42
0·37	0·213	0·43	0·67	0·88	1·30	1·72	2·53
0·38	0·222	0·45	0·70	0·92	1·36	1·79	2·64
0·39	0·231	0·47	0·73	0·95	1·41	1·86	2·75
0·40	0·241	0·48	0·76	0·99	1·47	1·93	2·86
0·41	0·250	0·50	0·78	1·03	1·53	2·01	2·97
0·42	0·260	0·52	0·81	1·07	1·58	2·09	3·08
0·43	0·269	0·54	0·84	1·11	1·64	2·16	3·29
0·44	0·279	0·56	0·87	1·15	1·70	2·24	3·32
0·45	0·289	0·58	0·90	1·19	1·76	2·32	3·44
0·46	0·299	0·61	0·94	1·23	1·82	2·40	3·56
0·47	0·309	0·63	0·97	1·27	1·88	2·48	3·68
0·48	0·319	0·65	1·00	1·31	1·94	2·57	3·80
0·49	0·329	0·67	1·03	1·35	2·00	2·65	3·92
0·50	0·339	0·69	1·06	1·39	2·06	2·73	4·05
0·51	0·350	0·71	1·10	1·44	2·13	2·82	4·18
0·52	0·361	0·73	1·13	1·48	2·19	2·90	4·31
0·53	0·371	0·76	1·16	1·52	2·25	2·99	4·44
0·54	0·382	0·78	1·20	1·57	2·32	3·08	4·57
0·55	0·393	0·80	1·23	1·62	2·39	3·17	4·70
0·56	0·404	0·82	1·26	1·66	2·45	3·26	4·84
0·57	0·415	0·85	1·30	1·70	2·52	3·35	4·98
0·58	0·427	0·87	1·33	1·75	2·59	3·44	5·11
0·59	0·438	0·89	1·37	1·80	2·66	3·53	5·25

Table 13—(Continued)

Head, H (feet)	Discharge, Q, for throat widths, W, of—						
	3 inches	6 inches	9 inches	1 foot	1·5 feet	2 feet	3 feet
	sec.-ft.	sec.-ft.	sec.-ft.	sec.-ft.	sec.-ft.	sec.-ft.	sec.-ft.
0·60	0·450	0·92	1·40	1·84	2·73	3·62	5·39
0·61	0·462	0·94	1·44	1·88	2·80	3·72	5·53
0·62	0·474	0·97	1·48	1·93	2·87	3·81	5·68
0·63	0·485	0·99	1·51	1·98	2·95	3·91	5·82
0·64	0·497	1·02	1·55	2·03	3·02	4·01	5·97
0·65	0·509	1·04	1·59	2·08	3·09	4·11	6·12
0·66	0·522	1·07	1·63	2·13	3·17	4·20	6·26
0·67	0·534	1·10	1·66	2·18	3·24	4·30	6·41
0·68	0·546	1·12	1·70	2·23	3·31	4·40	6·56
0·69	0·558	1·15	1·74	2·28	3·39	4·50	6·71
0·70	0·571	1·17	1·78	2·33	3·46	4·60	6·86
0·71	0·584	1·20	1·82	2·38	3·54	4·70	7·02
0·72	0·597	1·23	1·86	2·43	3·62	4·81	7·17
0·73	0·610	1·26	1·90	2·48	3·69	4·91	7·33
0·74	0·623	1·28	1·94	2·53	3·77	5·02	7·49
0·75	0·636	1·31	1·98	2·58	3·85	5·12	7·65
0·76	0·649	1·34	2·02	2·63	3·93	5·23	7·81
0·77	0·662	1·36	2·06	2·68	4·01	5·34	7·97
0·78	0·675	1·39	2·10	2·74	4·09	5·44	8·13
0·79	0·689	1·42	2·14	2·80	4·17	5·55	8·30
0·80	0·702	1·45	2·18	2·85	4·26	5·66	8·46
0·81	0·716	1·48	2·22	2·90	4·34	5·77	8·63
0·82	0·730	1·50	2·27	2·96	4·42	5·88	8·79
0·83	0·744	1·53	2·31	3·02	4·50	6·00	8·96
0·84	0·757	1·56	2·35	3·07	4·59	6·11	9·13
0·85	0·771	1·59	2·39	3·12	4·67	6·22	9·30
0·86	0·786	1·62	2·44	3·18	4·76	6·33	9·48
0·87	0·800	1·65	2·48	3·24	4·84	6·44	9·65
0·88	0·814	1·68	2·52	3·29	4·93	6·56	9·82
0·89	0·828	1·71	2·57	3·35	5·01	6·68	10·0
0·90	0·843	1·74	2·61	3·41	5·10	6·80	10·2
0·91	0·858	1·77	2·66	3·46	5·19	6·92	10·4
0·92	0·872	1·81	2·70	3·52	5·28	7·03	10·5
0·93	0·887	1·84	2·75	3·58	5·37	7·15	10·7
0·94	0·902	1·87	2·79	3·64	5·46	7·27	10·9
0·95	0·916	1·90	2·84	3·70	5·55	7·39	11·1
0·96	0·931	1·93	2·88	3·76	5·64	7·51	11·3
0·97	0·946	1·97	2·93	3·82	5·73	7·63	11·4
0·98	0·961	2·00	2·98	3·88	5·82	7·75	11·6
0·99	0·977	2·03	3·02	3·94	5·91	7·88	11·8
1·00	0·992	2·06	3·07	4·00	6·00	8·00	12·0

pump that can be installed quickly and then removed after the siphon flow has been started. Both of these methods are much preferred to cutting the lateral bank since this will usually result in some erosion and make the stream size hard to control.

Check drops as illustrated in Figs. 50 and 51 will be quite useful where it is necessary to slow the velocity of water flowing in a ditch.

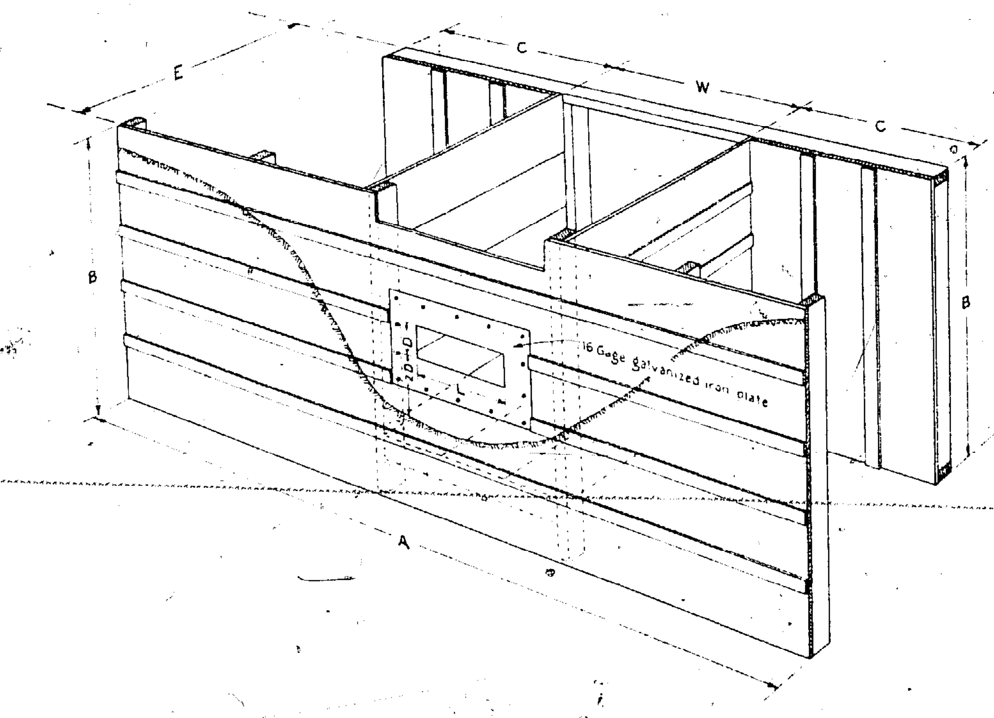


Fig. 48. Wooden submerged-orifice structure

Table 14

Recommended Sizes and Dimensions for Submerged-Orifice Structures

Approximate range in capacity, cubic feet per second	Size of orifice			Height of structure, B, feet	Width of head wall, A, feet	Length, E, feet	Width, W, feet	Length of down-stream wing wall, C, feet
	Height, D, inches	Length, L, inches	Area, square feet					
0·4 to 1·0	3	12	0·25	4·0	10·0	3·0	2·5	2·0
0·5 to 1·4	3	16	0·33	4·0	10·0	3·0	3·0	2·0
0·8 to 2·1	3	24	0·50	4·0	12·0	3·0	3·5	2·0
0·5 to 1·4	4	12	0·33	4·5	10·0	3·0	2·5	2·5
0·8 to 2·1	4	18	0·50	4·5	12·0	3·0	3·0	2·5
1·0 to 3·2	4	27	0·75	4·5	12·0	3·0	3·5	2·5
0·8 to 2·1	6	12	0·50	5·0	12·0	3·5	2·5	3·0
1·0 to 3·2	6	18	0·75	5·0	14·0	3·5	3·0	3·0
1·5 to 4·3	6	24	1·00	5·0	14·0	3·5	3·5	3·0
2·3 to 6·5	6	36	1·50	5·0	16·0	3·5	4·5	3·0
1·5 to 4·3	9	16	1·00	6·0	14·0	3·5	3·0	3·0
2·3 to 6·5	9	24	1·50	6·0	16·0	3·5	3·5	3·0
3·0 to 8·7	9	32	2·00	6·0	16·0	3·5	4·0	3·0

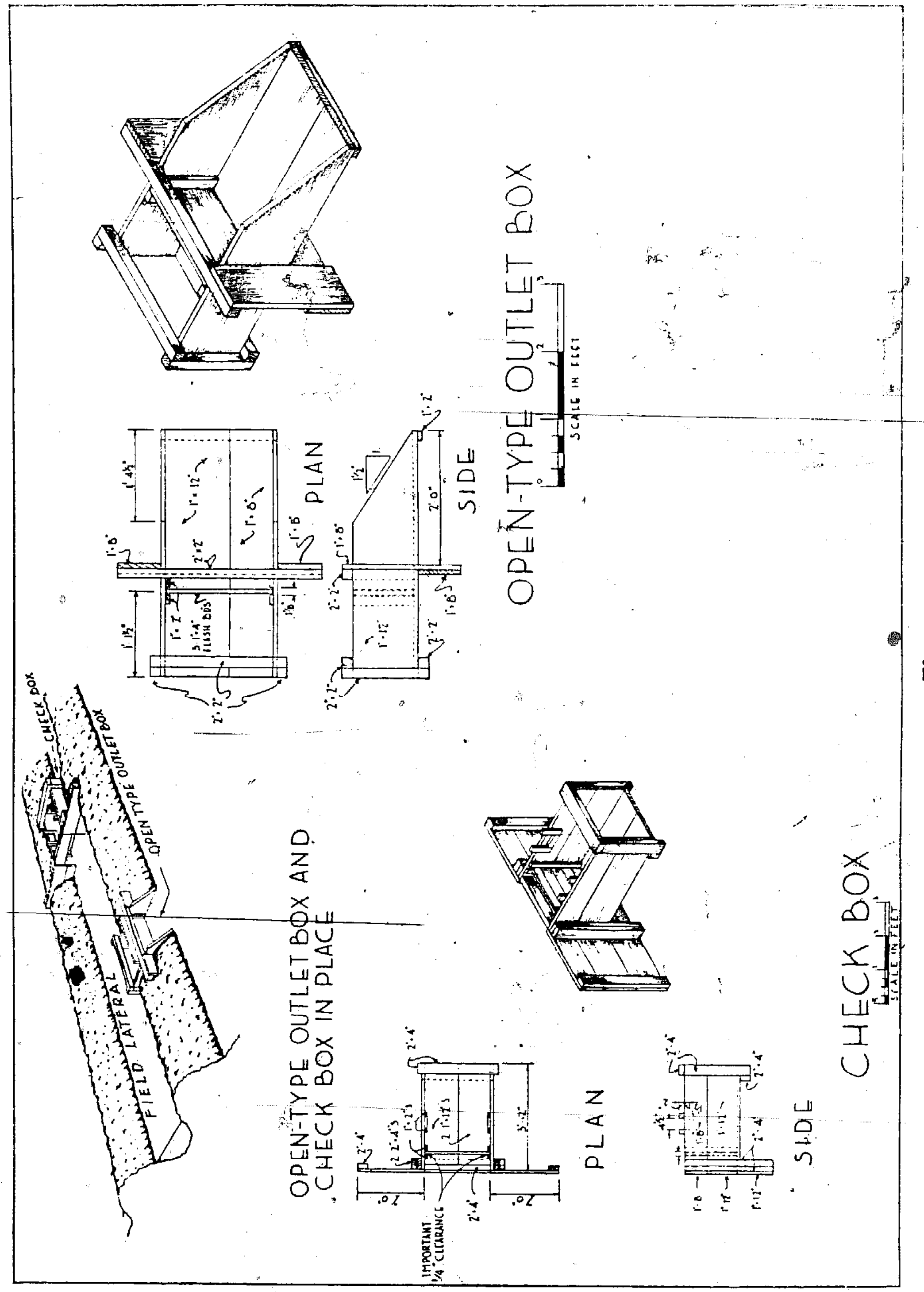


Fig. 49

Rock masonry or concrete block construction may be substituted and of course the size must be altered to suit the capacity of the ditch being protected.

Emergency drop structures, checks and turnouts can be made by using burlap sacks. By filling sacks with sand or coarse sandy soil,

drops of all sizes may be made, as well as small checks (Fig. 52). Emergency repairs to canal or lateral banks can be made with sandbags without interrupting the flow.

A convenient and fairly permanent canal turn-out can be made with gunny sacking, see Fig. 52. The following steps will assure good results:

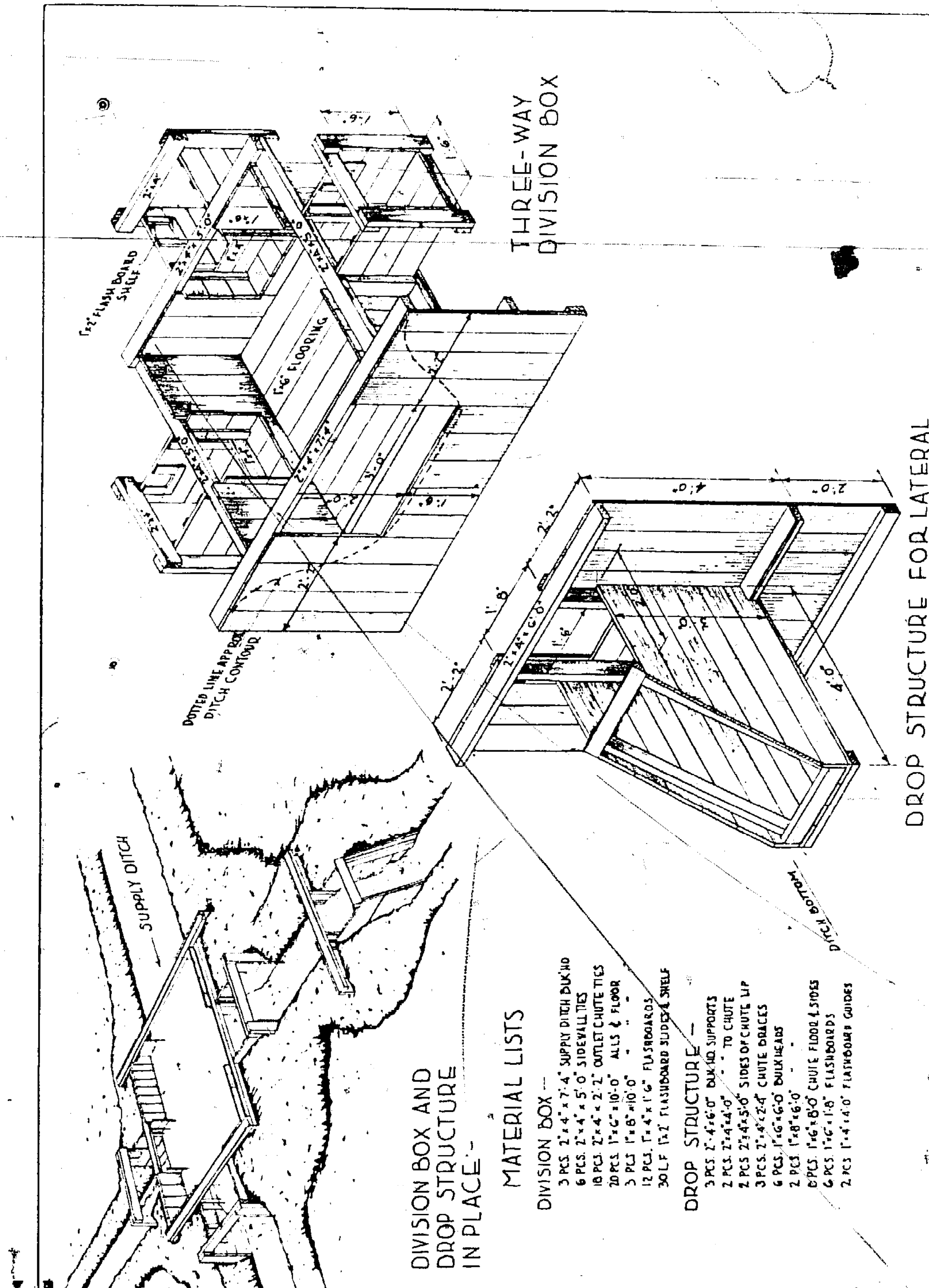


Fig. 50

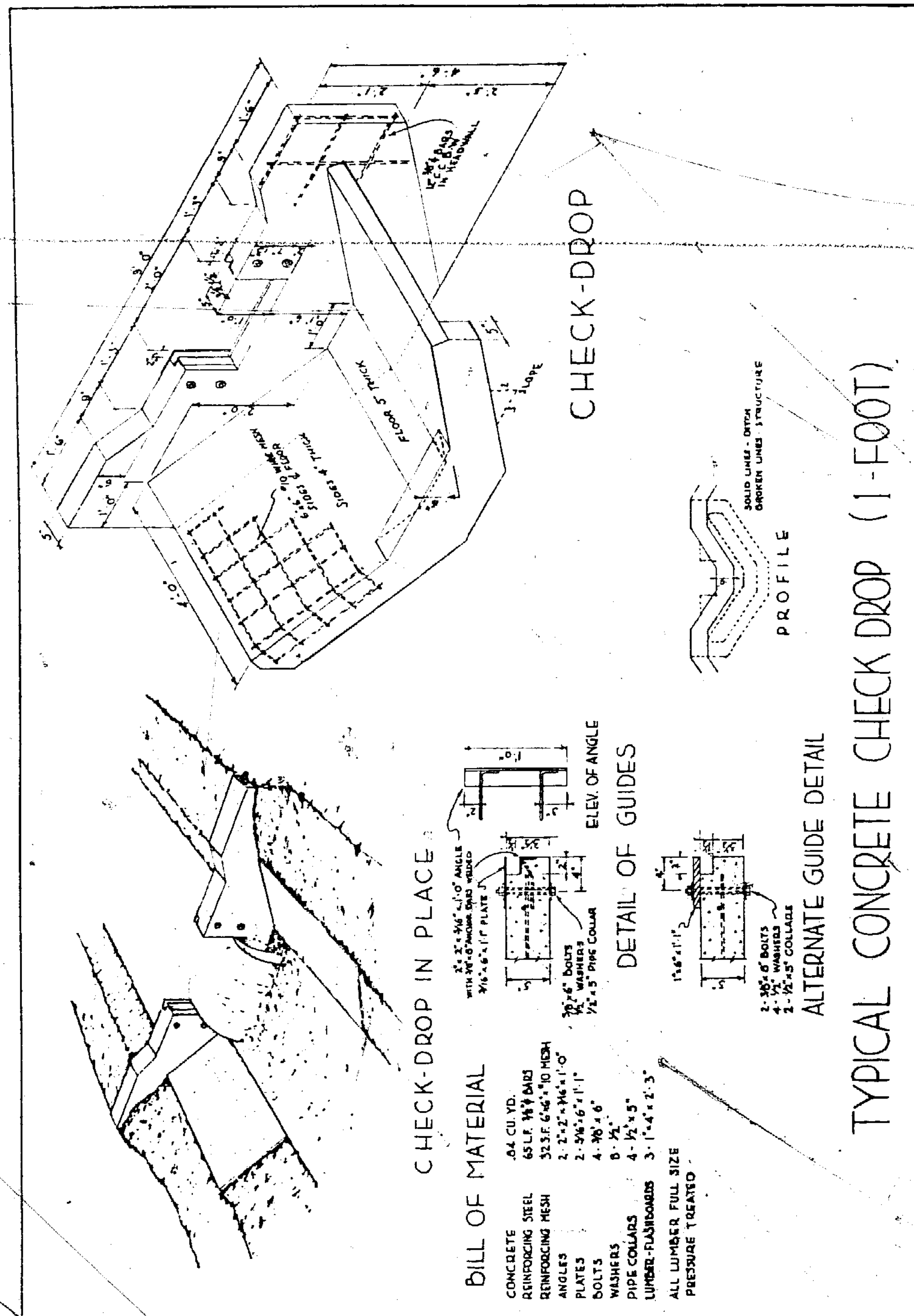


Fig. 51

1. Wet the square of sack material and spread on the ditch bank as shown at A, B, C, D.

2. Using the point of the irrigation shovel, starting at E push the edge of the sacking firmly into the mud, as shown by dotted line E, F, G.

3. Raise the edge of the sacking CD on the left hand, and with the shovel remove dirt from the ditchbank at H.

4. Pat the sacking at H until sufficient flow passes over it. The volume of flow may be controlled by raising and lowering the sacking at H, either by using a shovelful of dirt or a folded piece of sacking.

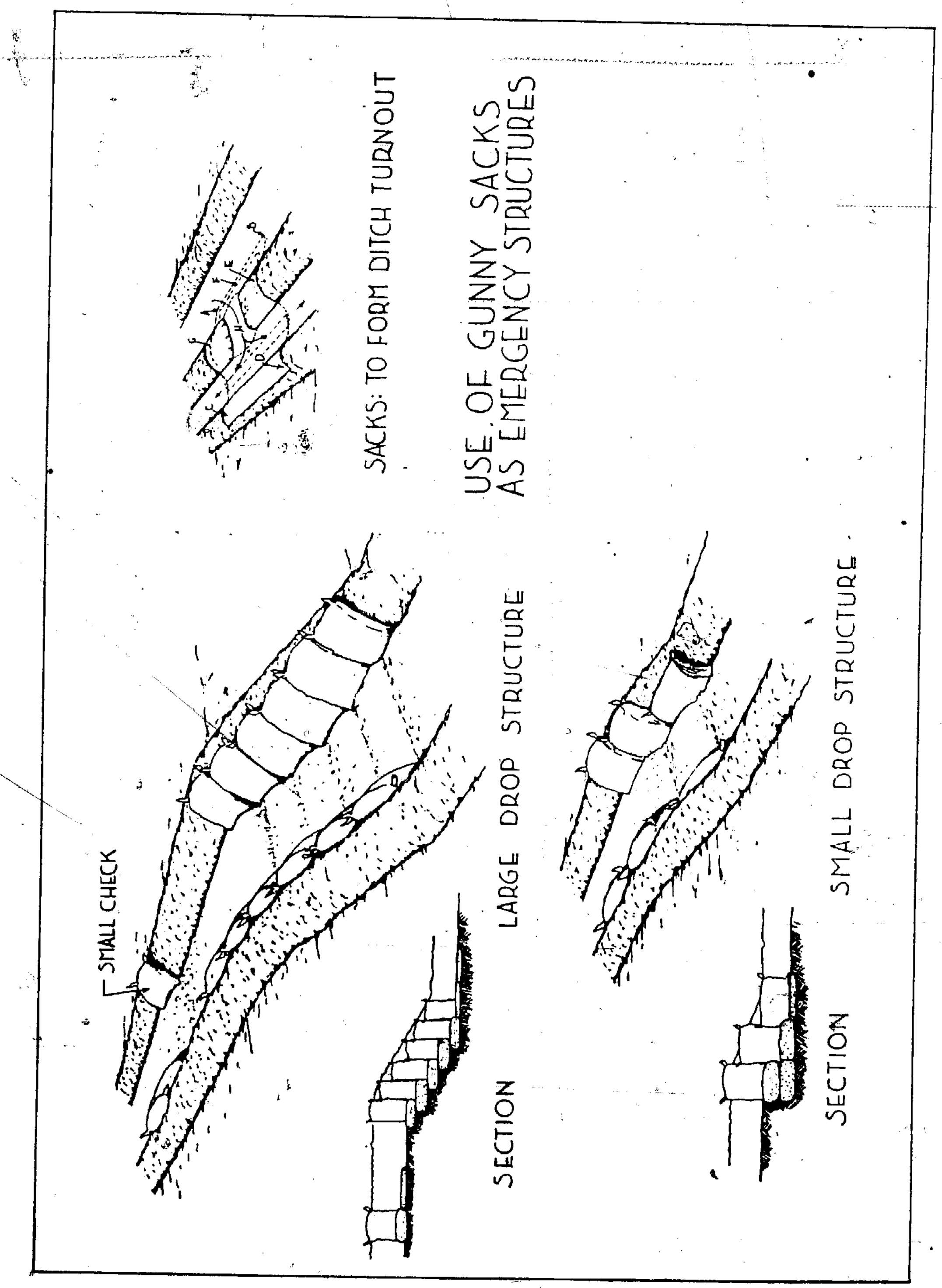


Fig. 52

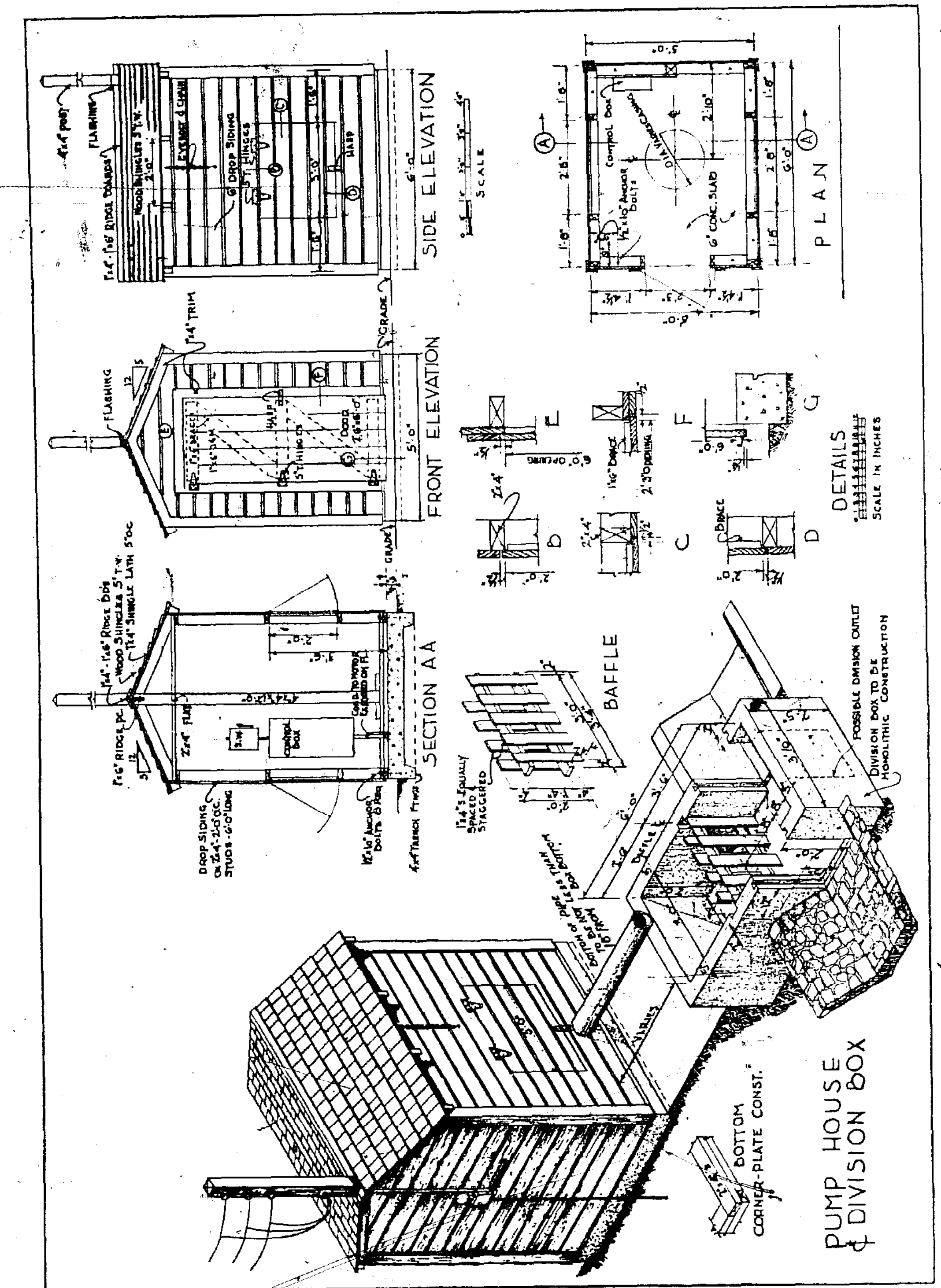


Fig. 53

5. The edge of the sacking *CD* is put in position as shown to prevent erosion of the ditchbank.

Pump House. Fig. 53 shows dimensioned drawing of a small pump house and division box. For larger equipment the pump house would have to be expanded accordingly.

Table 15

Flow Through Rectangular Submerged Orifices in Cubic Feet per Second*

Head, H, in feet	*Head, in inches (approx.)*	*Cross-sectional area of orifice, A*						
		0·25 sq. ft.	0·333 sq. ft.	0·50 sq. ft.	0·75 sq. ft.	1·00 sq. ft.	1·50 sq. ft.	2·00 sq. ft.
		Flow in cubic feet per second						
0·01	1/8	0·122	0·163	0·245	0·367	0·489	0·73	0·98
0·02	1/4	0·173	0·230	0·346	0·518	0·691	1·04	1·38
0·03	3/8	0·212	0·282	0·424	0·635	0·847	1·27	1·69
0·04	1/2	0·245	0·326	0·489	0·734	0·978	1·47	1·96
0·05	5/8	0·273	0·364	0·547	0·820	1·09	1·64	2·19
0·06	3/4	0·300	0·399	0·599	0·899	1·20	1·80	2·40
0·07	13/16	0·324	0·431	0·647	0·971	1·29	1·94	2·59
0·08	15/16	0·346	0·461	0·691	1·04	1·38	2·07	2·77
0·09	1 1/16	0·367	0·489	0·734	1·10	1·47	2·20	2·94
0·10	1 3/16	0·387	0·518	0·773	1·16	1·56	2·32	3·09
0·11	1 5/16	0·406	0·540	0·811	1·22	1·62	2·43	3·24
0·12	1 7/16	0·424	0·564	0·847	1·27	1·69	2·54	3·39
0·13	1 9/16	0·441	0·587	0·882	1·32	1·76	2·65	3·53
0·14	1 11/16	0·458	0·609	0·915	1·37	1·83	2·75	3·66
0·15	1 13/16	0·474	0·631	0·947	1·42	1·90	2·84	3·79
0·16	1 15/16	0·489	0·651	0·978	1·47	1·96	2·93	3·91
0·17	2 1/16	0·504	0·671	1·01	1·51	2·02	3·02	4·03
0·18	2 3/16	0·519	0·691	1·04	1·56	2·08	3·11	4·15
0·19	2 1/4	0·533	0·710	1·07	1·60	2·13	3·20	4·26
0·20	2 3/8	0·547	0·729	1·09	1·64	2·19	3·28	4·38
0·21	2 1/2	0·561	0·746	1·12	1·68	2·24	3·36	4·48
0·22	2 5/8	0·574	0·765	1·15	1·72	2·30	3·46	4·59
0·23	2 3/4	0·587	0·781	1·17	1·76	2·35	3·52	4·69
0·24	2 7/8	0·600	0·798	1·20	1·80	2·40	3·60	4·79
0·25	3	0·612	0·815	1·22	1·83	2·45	3·67	4·89
0·26	3 1/8	0·624	0·831	1·25	1·87	2·49	3·74	4·99
0·27	3 1/4	0·636	0·846	1·27	1·91	2·54	3·81	5·08
0·28	3 3/8	0·646	0·862	1·29	1·94	2·59	3·88	5·18
0·29	3 1/2	0·659	0·878	1·32	1·98	2·64	3·96	5·28
0·30	3 5/8	0·670	0·892	1·34	2·01	2·68	4·02	5·36
0·31	3 3/4	0·681	0·908	1·36	2·05	2·73	4·09	5·45
0·32	3 13/16	0·692	0·920	1·38	2·07	2·76	4·15	5·53
0·33	3 15/16	0·703	0·936	1·41	2·11	2·81	4·22	5·62
0·34	4 1/16	0·713	0·950	1·43	2·14	2·85	4·28	5·70
0·35	4 3/16	0·724	0·963	1·45	2·17	2·89	4·34	5·78
0·36	4 5/16	0·734	0·976	1·47	2·20	2·93	4·40	5·87
0·37	4 7/16	0·745	0·991	1·49	2·23	2·98	4·46	5·95
0·38	4 9/16	0·754	1·00	1·51	2·26	3·02	4·52	6·03
0·39	4 11/16	0·764	1·02	1·53	2·29	3·05	4·58	6·11
0·40	4 13/16	0·774	1·03	1·55	2·32	3·09	4·64	6·19
0·41	4 15/16	0·783	1·04	1·57	2·35	3·13	4·70	6·27
0·42	5 1/16	0·792	1·06	1·59	2·38	3·17	4·75	6·34
0·43	5 3/16	0·802	1·07	1·60	2·41	3·21	4·81	6·42
0·44	5 1/4	0·811	1·08	1·62	2·43	3·24	4·87	6·49
0·45	5 3/8	0·820	1·09	1·64	2·46	3·28	4·92	6·56
0·46	5 1/2	0·829	1·10	1·66	2·49	3·32	4·98	6·64
0·47	5 5/8	0·839	1·12	1·68	2·52	3·36	5·04	6·71
0·48	5 3/4	0·847	1·13	1·70	2·54	3·39	5·08	6·78
0·49	5 7/8	0·856	1·14	1·71	2·57	3·42	5·14	6·85
0·50	6	0·865	1·15	1·73	2·59	3·46	5·19	6·92
0·51	6 1/8	0·873	1·16	1·75	2·62	3·49	5·24	6·99
0·52	6 1/4	0·882	1·17	1·76	2·65	3·53	5·29	7·05
0·53	6 3/8	0·890	1·19	1·78	2·67	3·56	5·34	7·12
0·54	6 1/2	0·898	1·20	1·80	2·70	3·59	5·39	7·19
0·55	6 5/8	0·907	1·21	1·81	2·72	3·63	5·44	7·25
0·56	6 3/4	0·915	1·22	1·83	2·75	3·66	5·49	7·32
0·57	6 13/16	0·923	1·23	1·85	2·77	3·69	5·54	7·38
0·58	6 15/16	0·931	1·24	1·86	2·79	3·73	5·59	7·45
0·59	7 1/16	0·939	1·25	1·88	2·82	3·76	5·64	7·51
0·60	7 3/16	0·947	1·26	1·90	2·84	3·79	5·68	7·58

* Computed from the formula $Q = 0{\cdot}61 A\sqrt{2gH}$.

Table 15—(Continued)

Head, H, in feet	Head, in inches (approx.)	*Cross-sectional area of orifice, A* 0·25 sq. ft.	0·333 sq. ft.	0·50 sq. ft.	0·75 sq. ft.	1·00 sq. ft.	1·50 sq. ft.	2·00 sq. ft.
		Flow in cubic feet per second						
0·61	$7\frac{5}{16}$	0·955	1·27	1·91	2·87	3·82	5·73	7·64
0·62	$7\frac{7}{16}$	0·963	1·28	1·93	2·89	3·85	5·78	7·70
0·63	$7\frac{9}{16}$	0·971	1·29	1·94	2·91	3·88	5·82	7·76
0·64	$7\frac{11}{16}$	0·978	1·30	1·96	2·93	3·91	5·87	7·82
0·65	$7\frac{13}{16}$	0·986	1·31	1·97	2·96	3·94	5·92	7·89
0·66	$7\frac{15}{16}$	0·993	1·32	1·99	2·98	3·97	5·96	7·95
0·67	$8\frac{1}{16}$	1·00	1·33	2·00	3·00	4·00	6·01	8·01
0·68	$8\frac{3}{16}$	1·01	1·34	2·02	3·02	4·03	6·05	8·06
0·69	$8\frac{1}{4}$	1·02	1·35	2·03	3·05	4·06	6·10	8·13
0·70	$8\frac{3}{8}$	1·02	1·36	2·05	3·07	4·09	6·14	8·18
0·71	$8\frac{1}{2}$	1·03	1·37	2·06	3·09	4·12	6·19	8·25
0·72	$8\frac{5}{8}$	1·04	1·38	2·08	3·11	4·15	6·23	8·30
0·73	$8\frac{3}{4}$	1·05	1·39	2·09	3·14	4·18	6·27	8·36
0·74	$8\frac{7}{8}$	1·05	1·40	2·10	3·16	4·21	6·31	8·42
0·75	9	1·06	1·41	2·12	3·18	4·24	6·36	8·48
0·76	$9\frac{1}{8}$	1·07	1·42	2·13	3·20	4·26	6·40	8·53
0·77	$9\frac{1}{4}$	1·07	1·43	2·15	3·22	4·29	6·43	8·58
0·78	$9\frac{3}{8}$	1·08	1·44	2·16	3·24	4·32	6·48	8·64
0·79	$9\frac{1}{2}$	1·09	1·45	2·17	3·26	4·35	6·52	8·70
0·80	$9\frac{5}{8}$	1·09	1·46	2·19	3·28	4·38	6·56	8·75

DRAINAGE

Drainage in agriculture is the process of removal of excess water from soil. Excess water discharged by flow over the soil surface is referred to as 'surface drainage'. If the excess water saturates the pore spaces of the soil, either because of a high water table or because of an accumulation of gravitational or free water in the upper soil layers, the process of removal by downward flow through the soil is referred to as 'internal or subsurface drainage'. The terms 'artificial drainage' and 'natural drainage' indicate whether or not man has changed or influenced this drainage process.

The beneficial effects of drainage in improving the productive capacity of soils include the following points—enhancement of soil aeration and soil structure, stimulation of beneficial microbiological activity, increase in depth of plant rooting zone (see rooting depths), reduces erosion and diminishes the effects of drought.

Drainage improvement serves many other public and private interests —for example, mosquito control in Westmoreland—for this reason its justification should be based upon all benefits that may be derived therefrom.

A drainage programme for an irrigated area should be initiated and continuously integrated with the development of its irrigation system in order to attain an efficient overall water and salinity control programme. Failure in this respect will inevitably lead to such problems as are encountered in the Mid-Clarendon Irrigation area of Jamaica. It must always be kept in mind that irrigation practices are related to drainage—water

and air occur in soil in reciprocal amounts—and sometimes the need for artificial drainage facilities may be lessened or avoided altogether by efficient management of irrigation water.

It is not the intent of this chapter to discuss in detail installations of drainage systems. It will suffice to state that any drainage system must include major ditches or canals as outlets to dispose of water discharge from fields and that their design is influenced by many factors best grouped under the headings of drainage requirements, water-transmission properties of soil and boundary condition. It is important to bear in mind that the efficiency of a drainage system can be no better than its outlet.

Layout and Placement of Drains

Drainage systems may consist of intercepting drains or relief type drains, depending upon their location and function. Intercepting drains collect and divert water before it reaches the land under consideration and relief drains are placed to remove water from the land being drained. Pumped wells, tile or open drains may serve either of these purposes. Relief type drains are used in broad valleys where the land has little slope, whereas intercepting drains more often are used in areas where topography is irregular. In areas of rolling or irregular topography, water that percolates downward through the surface soil often flows laterally through the subsoil material in the direction of the land slope. In these areas seeps may be caused by a decrease in grade or in soil permeability. If the seepage water cannot be eliminated at its source, the placement of a tile or an open drain immediately above the seep to intercept such flows is usually the most effective procedure for solving this type of drainage problem.

Proper placement of drains is of considerable importance in the design of drainage systems. In non-uniform soils drainage system may be best designed by considering the nature and extent of subsoil layers and by locating the drains with respect to these subsoil materials. Generally drains should be oriented perpendicular to the direction of ground water flow and, where possible, should connect with sand and gravel layers or limestone sink holes.

In soils of alluvial origin—Clarendon and St. Catherine plains in Jamaica—the orientation of both permeable and impermeable deposits may be such that a few well placed drains may control ground water over a much larger area than the same length of drain installed with uniform spacing in accordance with some arbitrary pattern.

For a given spacing, assuming soil conditions do not change with depth and other conditions remain constant, the depth to the water table midway between drains increases directly with drain depth. Doubling the depth of drains will nearly double the rate of flow. Drain shape as well as size is unimportant in governing seepage rate of water from soils into drains—it is the depth that is important. Drain size and shape and grade are, however, very important in the movement of water in the drain itself. Proximity of drains to relatively impermeable layers is also an important consideration. Drains should not be placed too near on or in an impervious layer. Investigators have found that lowering the drain on to or into an impervious layer decreases the flow rate.

Types of Drains

1. **Open Drains.** Their primary function is to handle surface drainage, although they may be used to lower the water table and thus provide internal drainage. It is obvious that such ditches may interfere with mechanical operations within the field. However, in many places where the soils are so impervious as to preclude good internal drainage, field ditches are about the only practical means of draining the land.

Field drains and ditches are used rather extensively on the flat heavy clay soils of the Clarendon and St. Catherine plains of Jamaica. These soils tend to lose their tilth rapidly during the growth of the crop. Elaborate drainage systems are needed to help remove excess water and maintain tilth. In Trinidad in high rainfall areas, ditches alone are usually inadequate to provide a well drained root bed for the growing crop and the soil is cambered into a bed between the drains to facilitate the rapid removal of the surface water from the cropped area. On the Caroni Estates, Trinidad, sugar cane is grown on cambered beds with 24 feet between the drains. The drains discharge into drainage ditches at the edge of the field, which in turn lead to the main canals designed for the drainage area.

(*a*) *Contour open drains* are very popular in sloping areas subjected to irregular 'downpours' of rainfall where they serve a dual purpose of soil and water conservation. Contour drains when placed at regular intervals of ½ or 1 chain diminish sheet erosion by preventing surface water obtaining sufficient volume or velocity to carry an appreciable load. They also catch the sediments and provide opportunity for more deep percolation. They are particularly effective in this regard if their edges are grassed with Khus Khus or Napier and if their subsoil is relatively more porous. On the other hand if underlying layers are very impervious as is the case in Scotland District of Barbados they are difficult to maintain and actually facilitate landsliding.

(*b*) *Graded open drains* are drains laid out slightly off the contour with a variable fall commencing with 6 inches in 100 feet and increasing to as much as 5 feet in 100 feet depending largely on the nature of the soil and crop. They are more desirable than contour drains on soils with impervious

sub-layers since excessive water can be allowed to escape to grassed down runoff ditches.

In St. Vincent silt traps—simply much deepened sections usually 12 ft. × 2 ft. × 3 ft.—are placed in graded or contour drains on their 'Yellow Earth' soils as a further soil conservation measure and to reduce the need of frequent cleaning of these ditches.

(*c*) *Saucer-shaped open drains* are very shallow but wide drains with a variable fall. They are particularly suited to drainage of pastures where grazing cattle make maintenance of other shaped open drains nigh impossible.

2. **Tile drains** have some advantage over open drains. They do not waste land, encourage weeds, interfere with agricultural operations and are an excellent means of providing adequate internal drainage of the soil. On the other hand, they are not economical to install on tight clays that are impervious to the downward movement of water through the profile. Many failures of tile drainage have been experienced because the drainage engineers did not take into account the nature of the soil with which they were working. Tile drains, although the most popular method of draining land in Europe and North America, have only been used in a few isolated instances in the West Indies.

3. **Mole drains** achieve the same objective as tile drains. A torpedo-like 'mole' is pulled through the soil behind a subsoil attachment which leaves a cylindrical hollow tube in the soil to receive and discharge the water to the drainage ditches at the edge of the field. Mole drainage is not effective on those coarser textured soils that are so loose that the channels produced by the mole, will collapse. Neither is it effective on heavy plastic soils where the mole seals the soils to the movement of water.

CHAPTER 12

Land Reclamation

Reclamation of land in Jamaica is a complex problem requiring team work, good co-ordination for a satisfactory outcome, and a considerable outlay of capital. Detailed investigation and the laying of a good foundation are essential precedent requirements.

The primary step is to determine the potentiality of the area to be reclaimed, in particular with regard to the permanence of the reclamation and the probable value of the land when reclaimed. This has an important bearing on the second step, which is the determination of the suitability of the area from an engineering point of view, as the amount of money which can be spent on the project is closely related to the probable value and productivity of the area when reclaimed. A close study of the soil, climate, and vegetation of the area is of great importance. It is necessary to collect as much local information as possible regarding rainfall distribution, local floods, drought periods and general weather conditions. At the same time a start can be made on a systematic study of conditions within the area. Information should be collected as to the nature of the soil, its depth, texture, water holding capacity and supply of plant food. The presence of impermeable sandy or peat layers should be noted and, where salt is present, the salt content at various depths. In this respect the original vegetation is often a good guide to the present and potential conditions within the area. For instance if the dominant vegetation is cashaw and cactus the area is likely to be very salty, but if the soil is permeable and a high water table present, drainage may rectify this. On the other hand an occasional guango tree growing in the area, and not much cactus, would indicate much easier reclamation. Sometimes external factors can be of great importance and can easily be overlooked, for instance the incidence of parakeets in land intended for corn cultivation.

The Engineering side. As soon as the preliminary investigation has shown that there are prospects in the area, the engineering side should be considered as early as possible, since the cost of the actual reclamation may be prohibitive. Work on both aspects of the investigation should go on at the same time.

The necessary factors to be considered in the preliminary investigation are:

Regional consideration of drainage, run off. In cases of irrigation, investigation of water supply, cost, etc. A point should be stressed here. When a given area is being considered for reclamation, areas lying alongside should not be neglected. For instance by the proper siting of drains it may be possible to improve conditions gradually beyond the reclamation area so that an area, which may at the moment be too costly to reclaim, could be improved through time and eventually be suitable for reclamation.

It must also be appreciated that there is always a risk with land reclamation if thorough preliminary work has not been done, and for this reason a pilot scheme is often desirable.

To illustrate this an instance may be given where a project in Africa almost failed and which required drastic modification of the original engineering scheme to save the situation. The reclamation project was a tidal swamp area, although the flood water was usually fresh, because of the backing up of the river. However the inlet and outlet facilities provided did not allow of rapid flooding and drainage and, as a result of the changed conditions, compounds of iron and sulphur were released and caused crop failure. In this area where for thousands of years the land had been subject to rapid flooding and draining twice daily, a slowing down of the process nearly had a disastrous effect.

To adjust to new conditions requires time, and adjustment is often a gradual process, indicating the long term nature of much reclamation work, and also that quick results cannot always be looked for.

In contrast to the great expense usually involved in reclaiming land it has sometimes been possible to increase productivity, out of all proportion, quite simply and at little cost. This has been particularly true of grass land on which animals would not thrive. There are large areas of grass land in countries such as Australia and New Zealand which could not support stock because of mineral deficiencies in the herbage.

It sometimes happens that in a reclaimed area violent changes can occur and if care is not taken the assets recovered may waste away at a rapid rate. This is particularly true where swamp lands containing a lot of organic material are reclaimed when under natural conditions, the constant flooding has prevented the oxidation of the organic materials, but on drainage oxidation may proceed very quickly and, if not controlled, the volume of the soil decreases rapidly so that the permanence of the project becomes doubtful. Such conditions have arisen in parts of the Everglades in Florida.

Saline Areas

Many of the large reclamation projects have been the reclamation of saline areas and the effect of salts has been closely studied, both as to the effect on the water supply in the soil and on the growth of various plants. Just as we know in Jamaica that the growth of pinguin, cactus and wild ochro denotes salt conditions in an unimproved area, and that the species change as the area becomes more saline, so there are differences in the salt tolerance between economic crops. For instance cotton and Bahama grass are tolerant of salt and, in some conditions, tomatoes may be more tolerant than rice. In other countries lucerne has been used a great deal as an aid to reclamation. It tolerates salt well, it has a strong and deep root system, which assists in draining and opening up the soil and it also provides highly nutritious forage. Thus we can have a sequence of cropping depending on the degree of salinity, and on how far we wish to go before stopping. For instance if we wish to grow sugar cane we could plant this crop with much more salt in the soil than if citrus were planted.

There is one thing which must be carefully considered in almost all reclamation projects and that is the organic matter status of the soil. Except in very rare instances the addition of organic materials, either from the crop grown in the reclamation area, or from outside, is one of the most important aids to reclamation. Not only does it add plant nutrient to the soil but it often improves the physical status of the soil by improving its drainage qualities and water holding capacity. Very often it is also necessary to add other substances such as lime to acid soils, gypsum to saline soils, acid to alkaline soils, copper to peat and so forth. It may also be necessary to plough under an infertile sand or clay layer and to bring up good soil from underneath. In fact there is such a variety of treatments possible that each area must be considered on its own merits and it is not possible to give a recipe for reclamation which can be widely used.

Pump Drainage as applied in Jamaica

The area under pumped drainage in Jamaica is a small proportion of the total cane acreage and was confined until recently to the Caymanas Lagoon. The tide range in Jamaica is only 18 inches and the operation of sluices is of little help.

The schemes now embody these essential principles:

(1) A cut-off drain is arranged to interrupt any flow of water from higher portions of the estate to the area to be drained.

(2) A high level canal is required to take off the flow from the cut-off drain and other drainage from high levels to a natural water course or the sea. In many cases, it is necessary to raise the sides of this canal so that the water does not overflow into the pumped out area through which it has to pass.

(3) The area to be drained must be empoldered, that is, surrounded by a bank, dyke or dam to keep out surface water. It is generally possible to obtain material for this bank from a seepage cut-off drain which forms part of the low level drainage system inside the polder.

(4) A system of drains must be put through the empoldered area leading to a sump and a pump installed to lift the drainage water to a high level outlet drainage canal or other water course from which natural drainage to the sea can be obtained. The position of this sump is not necessarily at the lowest point of the drained area as other considerations may govern the choice of the site, such as ease of construction of pumping station, accessibility etc.

(5) The cardinal principle when setting out an area to be pump-drained is to ensure that as far as possible the only water to be pumped will be the rain water which actually falls within the polder plus the minimum of seepage through the surrounding dam.

(6) The justification for going to the expense of a pumped drainage system can only be the necessity of taking up more land after all that which can be gravity drained has already been dealt with. It is generally impossible economically to drain a swamp in which there are large springs unless these can be diverted.

A suitable formation is that found at Caymanas Lagoon which consists of a surface layer of decomposed vegetable matter then a layer of sand and below that an impervious clay bottom. The sand layer is very useful in that it gives a perfect subsoil drainage to the main drains.

Pumps. The amount of rain water to be handled per inch of rain over a given area can be easily calculated and it is then merely a question of fixing the capacity of the pump to dry out the scheme in a given time. Two inches of rain in 24 hours is considered safe but a factor in arriving at the size of the pump is also the kind of cultivation and damage it will suffer from flooding for a limited time. If there are mixed crops it is possible to arrange by means of sluices in the drainage layout a system of priorities for the drainage of any given area.

The development of low head drainage pumps and their prime movers fall into three headings.

(*a*) The horizontal centrifugal pump, which should always be installed with a drowned discharge, so that full advantage of the syphon effect be obtained and only the actual difference of level between suction and discharge is thus pumped against. Foot valves are not recommended for drainage purposes as they tend to choke and it is generally more satisfactory to install some type of ejector or air pump to prime the system by evacuation of the air.

(*b*) A vertical centrifugal or axial flow pump has much to recommend it as the pump is itself submerged and needs no priming. These pumps are simple, efficient, and resemble a ship's propeller placed in a tube. Strainer baskets are better left out on these installations for intermittent operations for when the pump stops, the water in the tube causes a backwash which clears the suction effectively. One great advantage of this type of pump is the small area of buildings required for the protection of the prime mover which can be placed well above flood level by merely extending the drive shaft vertically.

(*c*) Large water schemes have often gas operated pumps but these, though of a high efficiency, are not suitable for unattended operations or intermittent operations.

Work of an interesting nature has recently been carried on by Mr. O. M. Henzell at Caymanas Estate. A series of drains eight chains apart were dug to dry out a swampy area completely. The surface soil was found to have a concentration of salt between 30,000 and 35,000 parts per million, which would have to be reduced to 3,000 parts per million before grass would grow, and 1,000 before cane could be planted.

In order to reduce the salt, the land was flooded with water from the river by pumping, until the whole area was covered to a depth of at least six inches utilising the same pump which had been used to drain it. Water was allowed to stand on the surface for ten days, and then it was pumped out. The soil dried and cracked, after which the flooding was repeated. Five floodings at intervals of a month reduced the salt content to a point where Para grass would grow. Subsidiary drains were next dug at two chain intervals, and a similar series of floodings repeated. This irrigated the Para grass and at the same time reduced the salt content of the soil to a point where sugar cane could be planted.

It is interesting to note that a better washing out effect is obtained if the first floodings are done with slightly brackish water instead of absolutely fresh water.

The pump is driven by an electric motor of 25 h.p. and delivers 10,000 U.S. gallons per minute or 3,000 cubic yards per hour.

In dry weather, the pump runs a total of not more than twenty-four hours in a week, and it can keep the land dry even if two inches of rain falls in twenty-four hours.

CHAPTER 13

Pasture and Forage Crops

Introduction

In Jamaica until quite recently little care has been given to grassland agriculture. A large percentage of the land in the country is in grass. In the majority of cases, only poor quality pastures and fodder plants are available as feed for livestock. Cattle and other livestock are therefore maintained at a relatively low plane of nutrition.

Little emphasis was placed on improved systems of grassland management and animal nutrition aimed at increasing the productivity of the lands. However, great enthusiasm was displayed in an endeavour to improve animal production by way of introducing high yielding European breeds of cattle. Organized animal breeding programmes have been in existence in Jamaica since 1910. Such work has resulted in improving the type and potential production of dairy and beef cattle of farmers throughout the island. The Department of Agriculture's new breed of dairy cattle, the Jamaica-Hope, has been the resultant effect of one of these breeding programmes.

In order to exploit the potentialities of the existing cattle breeding programmes, the attention of farmers must now be directed towards improved systems of pasture management, animal nutrition and animal husbandry.

A rapidly expanding population demanding increased standards of living, together with soil deterioration resulting from severe soil erosion have stressed the need for well organized systems of land utilization and intensive agricultural practices. Livestock, grasses and forage crops have therefore assumed an important role in farm planning.

Role of Pastures and Forage Crops

The aim in Jamaica is to evolve stable systems of agriculture. It is felt that this goal of permanency in agriculture can only be attained in most areas by a system of mixed farming involving crops and livestock. In an attempt to achieve this end, several schemes have been initiated by the Ministry of Agriculture such as the Farm Development Programme, Revolving Herd Scheme, J.A.S. Cattle Insurance Co-op., Loan Bull Scheme and

Livestock Improvement Centres. Pastures and Forage crops assume an integral part in such development schemes. Grass has to be treated as a crop. Good pastures are essential to maintain the best economic returns from the land in terms of milk, beef and food crops.

Statistics on desirable animal protein consumption per head of population show that there is an urgent need to improve the milk and beef consumption per head of the Jamaican population. For this to be achieved, grasslands will have to be considerably improved to produce more milk and beef per acre of land.

The role of pastures and forage crops in Jamaica can therefore be summarized as follows:

(*a*) To improve the beef and milk production for which there is an increasing demand by the population. Grass furnishes the cheapest feed for cattle—the animal domesticated by man to supply meat, milk, butter, cheese, leather and also for work.

(*b*) Grass has been the major factor in a number of countries in increasing and maintaining the fertility of soils and the principal means of restoring soils worn out by cropping.

(*c*) Grass has been found to be one of the cheapest and most economic means of preventing soil erosion.

Survey of Grasslands in Jamaica

A rough survey (1943) of the area under pasture and forage crops in Jamaica revealed that about one third of the total area (approximately ¾ million acres) was under grass cover of varying types. 20% of the total land was under low growing 'commons' grass pastures comprised of four major grassland types of varying grades, dependent on the amount of existing weeds and scrub growth. 9% was under Guinea grass (*Panicum maximum*) and 3% under other grasses, chiefly, Para (*Panicum purpourascens*), *Pennesitum purpureum* strains:

Napier, Elephant and Uganda, Wynne or Molasses grass (*Melinis minutiflora*, and Guatemala grass (*Tripsacum laxum*).

Types of 'Commons' Grass

The four main types of 'commons' grass pastures found can be classified as follows:

(**a**) **Crab grass** of Manchester and the **'Pimento' grass** of St. Ann. This grass is also known as St. Augustine grass (*Stenotaphrum secundatum*). This grass is associated with **Bahia grass** (*Paspalum notatum*) and about six to eight other low growing varieties of grasses. The percentage of crab or pimento grass in these pastures varies considerably from paddock to paddock. On badly managed pastures only 20–30% of crab grass is present. Carry capacity and animal production in such cases are low.

Crab or Pimento Grass

Even the better crab grass pastures only show 45–55% of crab grass coverage in most areas.

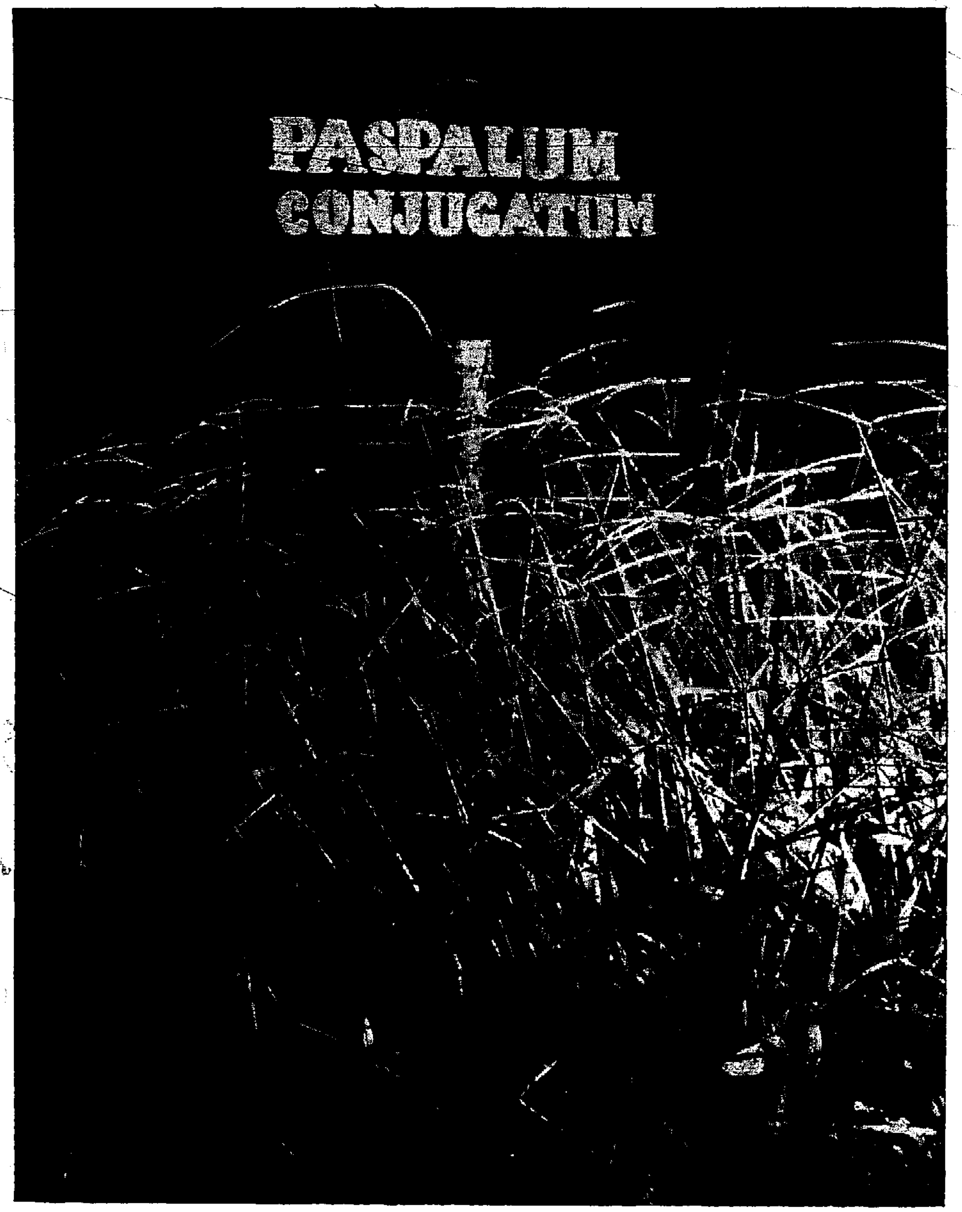
Animals do not seem to relish Bahia grass and a number of the other grasses found in these pastures. Carrying capacity of such pastures is therefore determined mainly by the amount of crab grass present. In the absence of good management overgrazing results in a decrease in crab grass coverage and an increase in Bahia and other unpalatable types.

These natural pastures are chiefly found on the limestone plateau in St. Ann, Manchester and St. Elizabeth at an altitude of around 800–2,300 ft. with 60–80 inches of annual rainfall and a marked dry season.

(**b**) **Carpet or flat grass** (*Axonopus compressus*). Flat grass assumes dominance in the higher rainfall belts (80 inches and upwards) with good rainfall distribution. These pastures are chiefly found in St. Thomas, Portland, upper St. Catherine and upper Westmoreland.

(**c**) **Sour grass** pastures (*Paspalum conjugatum*). These pastures are found on poorly drained soils, with high moisture content and acid conditions.

(**d**) **Seymour grass** pastures (*Andropogon pertusus*) are to be found on the coastal plains with a low rainfall precipitation and long periods of drought.



Sour Grass

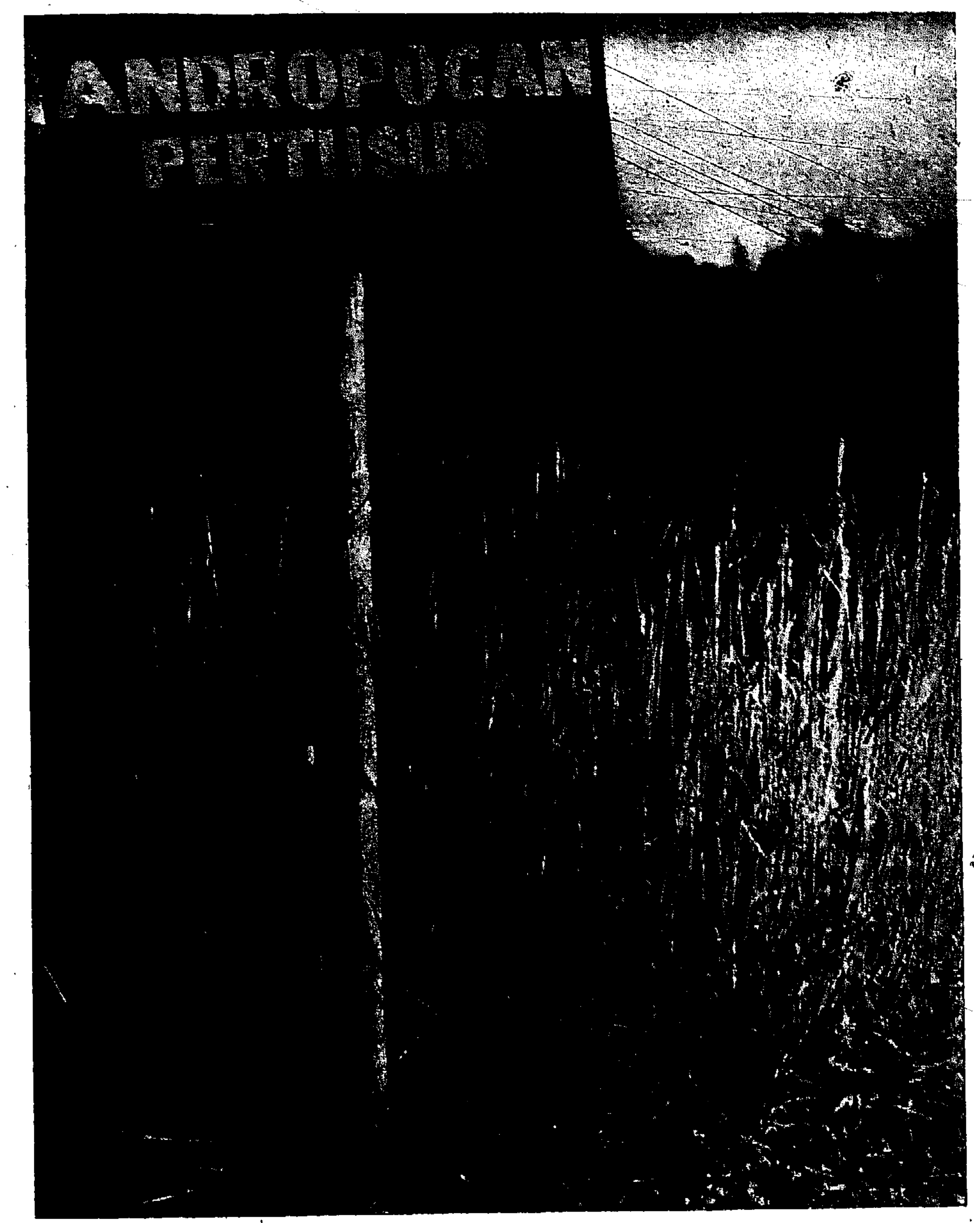
(e) A fifth type of 'commons' pasture existing in the island is mostly comprised of miscellaneous weeds, bush and grasses which have grown up after lands have been deteriorated by cropping and left to recover. Such lands are generally fenced around and termed pasture lands.

Most of these low growing 'commons' pastures are of low carrying capacity when compared with Guinea, Napier and Para grasses. In some cases, to obtain good animal production entire areas will have to be renovated and seeded down to higher yielding grasses such as Guinea, Napier, Para, Pangola and Wynne grass. The size of paddocks on these

commons often exceeds 100 acres. Such conditions do not lend themselves to sound management based on good systems of rotational grazing, mowing and intensified use of the land.

The Feeding Value of Grasses, Fodder Plants and other Foodstuffs

'The feeding of livestock is an art and the master's eye is still the most important factor.' Extensive work has however been done to obtain the underlying scientific principles and to bring into everyday practice the



Seymour Grass

knowledge thus gained. Several substances go to make up any foodstuff but the major substances can be grouped under six heads:

(*a*) Water (moisture)
(*b*) Crude protein
(*c*) Nitrogen-free-extractives (soluble carbohydrates)
(*d*) Crude fibre
(*e*) Fats and oils
(*f*) Ash (mineral matter)

Also present in small quantities are substances known as Vitamins which are necessary for the good health and performance of animals. Vitamins, like the trace elements in the mineral fraction, form but a small part of the foodstuff although they exercise great influence on the animal.

If the water is removed from any feed the residue left is generally spoken of as the dry matter. The amount of water present in any feed is very variable. Some grasses in the younger stage of growth will contain up to 85% of water. This is an extremely important factor as the other nutrients necessary for maintenance and production by animals are obtained from the dry matter. These substances which go to make up the dry matter are therefore generally expressed as a percentage of the dry matter content.

A thorough knowledge of the amount of these substances in any foodstuff is essential for arriving at suitable standards to assess the amount of any foodstuff required by animals for maintenance and good production. The palatability of any feed and the amount of each substance in that feed that is actually digested by animals are also important factors.

So far, most of the work in Jamaica has been centred around dry matter and crude protein estimations. It is hoped that with the Animal Nutrition Scheme now planned by the Ministry of Agriculture, a complete study of all feeds for livestock will be undertaken.

Yields and Nutrient Status of Grasses and Legumes

Grasses. In the grass evaluation experiment on 'red dirt' soil at Grove Place Agricultural Station the average dry matter production of grasses cut on 4, 6, 8 and 10 weekly bases for all cycles over a period of three years showed high production for the taller grasses as follows:

(*a*)	*Average dry matter per acre per annum for all cycles*
Napier grass (*Pennisetum purpureum*)	8·5 tons
Guinea grass (*Panicum maximum*)	6·0 ,,
Wynne or Molasses grass (*Melinis minutiflora*)	4·6 ,,
Para grass (*Panicum purpurascens*)	4·4 ,,

Guatemala grass (*Tripsacum laxum*) was the lowest yielder of the tall grasses with 3 tons dry matter per acre per annum for all cycles.

Napier and Guatemala grasses showed the lowest dry matter content. The average for all cutting cycles ranged from 16–17% for Napier grass and 15–16% for Guatemala grass over the three year period. The average dry matter content of Guinea grass and Para grass for all cycles ranged from 21%–22%. Wynne or molasses grass showed the highest average dry matter content of this group with 24%.

There was a gradual increase in annual dry matter yields as the grasses become more mature (i.e. from 4 to 10 weeks). However, the crude protein percentage of the dry matter showed a gradual decline as the period of growth increased ranging from 12–14% crude protein in the dry matter at four weeks old growth to 6–9% at 10 weeks growth.

For optimum animal production, a good balance has to be arrived at for dry matter yield of grasses and crude protein content. There was a gradual trend of decline in yields over the period of years for these grasses.

(*b*) On the other hand, the average dry matter yields for all cutting cycles of the low growing grasses which comprise most of the 'commons' pastures ranged from 3·2 to 1 ton of dry matter per acre per annum. Crab or Pimento grass gave an average yield per annum of two tons dry matter over this period.

Seymour grass, Bahama and Bahia grasses gave the highest yields of this group of three tons dry matter per acre. However, as previously mentioned, cattle do not seem to relish Bahia grass. The growth of Seymour grass is very seasonal.

There was very little increase in average yields of dry matter for these 'commons' grasses from 4 to 10 weeks growth. Highest yields were centred around the six-weekly cutting cycle. Unlike the taller grasses there was no evident trend in decline in yields over the years.

Dry matter content of this group of grasses ranged from 21%–35%. Crude protein percentage of the dry matter fell irregularly from 4 to 10 weeks ranging from 12–8%. There was no striking difference between 'commons' grasses in their crude protein percentage in the dry matter.

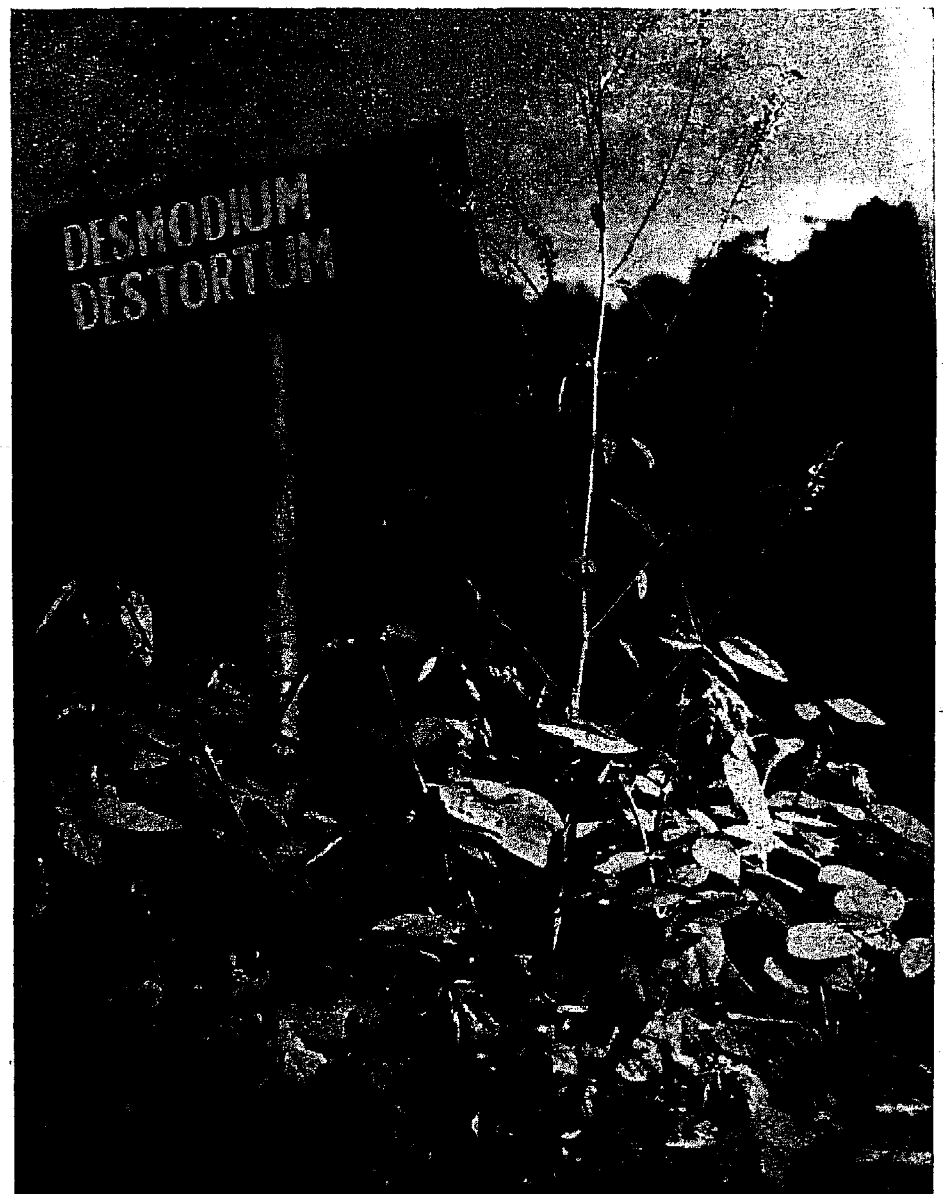
All grasses displayed seasonal trends in production. This is also an important factor in animal production and will be discussed under Management of Pastures and Silage.

Introduction of grasses by the Department of Agriculture has resulted in two promising varieties which are now being tested. These are Pangola grass (*Digitaria decumbens*) and Coastal Bermuda grass.

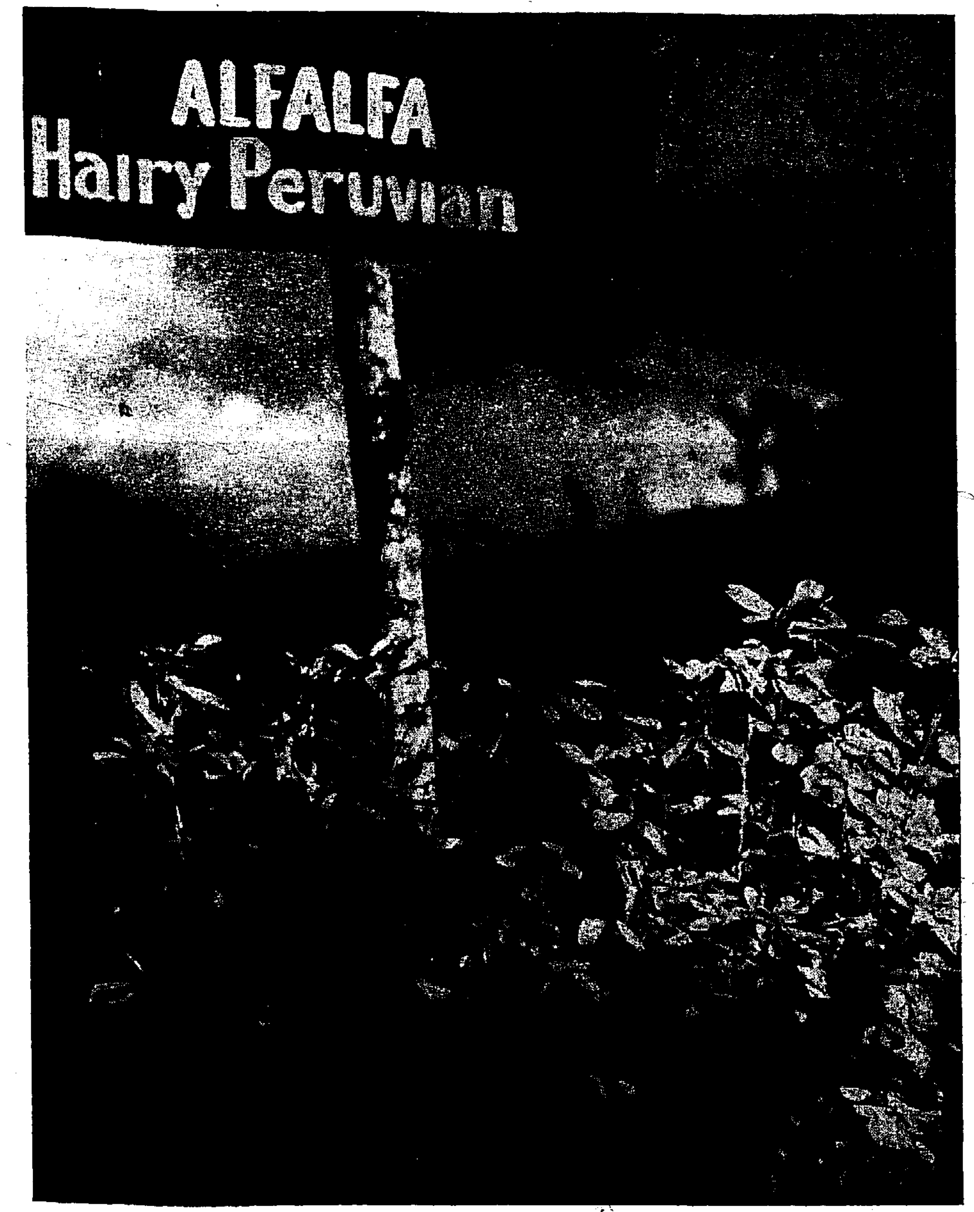
Legumes. One of the big problems in Tropical grassland is the paucity of suitable legumes for establishing grass legume mixtures which form the basis of temperate zone pastures. There are however quite a number of legumes present in the Tropics.

In the 'commons' grass pastures of Jamaica there are several species of Desmodium and Centrosema growing in association with the grasses. Only *Desmodium triflorium* and *Centrosema sop.* seem to be relished by cattle. The rest are not readily eaten.

Legumes which have been tested as cattle feed include: Cow peas, Bengal bean, Soya bean, Tropical Kudzu, Trailing Indigo, *Indigofera subulata, Centrosema pubescens, Desmodium adscendens, Desmodium triflorium, Desmodium distortum, Calapogonium muconoides,* Birdsfoot Trefoil (*Lotus carniculatus*), *Stylozanthes gracilis, S. sundrica, S. hamata,* several clovers and Alfalfa.



A Pasture Legume—Beggar Weed



Alfalfa

The dry matter production and crude protein percentage of the dry matter of six of these legumes are given below.

Total Dry Yield Tons/Acre (3 year period)

Kudzu	*Trailing indigo*	*Indigofera subulata*	*Centrosema pubescens*	*Desmodium adscendens*	*Alfalfa*
2·58	1·95	1·46	1·25	1·29	1·18

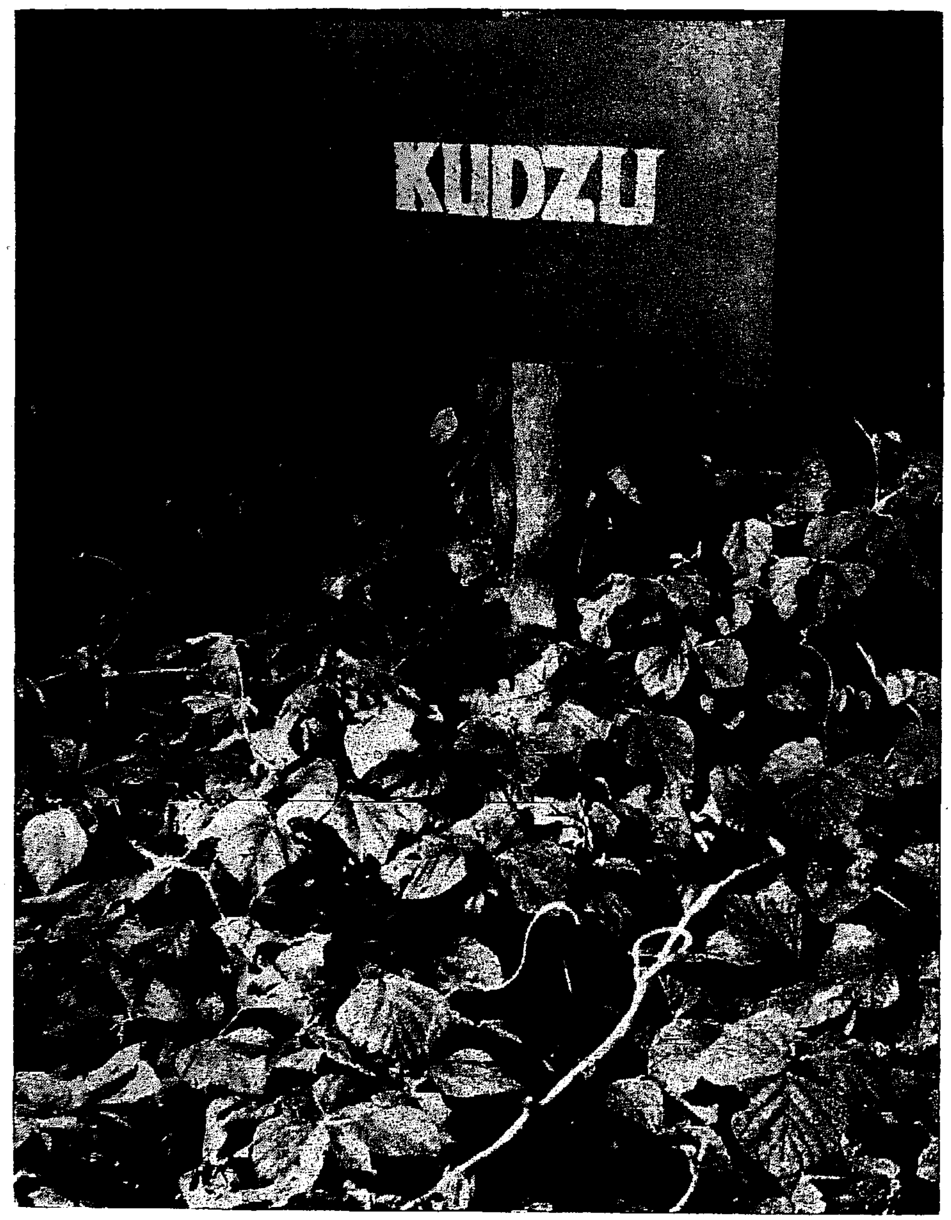
% Crude Protein in Dry Matter

Kudzu	*Trailing indigo*	*Indigofera subulata*	*Centrosema pubescens*	*Desmodium adscendens*	*Alfalfa*
19·03	20·19	20·71	20·76	18·73	18·90

Although found growing in 'commons' pastures, *Desmodium triflorium* would not persist as a pure stand.

Investigations into the possibility of establishing grass-legume mixtures have been carried out by the Department of Agriculture since 1949. The best results were obtained with Trailing Indigo and Wynne, Guinea, Napier and 'commons' grasses. It has however been found in Jamaica and elsewhere that Trailing Indigo when fed in quantity to cows causes abortion. The possible causes of toxicity are being investigated at the moment.

Kudzu also shows promise but it is extremely slow in establishing itself



Kudzu

both from seeds and 'crowns'. Reports from Puerto Rico have shown good results with Kudzu as a mixture with Wynne grass. The entire aspect of establishment of Kudzu is now being investigated in Jamaica.

Other promising pasture legumes now being tested are *Desmodium destortum*, *Stylozanthes gracilis* and Cuban Clover (*Melilotus alba*).

Cow pea, pigeon pea, bengal bean and soya bean have been used with grasses chiefly in silage making.

The value of legumes in pastures is twofold:

(*a*) They increase the protein content of feeds resulting in more animal production from pastures alone.

(*b*) They build up the nitrogen status of soils by the return of dead leaves high in nitrogen content and they produce nodules on their roots which also increase the nitrogen content of soils. The resultant effect will be better growth of grasses and increased soil fertility.

Other Fodder Plants. Other plants grown for fodder are several Sorghums, Sugarcane (chiefly Uba cane). Sorghums are cultivated for grain which is used as a carbohydrate feed and for cutting and feeding to stock or made into silage. Perennial sorghums such as Black Millet and Sudan grass are mostly used for fodder. Guinea corn and several other varieties are now grown by farmers for grain.

Uba cane is generally used as a dry season feed when it is cut and chaffed and fed to cattle, especially dairy cattle. Uba cane can also be used for silage making.

These feeds are generally low in crude protein content and high in carbohydrates. For optimum production, supplementary feeds high in crude protein content have to be used.

Other fodder plants available include plants such as Spanish needle, wild mint or buttonweed (*Borreria* spp.) bamboo leaves and leaves of various trees. Spanish needle and wild mint occur naturally as weeds. These plants however do not persist under heavy grazing. Leaves of the bamboo and other trees like breadnut and fig are only used when there is a scarcity of grass. Such fodder plants will continue to be of help in the survival of cattle during the dry seasons until proper management aimed at conserving adequate fodder for this period is practised by farmers.

OTHER GRASSES

Khus-Khus or Mart Grass (*Vetiveria Zizenioides*)

Certain grasses produce oil which they store in their tissues. These oils are frequently of economic value, but here in Jamaica they are not prepared on a commercial scale.

Among the oil grasses are: Citronella Grass—(*Cymbopogon Nardus*; and the fever or lemon grass and Khus-Khus. The name Khus-Khus is the Indian name for this aromatic grass which is also sometimes known as 'Cockroach' Grass and 'Khas-Khas'. In Cuba it is called 'Vetiver'.

Khus-Khus is commonly planted in the West Indies as a hedge plant. The roots are often sold in Jamaica for packing in clothing to keep it from moths. The aromatic roots are sometimes woven into screens which, when wet, are used to perfume living quarters. Benjamin's Khus-Khus perfume is also made from these roots.

Fever Grass or Lemon Grass (*Cymbopogon citratus*)

This common West Indian grass is generally found around dwellings. It grows in tufts and has a very sweet odour. The aromatic oil derived from it is used on a small scale in perfumery. In Jamaica it is often used for preparing a tea, which is regarded as a remedy for fevers and headaches.

Rhodes Grass (*Chloris gavana*)

A native of Africa, this grass has been cultivated in the warmer parts of America for forage. Having escaped into fields and waste places the species is rapidly becoming naturalized.

Rhodes grass gives promise of value in the drier parts of the West Indies.

Rice Grass (*Leersia Hexandra*)

This is a widely distributed grass found in swamps and ditches in tropical regions. It is a great pest and, once introduced, it is hard to get rid of. Its reddish flowers are very noticeable. In the Philippine Islands this grass is regularly cultivated, under the name of Lacate, as fodder for domestic animals. It is treated like rice being transplanted to wet and previously ploughed meadows. It is an important fodder grass in Australia and Malaya.

Big Quaking Grass (*Briza maxima*)

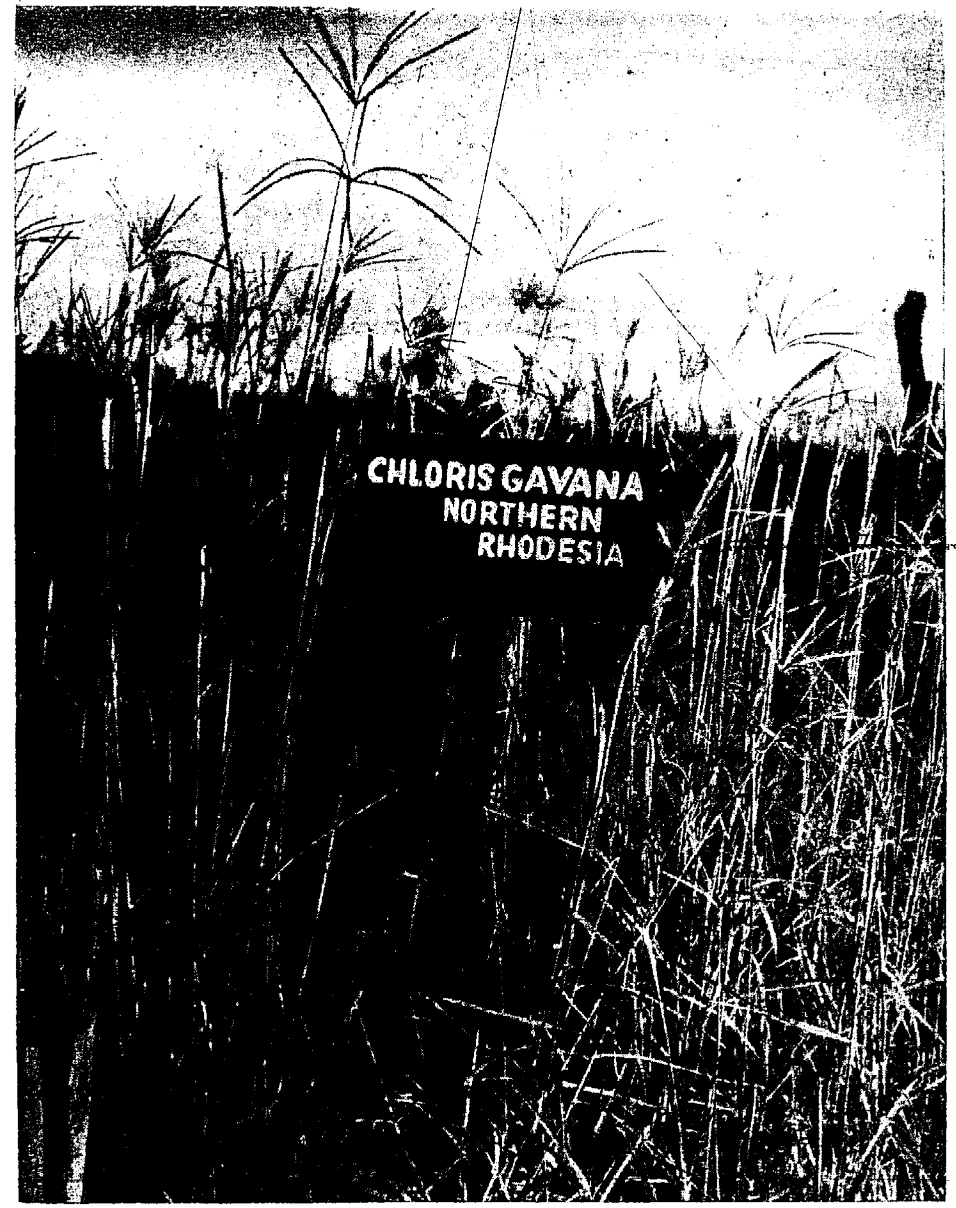
This plant is a native of Europe. It is found in open grounds and grass-lands in North America, Bermuda, and in Jamaica at Cinchona and Hardware Gap.

The handsome spikelets nod on their long stalks—hence the name 'Quaking Grass'.

A small species—Little Quaking Grass (B. Minor)—is much more often seen in the Blue Mountains.

Guinea Corn (*Kaverondo sorghum*). (See Chapter XXXVI).

Burr Grass (*Cenchrus echinatus*). (See Chapter XLVI).



Rhodes Grass

Guatemala Grass (*Tripsacum laxum*)

This grass is cultivated for forage in Cuba, Puerto Rico and St. Croix, and is being introduced into Jamaica for the same purpose. It is native to Mexico and Central America.

Bamboo (*Bambusa vulgaris*)

The Bamboo is found throughout the tropics. It is commonly cultivated around dwellings and grows along riversides, near ponds and often in pastures. The climbing bamboo (*Chusquea abietifolia*) of the Blue Mountains is the only bamboo indigenous to Jamaica. The common bamboo

(*Bambusa vulgaris*) was introduced from Hispaniola towards the end of the 18th century. Many other imported species are to be seen at Castleton and Hope Gardens.

The leaves of the Bamboo are a good stand-by in times of drought when other grasses are short. It may be fed to cows and it is said to increase a horse's stamina and ability to stand hard work better than the succulent grasses. The hollow stems, with cross partitions, are used for a great many purposes.

Bamboo is very popular for farm construction—fences, pig sties, fowl runs, rabbit hutches and feed hoppers, are all built of bamboos, to say nothing of its use for wattling houses and kitchens. A certain bamboo, *Tulda tuldoides*, is used for furniture-making in Puerto Rico. The bamboo is also a very promising source of paper.

In the far East, where the bamboo is a native, it is highly valued and put to a great variety of uses. In Jamaica, however, due to the fact that it is often infested with boring insects, bamboo is not widely used.

The best time to cut bamboo is from mid-October to the end of December. A remedy against borers is to soak the bamboo in water for six months to extract the sugar. (In China, bamboo is soaked, as it is rafted down the rivers, and is kept in the water until required.) To further prevent destruction by termites the split bamboo may be steeped in creoil.

Hay Grass or Wire Grass (*Sporobolus indicus*)

This grass when young and succulent is a first class fodder for all kinds of stock. With age the grass gets hard and wiry, greatly reducing its value as a feed.

In the country parts of Jamaica hay grass is often used to bind the plaster in building walls.

Iron-Grass (Goose Grass, Fowl-Foot Grass) (*Eleusine indica*)

This grass, a native of India, is common on open ground and waste places throughout the West Indies.

Salmon Grass (*Leptochloa sp.*)

The grasses in this genus are native to tropical America and the West Indies. Their inflorescence is very showy and one species (*L. virgata*), is occasionally grown as an ornamental border plant in the Southern United States.

Crow Foot Grass—Egyptian Grass (*Dactyloctenium aegyptium*)

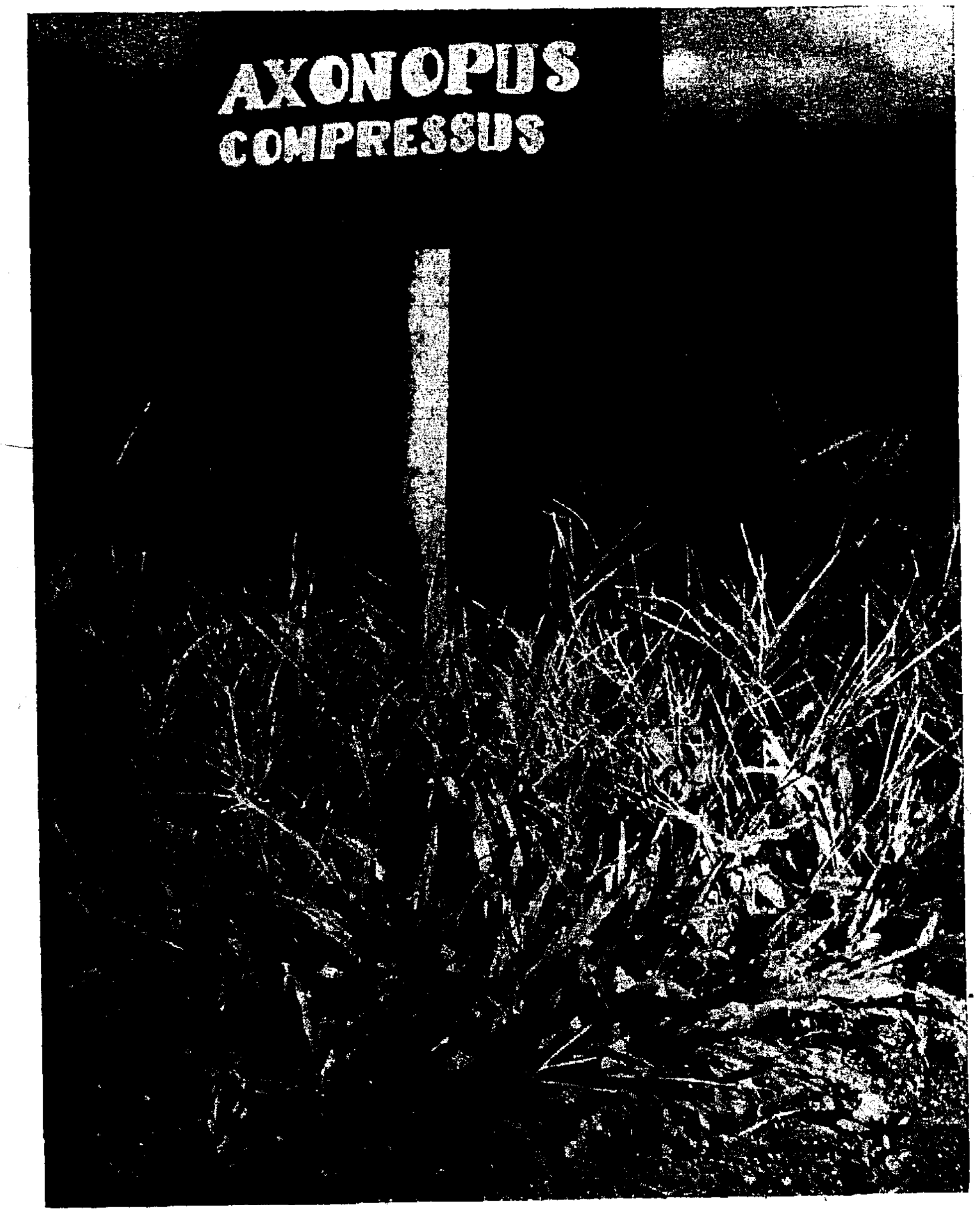
This is a common weed of waste places, which is found on all the West Indian islands.

Anthephora hermaphrodita. This is a native of Jamaica, other West Indian islands and parts of tropical America.

Bahama Grass

This well-known species is widespread throughout the warm regions of the earth and is a good fodder grass. It is a native of India. It is also known by other names such as 'Doub' and 'Doowa' in the United States, and 'Indian Couch Grass'.

Bahama Grass is an important cover plant for bare, barren land and for making smooth, compact lawns. It resists extreme drought, and, once established, it is very difficult to eradicate because of its vigorous rhizomes and stolons.



Savannah Grass

COMPOSITION OF GRASSES AND LEGUMES

Common Name	Botanical Name	Moisture %	Percentage dry matter: Protein	Fat	Fibre	Ash	Carbo-hydrates	N	P_2O_5	K_2O	CaO	MgO
Alfalfa	*Medicago sativa*	77·91	15·80	—	—	—	—	2·53	—	—	—	—
Amphilopia	*Andropogon pertusus*	40·00	4·90	1·40	34·70	10·20	48·80	0·78	3·10	0·66	1·09	—
	Andropogon ischaemum	40·27	7·00	—	—	—	—	1·12	—	—	—	—
Bahama Grass	*Cynodon dactylon*	35·47	6·30	—	—	—	—	1·01	—	—	—	—
Balica	*Paspalum notatum*	45·70	6·30	—	—	—	—	1·01	—	—	—	—
Blue Pea	*Clitoria ternatea*	82·92	22·73	—	—	—	—	3·64	—	—	—	—
Birdsfoot trefoil	*Lotus corniculatus*	75·29	19·08	—	—	—	—	3·05	—	—	—	—
Black millet	*Sorghum vulgare*	87·20	14·0	—	—	—	—	2·24	—	—	—	—
	Brachiaria dictyonium	78·10	10·62	—	—	—	—	1·70	—	—	—	—
	Calapogonium mucunoides	61·73	16·60	—	—	—	—	2·66	—	—	—	—
	Centrosema pubescens	77·06	23·20	—	—	—	—	3·71	—	—	—	—
Crab Grass	*Stenotaphrum secundatum*	56·73	8·13	—	—	—	—	1·30	0·75	0·97	0·91	0·74
Cuban kikuyu	*Digitaria sanguinalis*	69·92	8·20	—	—	—	—	1·31	—	—	—	—
	Desmodium adscendens	71·62	17·85	—	—	—	—	2·86	—	—	—	—
	Desmodium destortum	71·79	20·00	—	—	—	—	3·20	—	—	—	—
	Desmodium triflorum	67·74	20·12	—	—	—	—	3·22	—	—	—	—
Elephant Grass	*Pennisetum purpureum*	73·40	13·60	1·60	23·20	13·30	48·30	1·18	1·08	1·58	1·15	—
Guatemala Grass	*Tripsacum laxum*	72·95	6·41	1·14	32·80	12·40	—	1·98	0·55	1·19	0·50	—
Flat Savannah Grass	*Axonopus compressus*	48·65	6·98	—	—	—	—	1·21	—	—	—	—
Guinea Grass	*Panicum maximum*	35·19	5·20	1·40	35·60	—	—	0·83	0·34	1·43	1·74	0·60
Hybrid Napier	*Pennisetum purpureum*	56·48	9·90	—	—	—	—	1·58	—	—	—	—
	Indigofera endecaphylla	77·94	20·19	—	—	—	—	3·23	—	—	—	—
	Indigofera subulata	76·43	18·07	—	—	—	—	2·89	—	—	—	—
Kikuyu Grass	*Pennisetum clandestinum*	64·99	6·10	—	—	—	—	0·98	—	—	—	—
Kudzu (tropical)	*Pueraria phaseoloides*	80·64	18·92	—	—	—	—	3·03	—	—	—	—

COMPOSITION OF GRASSES AND LEGUMES (*Contd.*)

Common Name	Botanical Name	Moisture %	Percentage dry matter: Protein	Fat	Fibre	Ash	Carbo-hydrates	N	P_2O_5	K_2O	CaO	MgO
Malogilla Grass	*Eriochloa polystachya*	50·77	9·60	—	—	—	—	1·54	—	—	—	—
Napier Grass	*Pennisetum purpureum*	80·63	5·70	—	—	—	—	0·91	—	—	—	—
Pangola Grass	*Brachiaria decumbens*	88·67	10·33	—	—	—	—	1·65	—	—	—	—
	Paspalum dilatatum	67·33	5·75	—	—	—	—	0·92	—	—	—	—
	Panicum coloratum	23·00	8·60	1·50	28·8	9·50	51·60	1·39	0·18	—	—	0·47
	Paspalum conjugatum	76·37	9·75	—	—	—	—	1·56	—	—	—	—
Para Grass	*Brachiaria mutica*	*70·75	8·25	0·91	37·83	6·50	46·51	1·65	—	—	—	—
Piano Grass	*Themeda arguens*	—	4·04	—	31·2	3·60	—	0·65	0·47	0·59	1·01	—
Pimento Grass	*Stenotaphrum americanum*	*80·78	8·62	1·64	33·13	8·03	48·58	—	0·58	0·76	0·66	—
Rhodes Grass	*Chloris gayana*	30·92	7·94	—	—	—	—	1·27	—	—	—	—
	Setaria geniculata	63·45	4·60	—	—	—	—	0·51	—	—	—	—
Seymour Grass	*Andropogon pertusus*	59·84	6·20	30·8	3·1	—	—	0·99	0·37	0·57	1·09	—
	Stylosanthes lamata	76·97	18·20	—	—	—	—	2·91	—	—	—	—
Spanish Needle	*Bidens pilosa*	90·01	9·95	1·30	32·27	12·4	28·20	—	0·54	3·80	1·64	—
Sudan Grass	*Sorghum sudanense*	75·20	17·70	—	—	—	—	2·83	—	—	—	—
Swaziland finger	*Digitaria swazilandensis*	56·40	9·40	1·30	28·8	8·70	51·80	1·50	0·25	—	1·02	—
Uganda Grass	*Pennisetum purpureum*	63·02	12·00	—	—	—	—	1·92	—	—	—	—
Water Grass	*Commelina elegans*	93·90	20·30	—	—	—	—	3·25	—	—	—	—
Wynne Grass	*Melinis minutiflora* (Before flowering)	*72·32	4·75	2·90	26·83	8·07	57·45	0·76	—	—	—	—
	(During flowering)	*72·33	4·74	2·33	27·49	8·09	57·45	0·76	—	—	—	—

* Barnett, W. L. Miscellaneous Circular No. 2, Department of Agriculture.

Job's Tears (*Coix lacryma-jobi*)

This grass is found in waste, moist places, especially near dwellings and rivers throughout the West Indies. In Jamaica strings of beads are made from its seeds.

It is cultivated as an ornament in tropical America. The plant is also known as 'Christ's tears'.

A near relative of the Job's Tears is *Adlay* largely grown for the flour-content of its seeds in Eastern countries and useful as an adjunct for poultry feed.

Savannah Grass—Carpet Grass (*Axonopus compressus*)

This grass is widespread at low altitudes throughout the tropical regions. In the West Indies it is an important pasture grass on moist or swampy soil. It also makes a very satisfactory lawn grass.

CHAPTER 14

Management and Maintenance of Pastures

It cannot be over-emphasized that grass should be treated as a crop which requires skill in management and maintenance on par with any other of our farm crops. This altered outlook has received practical recognition from several farmers. In the majority of cases, however, the true economic value of grass and grassland products in relation to livestock and crop production has not yet been appreciated.

In view of the extensive animal breeding programmes that have been initiated by the Department of Agriculture and the farmers, this fact that grass must be treated as a crop cannot be too strongly stressed. The slow maturing beef types and low producing dairy animals reared mostly on roughage in the past, are rapidly becoming replaced by higher producing types. Unless the quality of feed available to these animals is improved, the full economic benefit of such breeding programmes will not be obtained.

Grass is the cheapest feed for cattle. The cheapest method of production is to put the animal where its food grows and let it do its own harvesting. Properly managed pastures with good quality grasses are therefore essential to good farm economy.

Good Management

The first objective of the cattle farmer in the improvement of pastures for increased production should be directed towards better management of the available pastures. Good management involves:

(*a*) Adequate subdivision of pastures.

(*b*) Rotational grazing management designed to get the animals on the pastures at the correct stage of growth thereby maintaining an even flow of good quality feed, together with the persistency of the sward, prevention of soil erosion, and maintenance of soil fertility.

Renovation Measures

The next stage of development should be the renovation of existing pastures. This can take the form of:

(*a*) Discing, draining, fertilizing and suitable management to increase the productivity of deteriorating pastures of desired grasses such as Guinea, Napier and Para.

(*b*) Reseeding badly deteriorated fields.

(*c*) Establishing better types of grass.

Sub-division of Pastures and Rotational Grazing

Pastures should be sub-divided in relation to the number and type of animals carried on the farm, the variety of grass, the topography of the land and the availability of water for the animals.

Adequate sub-division of pastures facilitates good rotational grazing practice. The rate of stocking should be adjusted to feed down each pasture in about four to six days. This pasture should be rested after it is fed to allow the grass to recover.

The nutritive value of any grass lies in its leaf. The best grass is therefore one which can produce the maximum amount of leaf growth with good palatability, bulk, and persistency.

Different varieties of grasses vary in their rate of recovery after grazing, flowering habits, and yielding potentialities under similar soil and climatic conditions. The rate of recovery of any grass, e.g. Guinea or Napier also varies with climatic and soil conditions.

Grazing Cycle

Stage of growth for each grass should be the foremost factor influencing the cycle of grazing

Rate of stocking should be in relation to the productivity of the pasture. The aim should be to obtain maintenance and maximum production per animal carried. Overstocking can result in loss in animal production together with overgrazing which will result in deterioration of pastures. Understocking on the other hand will result in a decline in the quality of available feed and hence reduction in animal production.

Carrying Capacity

Carrying Capacity varies with soil and climatic conditions and the inherent productive ability of the different grasses

During the peak growth periods of the year, Spring and Autumn, there will be excessive growth of grass. The best system of management would be to conserve this excess growth in the form of *silage* for feeding during the dry periods of the year.

It is essential to use mechanized equipment in large scale silage making to lower the cost of production.

The topography and condition of large areas of land under pasture in Jamaica are not suitable for mechanized farming. Excessive growth, if not removed, results in an increase in stem formation and a rapid decline in

the quality of feed. On such lands the choice of grasses grown is an important factor in maintaining the quality of feed throughout the year. Leafy types of pasture grasses such as Wynne or Molasses, Pangola, and possibly Coastal Bermuda, if they are well managed, can be very effective in achieving this end on lands unsuitable for mechanized farming.

On relatively flat lands, the taller and heavier yielding species such as *Pennisetum purpureum* strains (Napier, Elephant, Uganda) and Guinea grass are very useful. They can produce the required bulk for silage making with good aftermath grazing or cutting. Excessive stemmy growth on such lands can be effectively controlled by the use of the **mowing machine.**

Selection of types of grasses varying in their growth habits will also be of great importance in levelling off fodder production on the farm thereby increasing the period of good grazing over the twelve months of any year.

The underlying principles to be observed are much the same everywhere regardless of variation in degrees of intensity of grassland farming suited to different areas.

Establishment of Grasses

The grasses which will be dealt with are as follows:

Guinea grass (*Panicum maximum*)
Napier grass, Elephant grass, Uganda grass } (*Pennisetum purpureum* strains)
Molasses or
Wynne grass (*Melinis minutiflora*)
Para or John's grass (*Panicum purpurascens*)
Pangola grass (*Digitaria decumbens*)
Coastal Bermuda (*Cynodon* sp. hybrid)

Guinea Grass

This grass was accidentally introduced from West Africa over 150 years ago and for many years has been the principal, almost the only, fodder grass in cultivation, extensive pastures of it being established throughout the island, but thriving especially in the lowlands of St. Catherine, Clarendon, St. Elizabeth and Westmoreland.

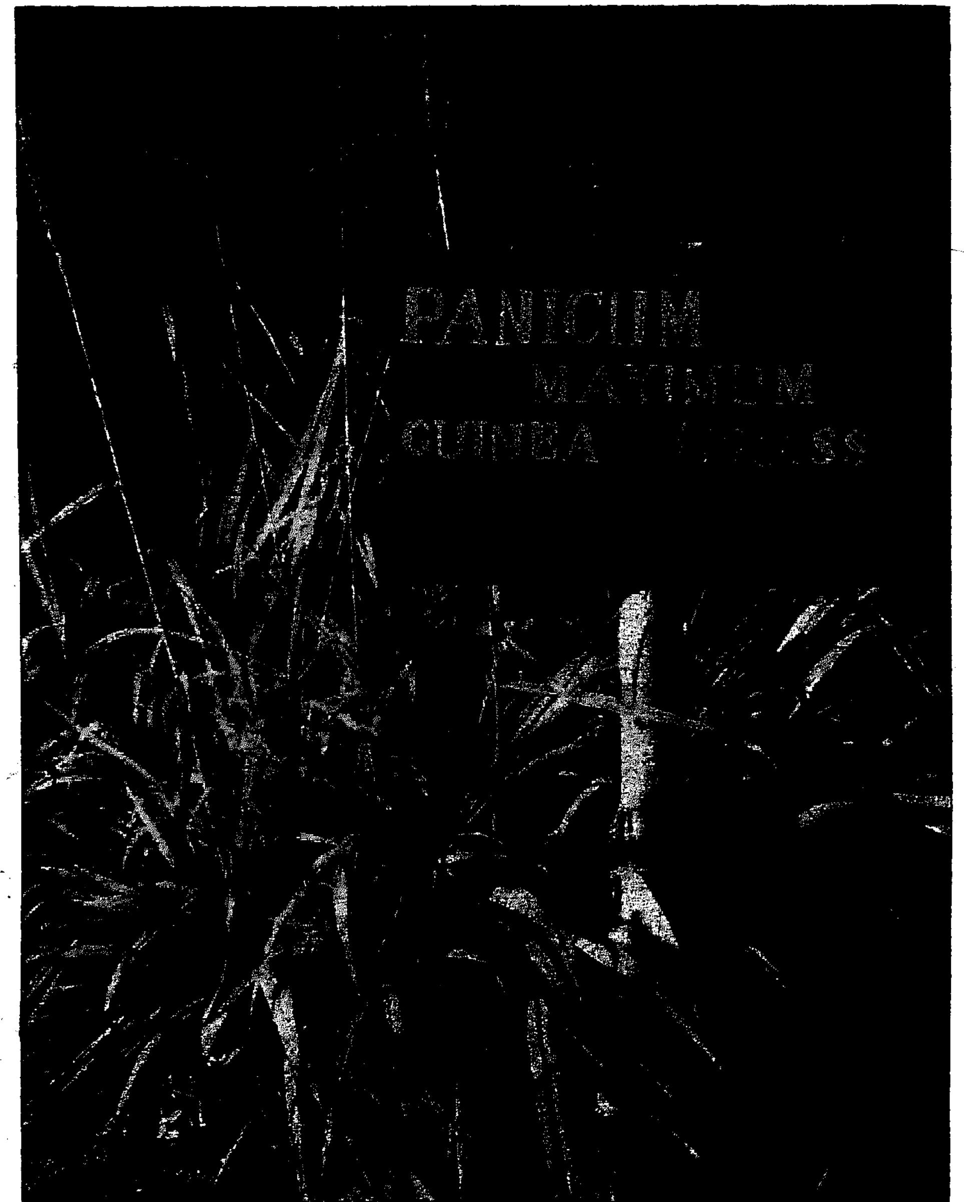
It rates high in nutritive value, especially when grazed or cut for feeding before it seeds, the seeding time occurring in October and November.

Guinea grass can be established as follows:

(*a*) Rooted Setts

(*b*) Direct Seeding.

(*a*) **Rooted Setts.** This method is extremely expensive as it entails the use of hand labour. The area should be properly ploughed and harrowed



Guinea Grass

Indigenous to Africa. Accidentally introduced into Jamaica in the eighteenth century. The island's most important fodder grass.

in order to obtain a good tilth for planting and to lessen weed competition in the early stages of establishment. Furrows should be dug about two feet apart and the rooted setts planted about 18 inches in the furrows.

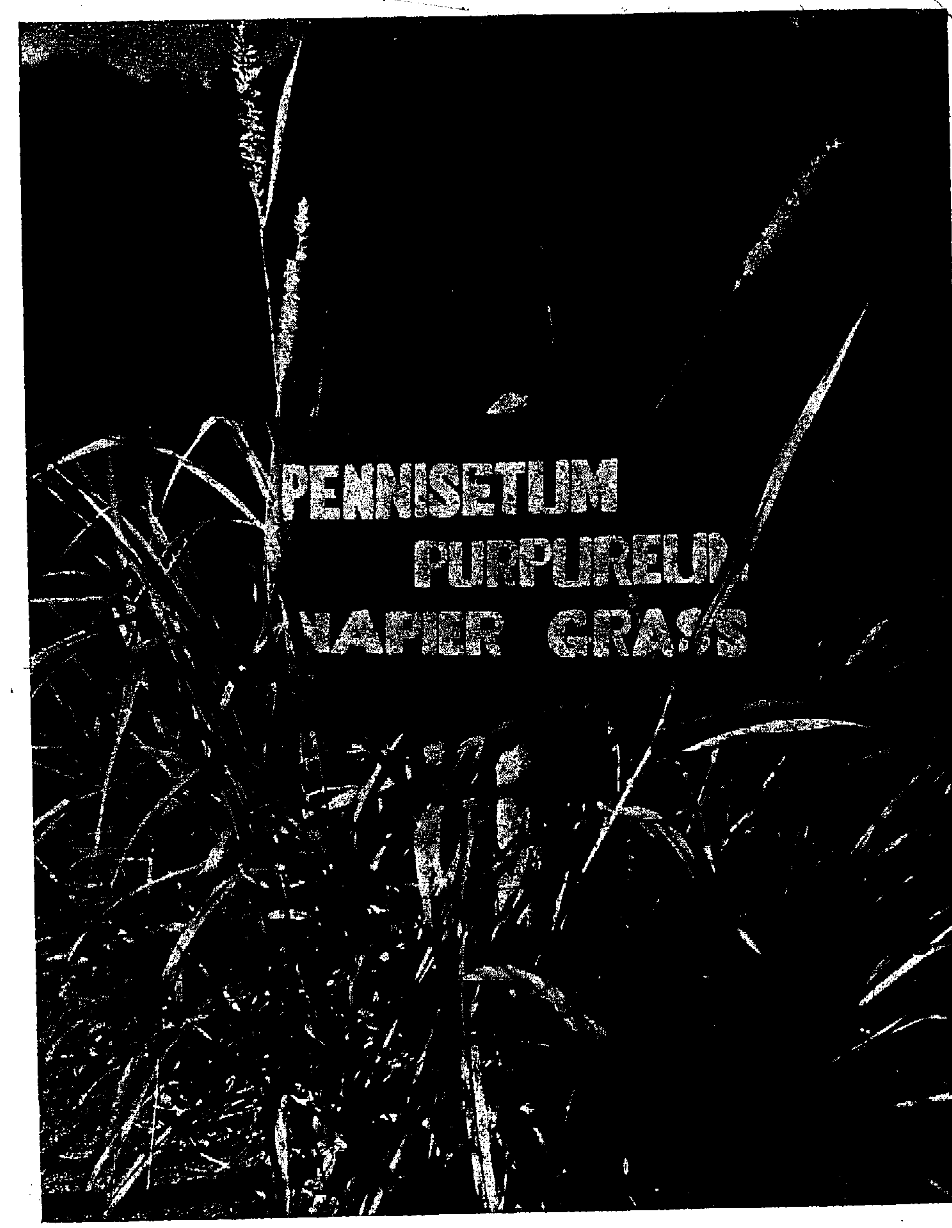
(*b*) **Seeding**. Seeding can be carried out as follows:

(i) By broadcasting seed after the land has been properly prepared.

(ii) Seeding under maize, sorghum or other arable cash crops with broadcast or in furrows.

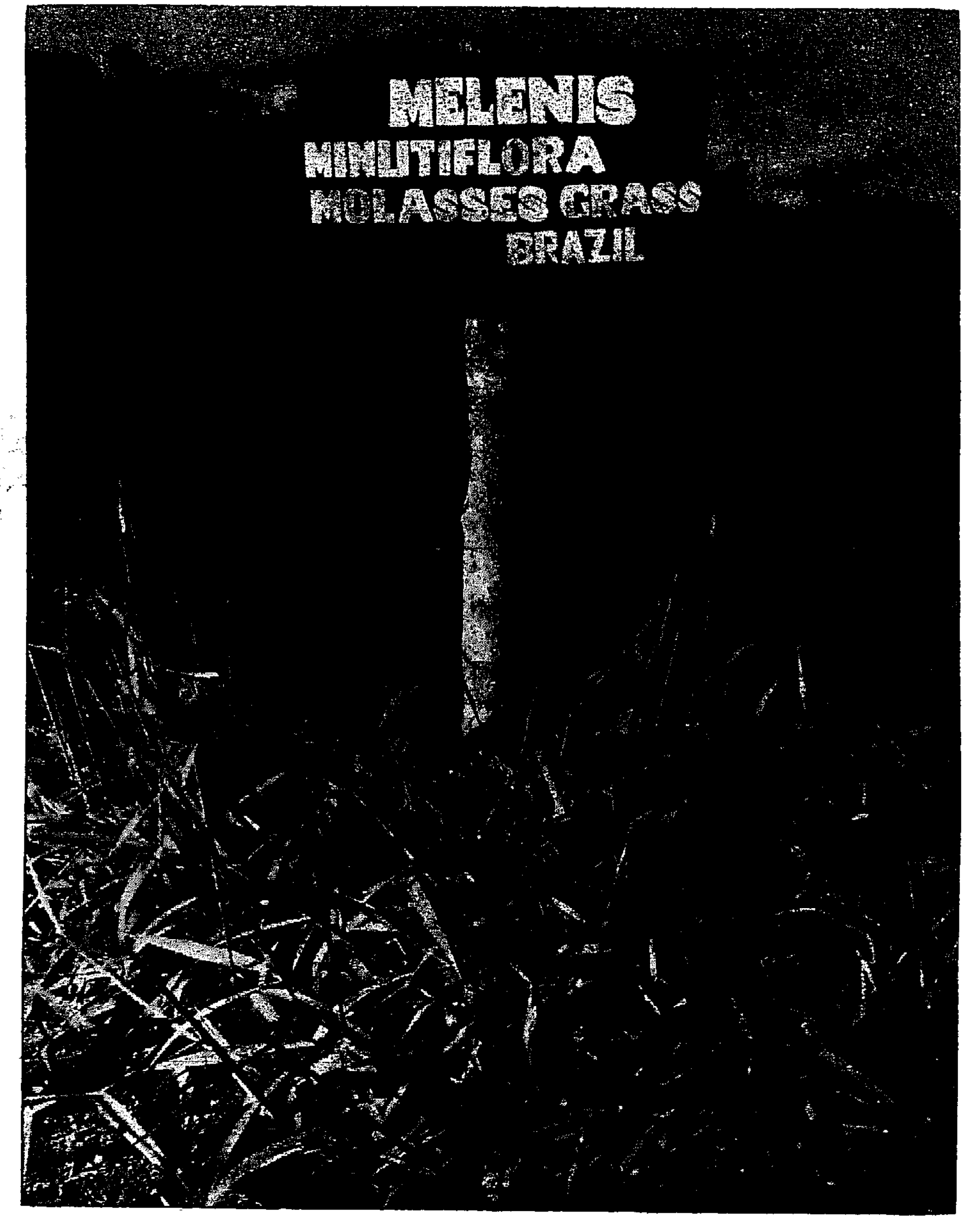
(iii) Allowing old pastures to run to seed followed by forking or discing after edible portions have been grazed off. Burning of stubble is practised in some cases but mowing back the stubble is advocated. Indiscriminate burning can lead to disastrous effects.

(iv) By seeding in drills. Drills should be about 18 inches to 24 inches apart and the grass seeds sown continuously in drills. This can be done either by hand or by a seed planter and is the cheapest method of establishment.



Napier Grass

Introduced into the West Indies from Africa. Other strains are Uganda and Elephant. A valuable forage and silage grass when cropped before fully mature.



Wynne or Molasses Grass
A valuable perennial grass, rooting at the lower nodes. The pungent odour does not affect the milk or flesh of cattle.

It has been found from experimental work carried out with this grass that the viability of seeds is very low. It varies with strains of guinea grass and ranges from about 4% to 48%.

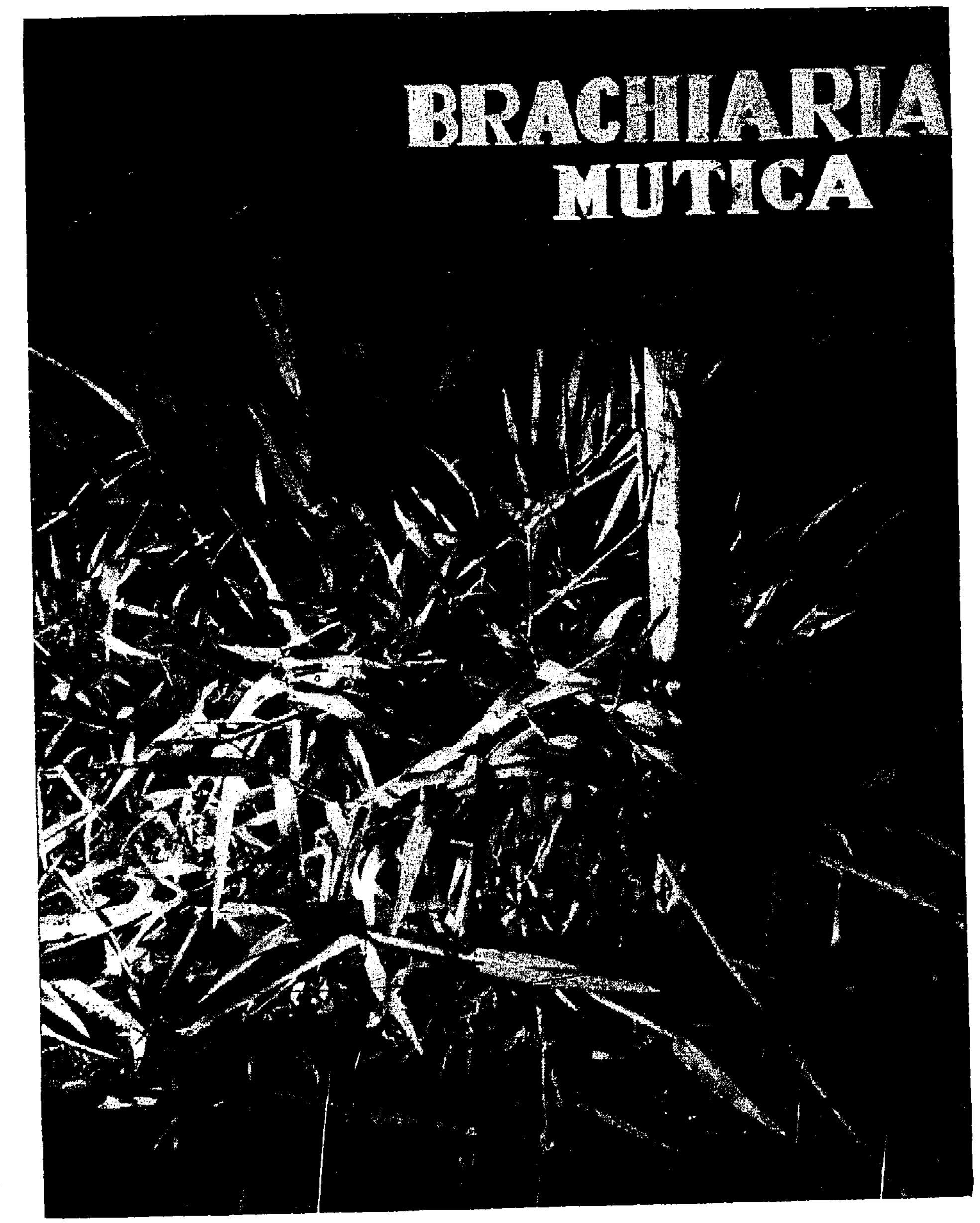
Experimental work has also shown that seeds should be lightly covered after sowing to ensure good germination.

In cases where damage to seeds by ants or other insects is anticipated, seeds should be treated with an insecticide such as Agrocide before sowing is carried out. Rate of sowing should be around ten lbs. per acre if fairly

good seeds are used. Unevenness in ripening of Guinea grass seed heads tends to lower the viability of seed if care is not exercised in the collection of seeds.

Pennesitum purpureum strains, Napier, Uganda, Elephant.

The land should be well prepared for the planting of these grasses. Weed competition can be a severe set back to the proper establishment and future persistency of these grasses if a good seed bed is not obtained.



Para or John's Grass
Introduced into the West Indies from South America. Roots and spreads easily from runners.

The best time to prepare land is during dry periods. Planting would then be carried out with the early Spring or Autumn rains. The method of establishment is by planting stem cuttings.

Furrows should be dug about three feet apart and the long stems laid continuously in these furrows and lightly covered with soil. For good establishment it might be necessary to inter-cultivate the field after germination of plants. At this spacing mechanical equipment can be used for intercultivation.

Molasses or Wynne Grass

Wynne grass is a prolific seeder and can be established easily from seeds. The viability of Wynne grass seed is very high. The chief value of this grass lies in its ability to grow on areas of low fertility, its fertility building potentialities and its usefulness in prevention of soil erosion. The productivity of large areas of stony land can be considerably improved by the establishment of Wynne grass pastures.

Methods of establishment are as follows:

(a) **Rooted Setts**

This is a very expensive method of establishing this grass and is not frequently used.

(b) **Direct Seeding**

(1) Preparation for seeding will depend on the nature and topography of the land. In some areas where it is not practicable to plough the entire area, furrows should be dug where possible and the seeds sown within the furrows.

(2) In some very stony areas the land can only be cleared and the seed broadcasted.

(3) On areas suitable for the plough the land should be prepared and the seed broadcasted or sown in drills.

(4) A good method of establishment which is now practised by farmers is to seed down under maize or other arable cash crops.

The rate of seeding varies from 5–10 lbs. per acre dependent on the type of land and quality of seed available. Wynne grass seed is very light and should be mixed with sawdust, before sowing.

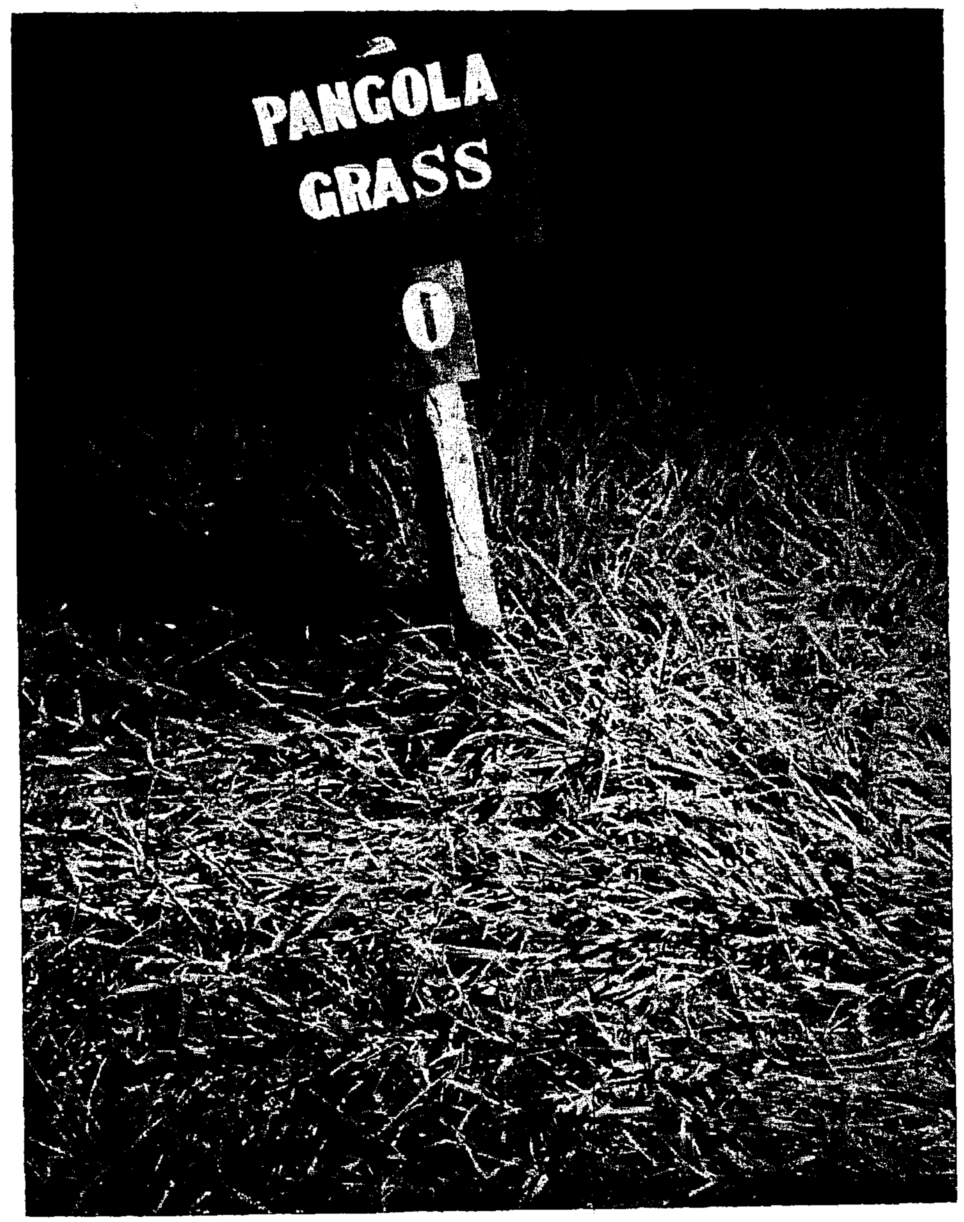
Para or John's Grass

This grass is very easily established from 'runners' and is most adaptable to areas of high rainfall with good soil moisture conditions.

Land should be prepared for planting and the runners spread over the field and disced in.

Pangola Grass

Pangola has of recent years come to the front as a hardy high yielding



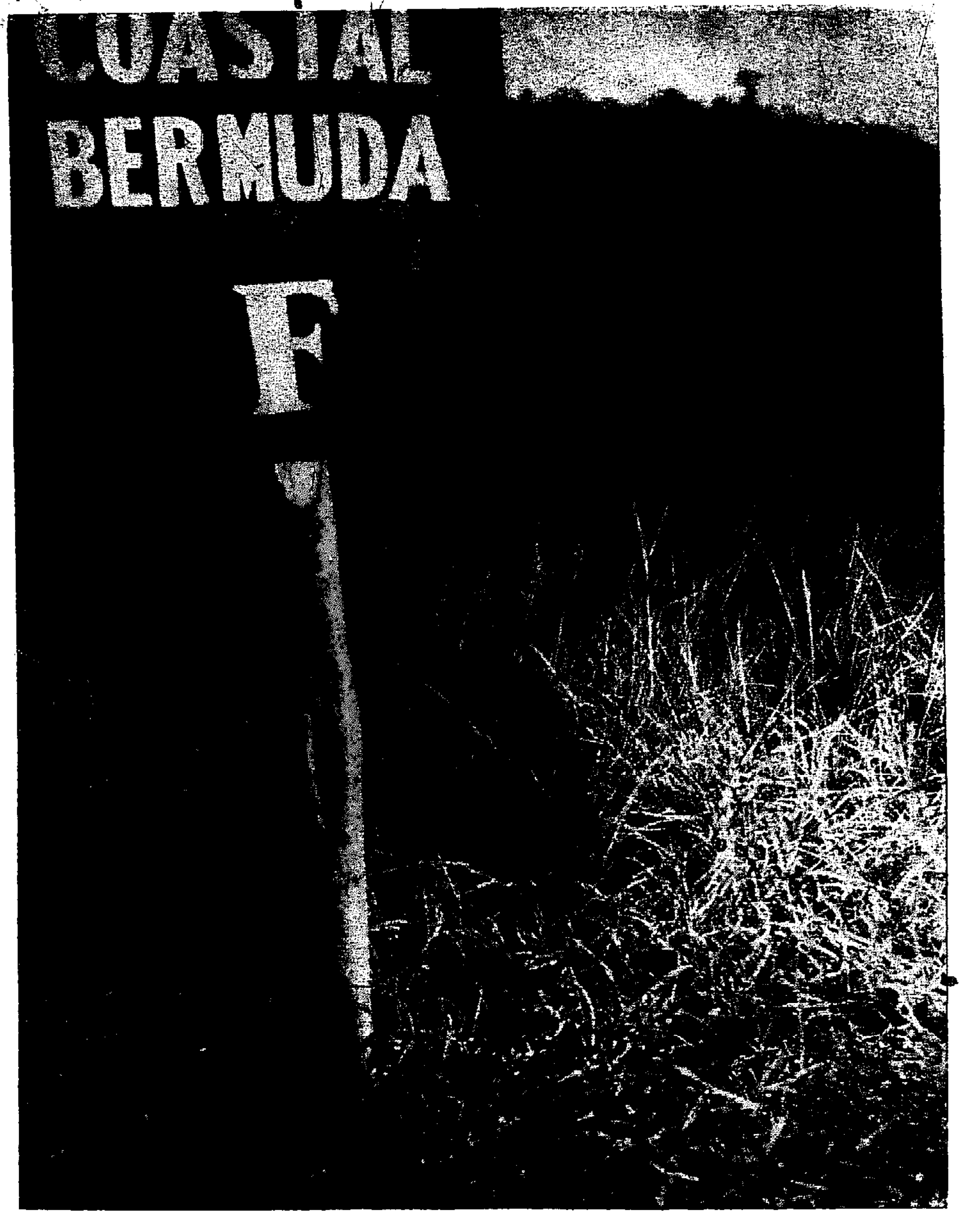
Pangola Grass
A promising fodder grass recently introduced.

and nutritive fodder grass, rivalling Guinea for first place. Seeding in the summer months, it rotates well with Guinea.

It has been established that steers pastured on fertilized Pangola reach 1,000 lbs. at 22 months dressing 600 lbs. prime beef.

Coastal Bermuda

This is another introduced type of pasture grass from Tifton, Georgia, which has also shown good production and drought resistant characteristics. It is established from 'runners' or 'rooted setts'.



Coastal Bermuda Grass
Introduced in 1952. Now being extensively grown in the South-Eastern States.

The land should be well prepared and furrows dug about two feet apart. Runners or rooted setts should then be planted out about two feet within the furrows.

It should be stressed here that the initial preparation of land for establishment of grasses should be on par with preparation of land for other crops. A large percentage of failures in good establishment of pastures in the past has been a direct result of farmers ignoring this simple but highly important fact.

Silage

It has been mentioned elsewhere that the best system of grassland management is to conserve the excess growth of grass on the farm in the Spring and Autumn in the form of silage.

Quite a lot has been said about silage in the past, but comparatively few farmers have adopted the principle of ensiling grass or preferably, grass and legumes, for feeding to cattle during the dry periods of the year. The cost involved, in the absence of mechanized farming, has been the alleged reason for this slow progress. Mechanization is essential in large scale silage making as it greatly reduces the cost of production.

In dairy farming, silage making should be an essential item on the farming programme. Silage made from grasses and legumes grown on the farm will greatly reduce the quantity of concentrates imported on the farm to feed the animals during the dry periods when the quantity and quality of grass available are limiting factors in the maintenance of production. The economics of silage making in relation to the price of the marketable product will determine the use of silage for beef production.

There are three main types of silos:

(1) Tower silo
(2) Pit silo
(3) Trench silo

All three main types are now being used in this country. Efforts are being made by the Department of Agriculture to carry out intensive studies on the best type of silo suitable for different areas, the economics of and methods of silage making, the quality of silage that can be produced and the nutritive value of silage in terms of milk and beef production.

Ley Farming, Mixed Farming or Alternate Husbandry

It has been previously stated that grasses and legumes have the ability to maintain and increase the fertility of soils and are the principal means of restoring soils worn out by cropping. This fact can be of great economic importance if a system of ley farming otherwise known as mixed farming or alternate husbandry is practised. This system entails the rotation of grass with crops. Grass becomes the integral part of the rotation as a whole and in a number of countries is regarded as the pivotal crop upon which rotations are based.

As a part of the planned rotation, grass leys offset the deterioration of soil structure and organic matter resulting from the cultivation of cereals and other arable crops.

Grass roots will give body to light soils and will result in better aeration, soil structure and penetration of water on heavy soils. With good management, grasses, legumes and the grazing animal, fertility can be restored. This stored up fertility can then be exploited in terms of good production from arable cropping.

The duration of a grass ley will be dependent on type of soil, topography of the land, the system of grassland farming practised. A six year rotation with a three or four year period under grass is the recommended practice in this country at the moment.

The value of such a system of agriculture has not yet been fully appreciated by farmers as a whole but in an effort to maintain high production from livestock and crops it will be of vital importance that this system be practised.

Livestock and grasses will have to be an integral part of farming if soil erosion is to be prevented and the production from livestock and arable crops improved to maintain a rapidly increasing population.

The economics of livestock production will have to be interpreted in terms of livestock products and the residual effects of animals and grasses in maintaining high crop yields.

Weed Control in Pastures

In most cases the incidence of weeds has been the result of poor grassland management. Overgrazing has resulted in the deterioration of pastures. The better grasses have been killed off and the remaining grasses are unable to smother the weeds. The most economic method of weed control in such cases is complete renovation of the pastures, together with better management practices.

Mowing of pastures once or twice annually where possible can be a very useful method of controlling weeds such as sheep burr (*Acanthospermum humile*), devil's horse whip (*Achyrantes aspera*), broom weed (*Sida acuta*), sensitive mimosa (*Mimosa pudica*), marigold (*Tagetes patula*), Tansy (*Ambrosia paniculata*) and several others.

Selective weed killers, especially 2-4-5T, have also proved very effective on several of the above mentioned weeds. The price of weed killers is the limiting factor in the control of weeds in pastures at the moment. Detailed information on the use of these selective proprietary products can be obtained from the commercial firms that sell them.

Nightshade (*Echites* sp.) and Guinea Hen weed (*Petiveria albacea*) are generally reckoned to be the two most noxious weeds of pastures.

Nightshade when eaten by animals can result in death. Experimental work on the toxity of nightshade has been carried out by the Veterinary Division of the Department of Agriculture. Efforts are being made to improve on the existing chemical test for urechitoxin the active poison in the plant.

The most effective method of eradicating this weed is to dig it out. The plants should then be burnt or buried as the dry leaves have been found to be very poisonous to stock. Good results have also been obtained from some of the selective weed killers e.g. 2-4-5T that are now available.

Guinea hen weed affects the flavour of milk, when it is eaten by milch cows. It is mostly found in well shaded pastures. It can be controlled by:

(1) Regular mowing
(2) Digging out of plants
(3) Selective weed killers

The best period of the year to use any selective weed killer is during the dry periods of the year. Their effectiveness will be greatly lowered if it rains immediately after spraying has been carried out.

CHAPTER 15

The Influence of Improved Pastures on Beef and Milk Production

How many times as we go about the countryside do we see a lonely cow tied to a stake? Generally there is very little grass and no shelter from the sun. Sometimes if the owner is not too busy elsewhere he will take the animal a bucket of water at midday and move her to another spot. If he is too far away the poor cow goes hungry and without water.

The outcome of this primitive way of keeping cows is such a low return in milk and beef that cattle rearing has not been a payable concern to the average small farmer. Among the big farmers also, there is much to be desired. Tethering is not practised, but pastures on which several cows are allowed to roam are so badly kept that not much grass is available after a while.

Slow Growth

Animals on such pastures do not show any clear sign of hunger but grow and fatten too slowly for economic returns. If only farmers knew what could be done with a more sensible approach to grasses and grazing, it is felt that a great change for the better would come over our livestock industry.

Many progressive medium-sized farmers have been planting grass of late, and, among the large penkeepers, some are growing grass with the care and attention usually reserved for sugar and bananas. Their success can be gauged by the many prizes won at the Denbigh and Frome Shows.

Subdivisions

Where there is a great deal to be done is in the subdivision of pastures, something which is an absolute necessity in good pasture management.

We present here a series of pictures taken at Grove Place Experimental Station. These pictures illustrate what is being recommended. What the Government is trying to do is to develop a system of pasture management for the three- to five-acre farmer so that he can carry three fully grown animals on two acres of land, not forgetting the calves, which most small farmers sell when quite young.

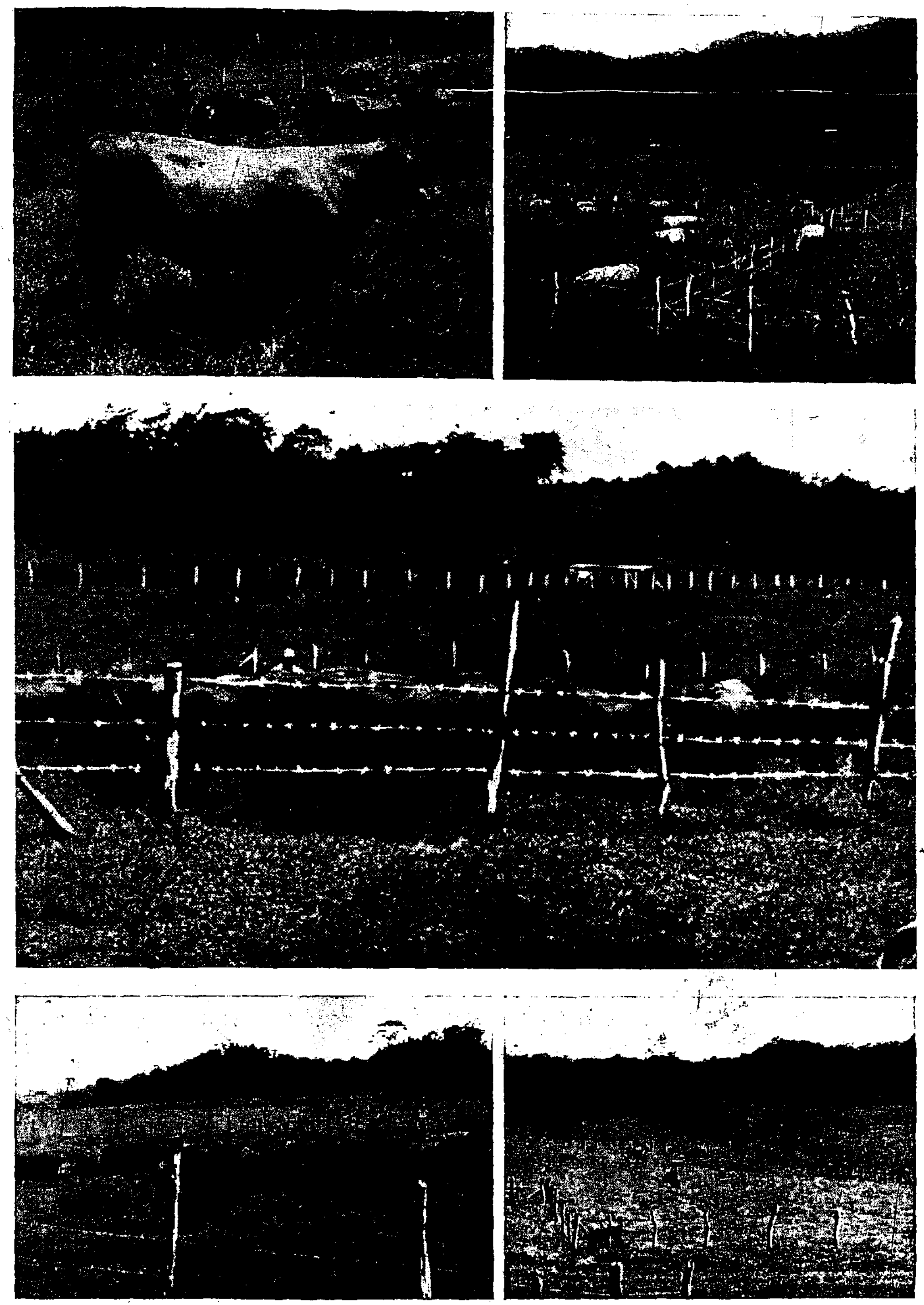


Fig. 1. Use of paddocks for rotational grazing

Above left Jamaica Red Steer, fed on fertilized Pangola, weighing 1,050 lbs. at 22 months.
Above right Dairy cows in smaller sized paddocks of Napier Grass at Grove Place.
Centre Coastal Bermuda, a newcomer to the varieties of grasses at Grove Place, carrying twenty steers on ten acres.
Below left Fertilized Pangola, carrying twenty-four head on ten acres.
Below right Subdivided Pangola pastures at Grove Place, showing steers feeding in paddocks.

Grove Place Methods

The method can be followed in detail by any small or big farmer. The results will mean financial success with either milk or beef, completely changing the current situation of low milk yields and shortage of beef for domestic supplies.

One of the old time pastures containing forty acres was selected. This pasture, which had its fair share of stones, sloping lands and level, was divided into four plots of ten acres each, ploughed, harrowed and planted out with Pangola (20 acres), Coastal Bermuda (10 acres) and Crab grass (10 acres). Of the twenty acres of Pangola half was fertilized and the other ten acres went unfertilized.

There was a further subdivision of the ten-acre lots into equal plots of one acre, making forty paddocks for grazing.

Enter Coastal Bermuda

At the start of the experiment only one steer was carried to the acre, but these were found to be unable to eat all the grass in the Pangola and Coastal Bermuda plots. By gradual stocking ~~and careful~~ checking of the weights of animals each week, it was found that the ten acres ~~of fertilized~~ Pangola could carry 24 head, the unfertilized Pangola 20 head and the Coastal Bermuda 20.

A regular system of rotational grazing is followed, each plot being fed for five days before moving the steers on to another. By the time the cycle is completed, each plot gets rested for roughly six weeks, long enough for the grass to recover and put on a new bloom of lush blades.

Steady Gains

The efficiency of this system is clearly seen in the weight gained by each animal. On the fertilized Pangola plots the average daily gain is 1½ lbs. per steer or 36 lbs. all told. On the unfertilized plots the gain is 1·2 lbs. per steer or 24 lbs. all told each day.

Of the Crab grass—the grass which covers nearly all Manchester pastures as well as those in the other major cattle properties—even though planted side by side with the Pangola and Coastal Bermuda the growth is so poor by comparison that not more than eight head can be carried on the ten acres. And the daily gain? A mere 6 to 9 lbs. by all eight.

A further contrast was seen in the finish of the steers. While those on the Pangola and Coastal Bermuda easily qualified as prime animals there was not one among the eight on Crab grass that qualified. They were all paunchy, having to eat so great an amount of the low protein content grass for minimum body requirement. Another contrasting feature was the way the Pangola and Coastal Bermuda stood up well under drought conditions while the Crab grass was parched and brown after a few weeks of dry weather.

Fertilized Grass

On the fertilized Pangola plots steers reach 1,000 lbs. at 22 months old. These dress 60 per cent prime beef which means 600 lbs. at £9 per 100 lbs. or £54 per steer.

Of special interest to the small farmer is the demonstration at the Newell Pilot Area in the dry plains of St. Elizabeth. There the Government runs a ten-acre farm, planting the same crops the farmers grow, reserving two acres for dairying. These two acres are subdivided into eight quarter-acre plots and planted with Pangola and Guinea grass. When seen by a representative from the Central Information Service in the midst of a drought that had left most of St. Elizabeth parched dry, there was green grass sufficient to keep two dairy cows in milk without feeding them an ounce of concentrated food. The cows were each giving eight and ten quarts of milk per day and looked in the bloom of health.

As at Grove Place, each plot is fed for five days before changing over the animals to another plot. Fertilizer is applied at the rate of ¾ cwt. sulphate of ammonia and ¾ cwt. muriate of potash per acre laid on in March, May, August and November of each year. Once a year the plots are cut back ~~(mowed) to encourage new and more luxuriant~~ growth.

At Newell where the climate is dry nearly all year, the pastures are irrigated by overhead irrigation but at Grove Place and other areas of moderate rainfall excellent results are obtained with Pangola and Coastal Bermuda without irrigation.

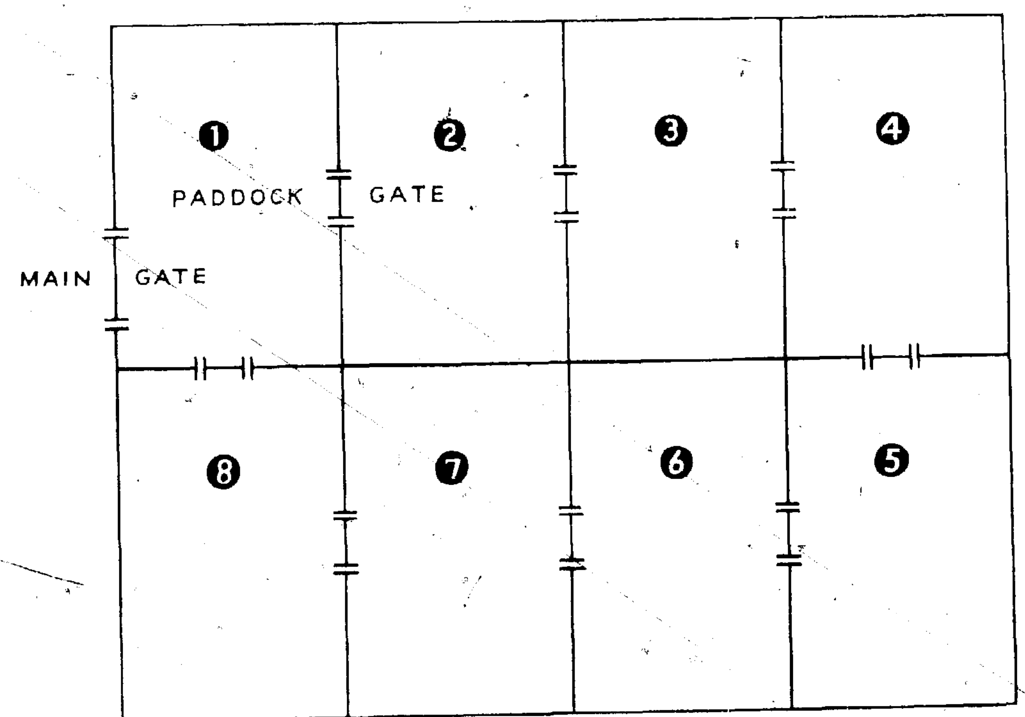


Fig. 2. Diagram of 2-acre plot, sub-divided in eight paddocks of ¼ acre each. Start feeding at No. 1 and move to next every five days.

Matter of Cost

In subdividing an even two-acre plot of say 5 chains by 4 chains into eight paddocks of ¼ acre each, the farmer will need eight rolls of barbed wire to give him a three-strand enclosure of the whole pasture and the subdivisions. He will need also 400 fence posts and 60 lbs. of staples at a cost as set out hereunder:

8 rolls barbed wire @ 70/- per roll	£28 0 0
400 fence posts @ 1/- each	20 0 0
60 lbs. staples @ 8d. per lb.	2 0 0
Total	£50 0 0

There need be only one substantial gate. As most farmers know, there is an economical way of making temporary gates with the same wire used for the subdivisions.

It is appreciated that carrying out such a system of subdivision for rotational grazing is costly in the first instance but the increased returns of milk and beef will pay off the expenses in a short while.

According to a dairy expert it is amazing what milch cows will do when properly fed. Small farmers' cows, giving three and four quarts of milk, with their owners have been taken in at Bodles Agricultural Station and when given the proper care and attention have given six and eight quarts.

Ample Repayment

It follows then that whether it be steer or milch cow the animal will more than repay the cost of providing better pastures, subdivided to ensure the right amount of grazing instead of the trampling of grass that is done when they are free to roam all over the pasture at the same time.

The farmer should not forget to provide a full supply of water at all times of the day and night. This can be done by cutting a 44-gallon drum across to make two water troughs. Drums can be bought cheaply at the local P.W.D. offices. For best results animals should be shaded from the sun. A simple and cheap shelter can be made with a few sticks and dry coconut limbs so constructed as to be easily moved from one paddock to the other.

Farmers, especially those in Development Areas where generous grants are made for pasture improvement, should take the opportunity of following this pattern as there can be no lasting success by sticking to the old way of raising cattle.

CHAPTER 16

Silage for Dairy Cows

The small dairy farmer who maintains five or six cows on four or five acres of fodder and pasture grass is usually faced with a serious decline in milk production during the period January to May. The decline in milk production is invariably the result of the seasonal scarcity of fresh, succulent, nutritious feed. In addition, the absence of good feed usually means that cows are obliged to eat dry, strawy, weedy grass which not only lacks nutritive value, but often causes digestive troubles, constipation, and difficult birth. All these troubles can be completely eliminated from the farm, easily and cheaply; good health and a high level of production can be maintained—by the use of silage.

Making a Silo

A spot should be selected near the dairy shed, if possible higher than the surrounding land and reasonably free from solid rock for easy excavation; if an elevated spot is not possible, then at least the selected post should be protected from flood water by diversion drains. When the pit has been excavated to the desired depth and diameter, the excavation should be lined with stones, and the latter should be bound and rendered at the surface with mortar to a smooth finish; the stone and mortar lining should be projected above the mouth to any desired height in order to provide for the desired capacity, but at least for two feet in order to protect the contents from flood water.

In order to decide on the capacity of a silo, the following formula may be used:

$$\frac{\text{Depth} \times \text{Radius} \times \text{Radius}}{20} = \text{tons.}$$

Estimated Quantities of Silage

It is important that it should be understood that it is not worth while to make a silo of less than four tons capacity, except under very special conditions; spoilage in silos of less than four tons capacity is often excessive. A cow of average size not provided with any other fodder will consume about 50 pounds of silage in 24 hours; on this basis a farmer knowing the number of cows to be provided for and the approximate length of the period during which silage is to be used, may estimate the quantity needed; for example:

20 cows	@ 50 lbs. per day for 90 days	90,000 lbs.
5 heifers	@ 30 lbs. per day for 90 days	13,500 lbs.
5 calves	@ 15 lbs. per day for 90 days	6,750 lbs.
		* 59 tons (long)

The bare requirements would be 59 tons of silage, and an allowance for wastage should be included, bringing the total to 65 tons in order to provide adequately for the herd described for 90 days. The following table may be used to estimate the dimensions of a silo required to provide 65 tons of silage.

Inside Diameter of Silo in feet	*No. of Short Tons of Silage*											
	Depth of Silage in feet											
	8	10	12	14	16	18	20	22	24	26	28	30
10	11	14	17	20	23	26	28	32	35	39	42	47
12	16	20	24	29	33	38	40	45	50	55	61	67
14	21	27	33	39	45	51	54	61	68	75	83	91
16	28	35	43	51	59	67	71	80	90	98		

Note. The first line of figures above refers to depth of silage in feet. The number of short tons is determined by the figures opposite the diameter dimensions. Thus 16 feet depth × 12 feet diameter yield 33 short tons of silage.

The Making of Silage

A silo of ten tons capacity or less should be filled in two operations, that is, on two separate days with two or three days between operations. Similarly, a larger silo should be filled in proportionate operations, though this recommendation is not as essential as in the case of the smaller size.

The material which may be used for silage varies considerably; corn, guinea corn, sugar cane leaves, uba cane leaves, napier grass, pangola, elephant grass, guinea grass, guatemala grass may be used singly or in mixtures; the important point to be borne in mind is that the material should be young, fresh and green. Uba and sugar cane should be cut before the stem is formed, guinea grass should be cut before flowering and seeding takes place; napier, guatemala, and elephant should be cut while the stems are still tender and green. If only fresh, leafy growth described above is used, there is no need for chaffing the material; as it is brought to the silo it should be scattered thinly over the entire surface of the silo, and should be constantly trampled to cause consolidation. Trampling close to the walls is especially important.

* A long ton weighs 240 lbs. more than a short ton.

Silage which is considerably more nutritious than grass silage may be produced by combining fresh young leguminous fodders with grass at the time of filling of the silo. Cow peas, edua peas, soya beans, Bengal beans, and St. Vincent plum fodders have been used with success at the level of 20–25% of the total bulk. Chaffing of this material is necessary, however.

The use of molasses is recommended in all silos, for increased palatability, increased nutritive value, and in the case of young grasses, or silage with leguminous mixtures, as an aid to the essential fermentation. Molasses should be used at the rate of 20 pounds to every ton of grass material, as follows: if the material is wet with rain or dew, add two parts of water to one of molasses before application; if the material is dry, add four parts of water to one of molasses. As each layer of material, a few inches thick, is laid down, sprinkle on the molasses-water mixture, unless a blower with a continuous molasses sprayer attached is used. In leguminous mixtures, 25% more molasses should be used.

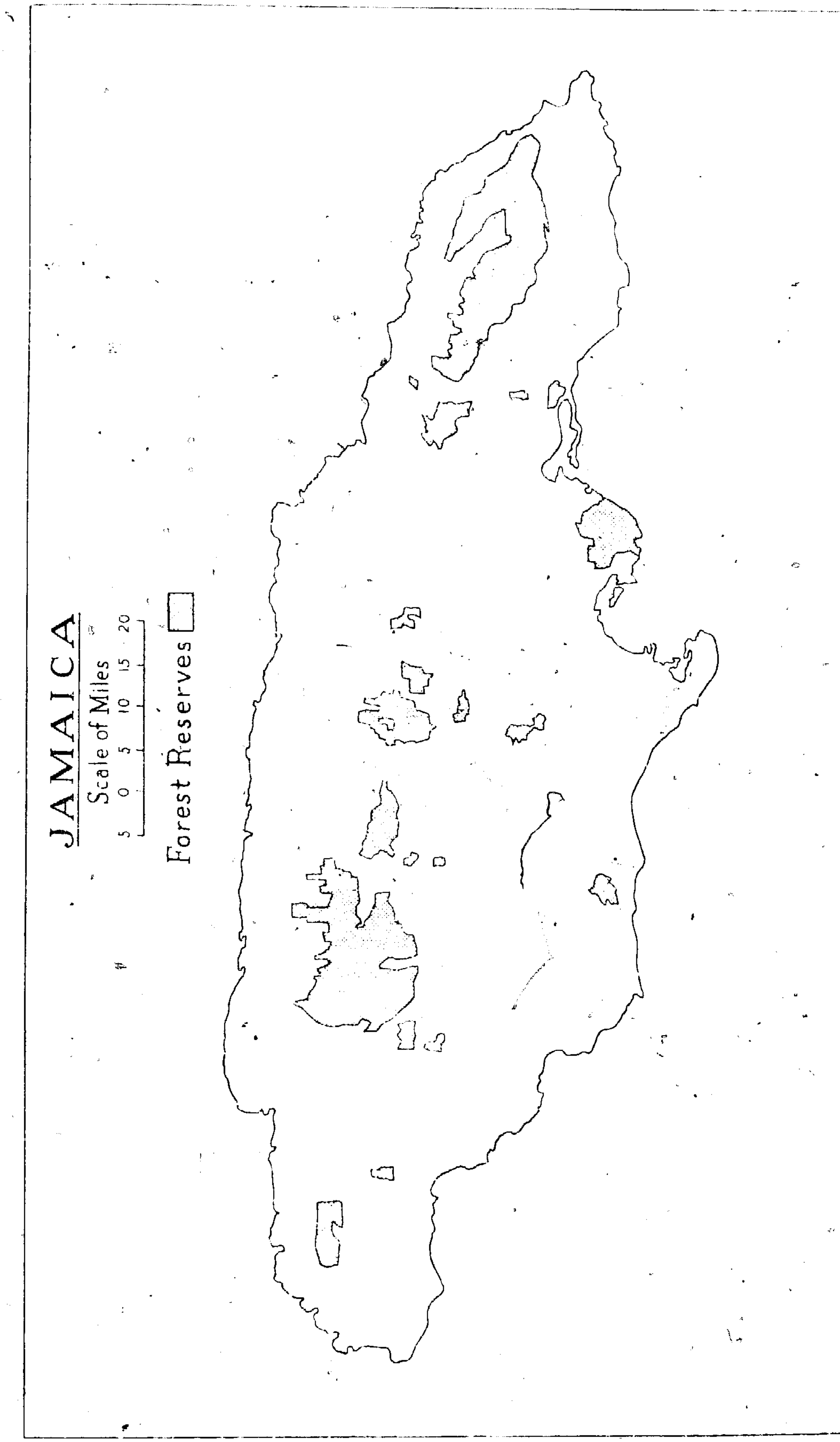
When it is not possible to obtain young, fresh material, and older material must be used, then chaffing is essential. Once chaffing has taken place, the remaining operations are similar to those described above, with the exception that only 12 pounds of molasses need be used per ton of grass material plus 35% more if legumes are included.

After a silo has been filled level with the top and has been thoroughly trampled, the silage will settle gradually over a period of several days, bringing the need for refilling once or perhaps twice to compensate for shrinkage. After the final refill a thick layer of dried grass should be laid over the silage and trampled down; finally, a few heavy logs laid over the dried layer will assist consolidation. A pointed conical roof should now be erected over the silo with eaves reaching down below the rim to shed rain water.

Feeding the Silage to Cows

Silage made in the spring of the year when grass is young and nutritious will keep perfectly until the winter drought period comes; then it is possible to supply the milch cows with feed every bit as nutritious and as palatable as fresh grass in the natural state. It is true that some cows do not take naturally and readily to silage, but they may be taught to consume it with relish.

As soon as it may become necessary to open a silo to feed cows, logs and the dried grass layer should be removed; it is commonly found that a layer of silage a few inches thick from the top downwards will have spoiled—turned black or slimy with white streaks of fungus here and there. This should be thrown away. The colour of the good silage exposed below may be green, yellow-green, or brownish-green, and it will have a strong pleasant smell; there will be no sliminess or streaks of fungus. The silage may be fed at will to cattle, care being taken only that each day's supply should be removed from the whole surface of the silage rather than from one spot; in this way an even surface will be maintained and no one section will be over-exposed to air. After each day's supply has been taken out, the surface of the silage should be covered with old bags to prevent drying out; if it should become necessary to interrupt the feeding of silage for more than a day or two, then the silage must be sealed off as it was when the silo was first filled.



CHAPTER 17

Forestry Practices

Forestry can be practised on a small or large scale according to the needs of the State or the individual. So far as the farmer is concerned, be he large or small, there must be some scope for growing trees.

On many holdings, both large and small, there are considerable areas of land which are at present completely unproductive, either because they are steep and rocky, or because of soil deterioration due to over-exploitation. Many of these sites are suitable for growing timber trees, eventually becoming valuable adjuncts to the property. Large properties contain areas of 'ruinate' which are capable of improvement.

Forestry has often been described as the 'handmaiden' of agriculture, particularly in tropical countries subject to alternating periods of heavy rainfall and prolonged drought, the implication being that Forestry is a real need and help to the successful practice of sound agriculture. In spite of modern science, wood is still an essential product for man's existence. The farmer who realizes this, and wishes to put his land to the best use, can produce trees for the following purposes:

(a) To provide timber and firewood for his ordinary domestic requirements. If he is a large farmer he can even enter the lumber trade thereby employing labour on Forestry during slack farming seasons.

(b) To protect the soil and prevent erosion.

(c) To act as wind-breaks and thereby protect his agricultural crops.

(i) Selection of sites

It is a well-known fact that throughout the world Forest Departments are allotted the poorest type of land, the popular idea being that where short rotation agricultural crops cannot be grown, those interested in Forestry can grow trees. Nothing is further from the truth.

While it is true that timber trees can often flourish on land unsuited to agricultural crops, it must be remembered that trees, like any other plants, demand their fair share of soil nutrients, water, etc.

It is hopeless to expect trees to grow satisfactorily on pure rock, on badly eroded soils, or on excessively acid or alkaline soils. To make the

growing of trees an economic proposition the sites must be carefully selected.

(ii) Selection of species

Having selected the site, some care is required in selecting the species of trees to grow on it. The selector must know something about the requirements for the trees:

(*a*) suitability to the locality. The site locality includes soil, climate, i.e. rainfall, temperature, humidity, also altitude and aspect;

(*b*) ease of establishment, e.g. can it be directly sown? successfully grown as bare-rooted transplants? or is it advisable to plant it as a potted plant?

(*c*) rapidity of growth, e.g. in a mixture, fast-growing trees can be reaped early, slow-growing later;

(*d*) economic value.

It is advisable to note which useful species are growing naturally in the locality.

(iii) Planting

(**a**) **Bare-rooted plants.** Holes not less than 12 inches deep and 8 inches diameter should be dug before the plants reach the site, and the plants should be puddled in mud and water while awaiting planting. The plants should be placed in the hole without distorting the roots and after the soil has been replaced and firmed the plants should be in a position similar to that before they are removed for planting i.e. the same portion of the plant should be above ground.

The surface of the filled in hole should be such that rain water will be carried off and not collect round the plant.

(**b**) **Potted plants.** Should be planted in a similar manner. If bamboo joints are used, then the joint must be split and half removed; if plastic bags are used the bottom must be torn off before planting. Bamboo baskets can be planted whole. Planting should be carried out during the first part of a rainy season.

Do not plant under the shade of other things.

(iv) Maintenance

Direct sowing. Certain large seeds can be directly sown e.g. Broadleaf, bullet wood, santa maria. It is best to sow several seeds in cleared patches. Subsequent, careful maintenance is required and after establishment one plant is left in the patch.

In a country like Jamaica, due to warmth, rainfall, humidity, the growth of weeds and bushes presents a problem in maintenance of plants which can only be solved by constant inspections and subsequent clearing of the plants until they are well established.

(v) Forestry and Health

A farm without some forest is a poor place without shade for man and his animals.

What is even more important is the value of Forest even Ruinate Forest—for the protection of water supplies and prevention of flood. Any farmer who has a spring or stream should not clear all the Forest from its watershed. By so doing he will be removing a valuable sponge which soaks up water releasing it in dry weather to keep the spring or stream flowing. He is making floods worse too. Farmers who share a spring or stream should work together to preserve the forest even if it is only ruinate on its watershed. The watershed of a spring is that part which slopes down to the spring (not only the spring itself). The more forest preserved the better the spring should be: overclearing of streams causes dirtying of the water from animals. Also never have a latrine pit within 300 feet of a stream and do not let the pit flood in heavy rain into the stream or illness will follow as the water is sure to be fouled by the overflow from the latrine.

(vi) Forest Department Organisation

The Forest Department has a Headquarters' establishment in Kingston and Divisional offices at Moneague and Wait-a-Bit, Subdivisional offices at Port Antonio, Teak Pen (Clarendon) and Elderslie.

Staff offers advice on suitability of site and choice of species.

The Department collects seed and maintains nurseries, the chief of which is at Twickenham Park.

Tree Planting Notes

Species. It is assumed in these notes that the purpose of tree planting is the production of timber or other forest products such as firewood, yam-sticks etc. The following indicate the principal species recommended and notes on them:

Mahoe. Elevation, sea-level to 4,000 feet: rainfall 60 inches and up: should not be planted in excessively exposed situations. Undoubtedly the most generally promising species for the damper areas of Jamaica.

Cedar. Sea-level to 3,500 feet: grown under wide range of soil and rainfall conditions: apparently clayey soils in wet districts should be avoided.

Highly susceptible to shoot borer, a larva which tunnels down the leading shoot, causing loss of height growth and excessive branching. Should not be planted in pure stands but in mixture with other species. Wherever possible should be grown with light overhead shade.

Mahogany. Sea-level to 2,000 feet: not suitable for high rainfall areas,

unless on very free-draining limestone: will grow well with rainfall as low as 35 inches.

Teak. Lowland areas to 1,500 feet: fairly deep soil and freedom from waterlogging necessary: most favourable rainfall is between 60 inches and 125 inches, but may be planted with rainfall as low as 40 inches or as high as 175 inches.

Podo (Cape Yacca). This species is a native of South Africa and produces a light pine-type timber suitable for general constructional work. Grown under wide range of conditions (i.e. down to sea level), but shows best growth at elevations over 3,000 feet.

Fiddlewood. Suitable for dry areas and for all limestone areas irrespective of rainfall. Sea-level to 2,000 feet.

Santa Maria. While the timber of this tree is not popular, it is a useful species for covering up degraded hillsides with rainfall of 60 inches and over at altitudes below 3,000 feet.

Silky Oak (Grevillea). A quick growing tree, with ornamental though somewhat soft timber suitable for furniture and interior constructional work. Grows best at elevations over 2,000 feet.

Yokewood (Mastwood). Suitable for the lowlands under 1,500 feet, particularly in dry or rocky areas.

The following species are quickgrowing and suitable for firewood:

Cassia siamea. A first class tree for firewood production, suitable for all lowland areas (probably not much above 1,000 feet). Vigorous coppicer.

Rose Apple. Suitable for degraded soils under high rainfall conditions, altitude 1,500 feet to 3,000 feet. Initial growth relatively slow but a vigorous coppicer.

Acacia spp. (Australian Wattle). Suitable for high elevations from 3,000 feet up.

Seed Collection and Nurseries. Wherever possible seed should be collected from healthy trees growing in the same district in which it is desired to plant. The following general rules should be observed:

(*a*) Collect from mature, healthy trees with good stem form.

(*b*) Collect seed when it is fully ripe.

(*c*) Do not store seed—sow as soon as possible after collection. Nurseries should be formed on level well-drained, fertile land: if the ground is sloping, beds should be prepared on the contour. Beds should be flat, 4 feet wide, with a drain 2 inches to 3 inches deep and 1 foot wide between each bed. The soil should be worked to a fine tilth to a depth of 9 inches: weeds should be pulled out before they become large.

Mahoe. Seed crop very variable, but mainly March to June in the eastern parishes: seed may, however, be produced at other times. 1,500–

1,600 seed to the ounce, 10 ounces to the quart. Collect off trees when capsules begin to open and turn brown; spread in the sun and shake out seed from capsules. Soak seed for 24 hours and sow fairly thickly in nursery bed, cover ½ inch: germination approximately 30% variable. After germination when plants 3 inches to 4 inches high transplant to 6 inches apart and water. Trees are ready for planting out when 2 feet to 3 feet high: strip off all leaves except terminal pair before planting.

Cedar. Seed crop extremely variable, and seed may be procured in some districts almost throughout the year. Approximately 3,000 seed per ounce, 16,000 seed per quart. Collect as for Mahoe. Germination rapid; up to 90% if seed fresh, but viability quickly falls off and all seed should be sown within two weeks of collection. Sow thinly, cover ½ inch and if necessary thin out to 6 inch distance in nursery beds. Transplant at 2 feet to 3 feet high after stripping leaves.

Mahogany. Seed crop March to April. Collect as for Cedar. Approximately 400–600 seed per quart. Germination good, 85% in 1–3 weeks: seed must be sown within one month of collection. Seed should be sown in rows 6 inches apart, 3 inches between seeds in the rows covered approximately 1 inch. Transplant at 18 inches to 30 inches after stripping leaves.

Teak. Seed crop January to March: beat off trees when fruit turning brown; 250–300 seed per quart. Seed will store for a year or so. Germination very slow up to 6 months, sometimes longer, improved slightly by soaking in water for two days before sowing. Sow in rows 9 inches apart, seeds 4 inches to 6 inches apart in the rows and cover. Transplant as 'stump' plants: dig up plants when stem approximately thickness of forefinger prune back the stem to 2 inches from ground level and trim the root to 9 inches. Then plant out.

Podo. Seed crop May to June: ripe seed is picked off the ground and dried in the sun for a few days. Approximately 400 seed per quart. Germination is very slow and may take 3–6 months. Sow 6 inches apart, cover 1 inch and transplant with full foliage when 12 inches to 24 inches high. Initial growth in nursery is slow and may take 18 months before ready to transplant.

Fiddlewood. Seed crop January to June: ripe seed picked off tree. Approximately 30,000–40,000 seed per quart. Germination low. Sow thinly and cover lightly: pick out to 6 inches apart. When plant 2 feet to 3 feet high, take out from beds, cut back to 1 foot and plant.

Santa Maria. Seed crop variable: ripe seed picked off ground: 150 seed per quart. Seed may be stored when dried up to 4 months. Germination to 80% in 4 to 7 weeks. Should not be sown in nurseries but direct in the field.

Silky Oak. Little information is available concerning this tree: con-

siderable difficulties have been experienced in collecting seed and every opportunity should be taken to secure supplies.

Yokewood. Seed crop variable: collect off tree as pods beginning to split and the silky floss begins to show. Dry and shake in sack to separate seed from pod. Sow thinly and transplant to 6 inches. Plant at 2 feet to 3 feet.

Cassia siamea. Seed throughout the year: 17,000 seed per lb.: 23,000 seed per quart. Seed can be stored a long time, but should be soaked for three days in cold water before sowing. Germination good within a few days. Sow in lines 1 foot apart—approximately 3 inches between seeds: thin out to 9 inches apart in the lines. Leave in bed till stem up to ½ inch diameter, then stump as for teak and plant out. Alternatively seed may be sown direct in the field.

Rose Apple. Should not be sown in nurseries but sown direct in the field.

Acacia. Seed imported: locally grown trees should soon be producing seed. Seed 24,000–32,000 per lb. Seed must be immersed in boiling water and left in the water till cold; then dry and sow. This species should not be sown in nurseries as it will not transplant: should either be sown at stake or in baskets.

Planting

When nursery plants are ready for putting out in the field, the soil round them should be thoroughly loosened with a fork, and the plants should be removed with the minimum amount of damage to the roots. Every precaution must be taken to prevent the roots drying out and they should be wrapped in wet moss or canvas: they should be taken to the planting site without delay.

In general, young timber trees should be planted out at 10 feet × 10 feet, but Teak and **Cassia siamea** may be planted closer.

In the case of direct sowing in the field, a spot 2 feet across should be hoed and 2–3 seeds sown approximately 9 inches apart. Thin out to one stem later.

CHAPTER 18

Plant Propagation

Budding, Grafting, Layering and Division

Though the majority of plants are increased by seeds or cuttings; budding, grafting, layering and division are of considerable importance.

Budding

Budding is widely practised in nurseries for the propagation of many plants such as roses, and for most fruit trees, as well as their ornamental counterparts. Though most of these can be struck from cuttings, better results are usually obtained when they are budded on stocks selected for the particular purpose and considerable research has been done along these lines. In some cases the stock is chosen for its resistance to a root fungus or insect pest, in others for its dwarfing effect or to increase vigour, but generally it is selected for its ability to produce healthy, well rooted plants.

Botanical relationship between stock and scion is important (unrelated species will not unite successfully) but this alone is not always a safe guide to compatibility, but in general, stocks and scions of the same species and even of the same genus may be expected to unite.

Usually stocks are raised from seed or cuttings and with the latter all but the top two or three eyes are removed to prevent suckers from below the bud being a source of trouble in after years. For the same reason seedlings should be budded below the point where the seed-leaves grow. The usual time for budding is from late spring to early autumn, the governing factors being a condition of active growth in the stock and a supply of mature budding wood.

Unless the stock is growing well, with a good flow of sap, the bark will not separate freely from the wood and in dry weather it may be necessary to water for a week or two before commencing operations, to ensure this condition.

Special budding knives may be purchased. Some have a flat tapered handle which is used for opening the bark, while others have a projection on the back of the blade for the same purpose. Whichever type of knife is used it is essential to keep it very sharp.

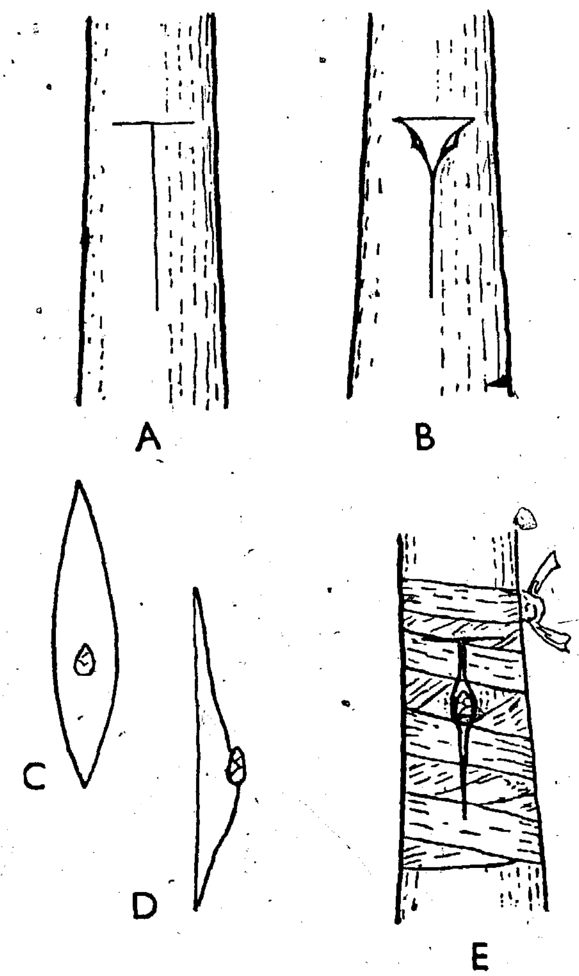


Fig. 1

While there are many types of budding, mostly designed to meet the peculiarities of a particular plant, the type in general use is shield or T budding, so called from the elongated shield shape of the prepared bud or the T-shaped cut made in the stock to receive the bud. The cut is made by drawing the point of the knife up the stem for one to one-and-a-half inches, according to the thickness of the stock, and then running the blade across the top of the cut about a third of the way round the stem. These cuts are made only to the depth of the bark. (A)

The budding wood should be fully developed and the immature top of the shoot discarded. To prepare the bud, cut into the stem about half-an-inch below the eye and then cut upwards along the stem—just deep enough to take a very thin strip of wood with the bark—and finish the cut an inch or so above the eye. (C—D)

Usually the wood adhering to the bark is removed by inserting the point of the knife between the wood and the bark at the bottom of the cut, usually indicate the best method to use for a particular plant. Select vigorous, well rooted pieces and plant direct in their flowering quarters.

Bulbs increase by division offsets, and also, in such plants as gladiolus, by bulbils. Divisions and offsets may not be separable the first year and should be left intact until they can be broken apart without injuring the basal disc from which the roots grow. Bulbils should be planted much closer together than mature bulbs and allowed to grow another year before treating them as flowering bulbs.

Air Layering. Air layering or marcotting is an improvement on the conventional method of inarching. It holds promise of quick and cheap propagation.

In this method a shoot about $\frac{1}{4}$–$\frac{1}{2}$ inch thick is taken and a ring of bark $1\frac{1}{2}$–2 inches broad is removed from all round the shoot at a place about 1–$1\frac{1}{2}$ feet below the growing point. The ringed portion of the shoot is wrapped in wet moss and covered with several folds of a plastic wrap. Plastic wraps like Alkathene, permit exchange of gases without letting moisture escape, and thus obviate the necessity of watering the gootee. Singh (1954) has tried the application of various concentrations of a naphthaleneacetic acid (NAA) and B indoleacetic acid (IAA), to the upper edge of the bark before wrapping up the gootee. The results are encouraging. Up to 37 per cent rooting has been obtained with 1 per cent NAA.

Inarching. The following is an easy way of grafting. Stock of about a year old is dug from nursery beds. Balls of earth are kept attached to the roots. Water is sprinkled over these balls, gently, so that they do not become loose. After a day or two the balls will be hard enough to be handled. The surplus roots are then removed from the roots, leaving only the earth containing the main roots. This is covered by fibre, moss, or soft hay and tied with cotton string or raffia. The treated balls are dipped in water for about half a minute and stored close together, upright, for about 8 days. If any become dry, dip in water again. Alkathene or similar film is then cut in pieces about 8 × 12 inches and made into bags, lengthwise, and the moist balls with the seedlings put into these, more moss or hay being added in the bags to cover the balls snugly. The open mouth of the bag is then closed with string. Another band of string is tied round the middle of the bag, with ends long enough to tie to the intended mother branch. Take every precaution that air, sun rays, or water cannot enter the bags. Now hang on the mother tree, close to a suitable branch for inarching, and unite and tie in the usual manner. Union should be perfected in 6 weeks. Then detach the grafts gently, in another 4 weeks. After detaching from the mother tree, the grafts are planted in pots or baskets, or in the ground and kept cool and shaded.

PART TWO

(1) MAJOR FIELD CROPS

CHAPTER 19

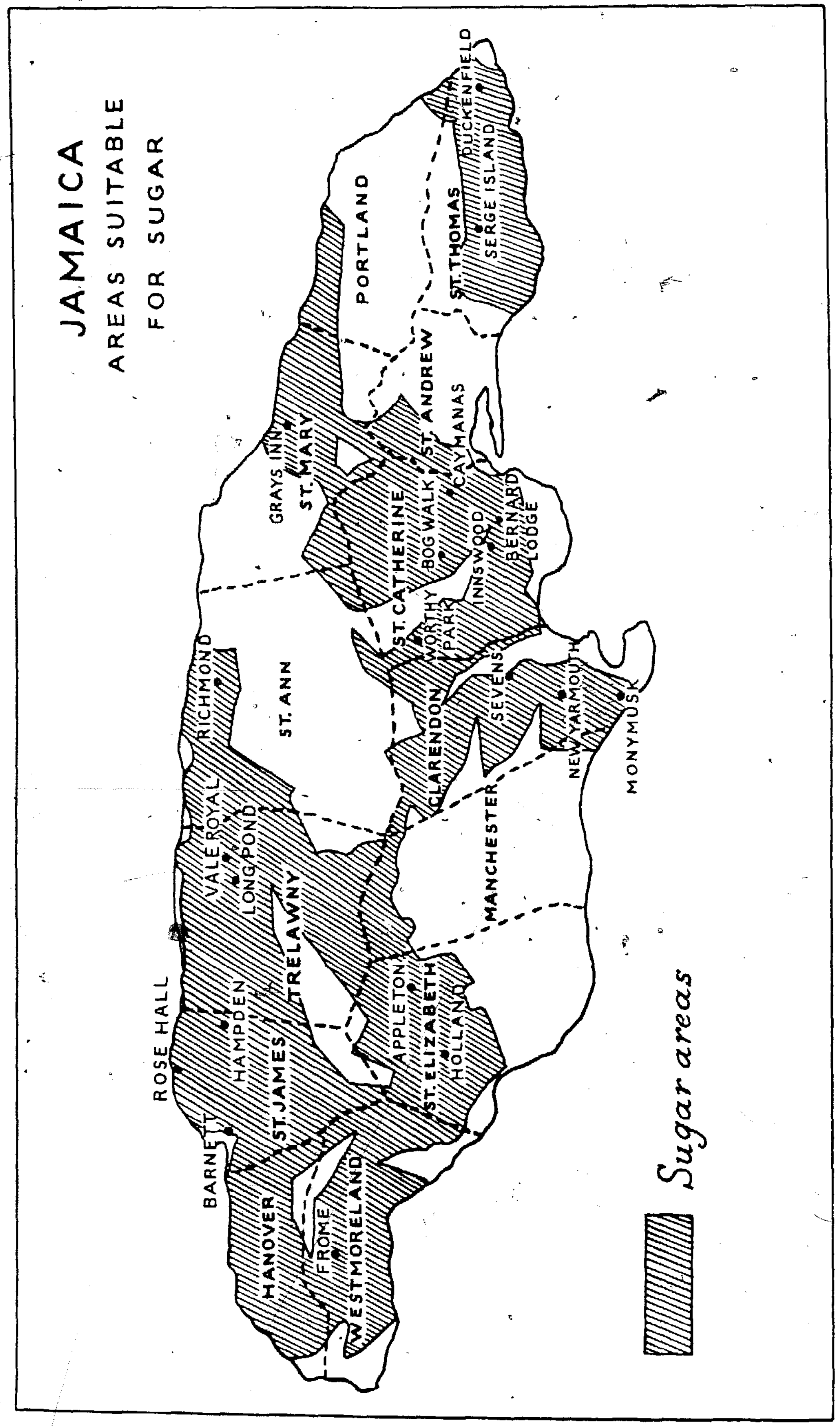
Sugar Cane

The actual date of the introduction of sugar cane into the West Indies is uncertain but there are indications that it was known not many years after the landing of Columbus. The plant had been introduced into Spain by the Moors and the favourable soil and climate made the spread of cane cultivation easy.

By the time of the British occupation of Jamaica, a small industry had been established. The industry attained its peak (making allowances for the primitive methods of cultivation existing then and the much lower sucrose content of those early varieties) in 1805 when 99,000 tons of sugar were recorded. This activity in the industry was due to the high prices realized for sugar during the Napoleonic wars, these ranging from £50 to £60 a ton, an extraordinary price when purchasing value of the pound at that time is borne in mind.

Since that time sugar has played a predominant role in the history of Jamaica, although the Island's economic base has more lately been broadened and diversified.

During crop some 80,000 to 90,000 persons are engaged in the fields and factories and sugar, with its accessories rum and molasses, account for between 25% and 30% of the total value of domestic exports. This total is produced by twenty operating factories milling between 62% and 61% of the total tonnage of canes from their own fields, the remainder representing purchases of canes from independent cane farmers numbering in all about 20,000 and ranging from large companies to small peasant holdings. The two largest sugar estates are Frome and Monymusk owned by West Indies Sugar Co. Ltd., together producing in 1959 135,108 tons of sugar, 35% of the total output.



INTRODUCTION

Sugar cane is grown in a wide variety of soil and climatic conditions in Jamaica. The soils vary in texture from heavy clays through medium loams to very sandy soils. Climate varies from heavy rainfall areas in the extreme eastern and western belts to the dry St. Catherine and Clarendon regions of the south, and St. James and Trelawny in the north. Cultivation practices are adapted to the different conditions prevailing.

(i) Land Preparation

Under the majority of existing conditions harrowing is the first operation carried out. This is effected by 3 to 5 tons Rome harrows drawn by crawler tractors. In cases where trash is burnt, only two passes are made, and where trash is not burnt the average number of passes is between four and five. The main purposes of harrowing are to break up and turn over old stools, and incorporate the trash in the soil. On very light, sandy soils this is the only cultivation operation necessary. In other cases, knifing or ripping follows, to a depth of about 18 inches by a Killefer or similar knifer or a road ripper drawn by a heavy crawler tractor. Two cuts are generally made, one in the direction of the rows and the other at right angles to this. This operation shatters structureless clay subsoils if sufficiently dry thereby giving them a temporary structure, it enhances soil aeration generally and incorporates a small proportion of the humic rich topsoil in lower strata.

(ii) Land Forms

After final harrowing, the next set of operations depends on the form of the soil surface on which the cane is to be planted. There are three main types:

(*a*) Flat
(*b*) Bank and furrow
(*c*) Cambered bed.

(*a*) Flat planting is a feature of the dry, unirrigated areas of St. James and Trelawny. Shallow furrows are drawn across the field at 4-foot intervals, and the cane setts planted at the bottom of these furrows. The furrows are filled in by one or two earthing up operations, so that the final form of the land is level. The first earthing-up operation is done about 6 weeks after planting, and the second about 6 weeks thereafter. These earthing up operations effect weeding as well.

(*b*) Where the bank and furrow system is employed, the cane is planted either at the bottom of the furrow and moulded up in successive operations so that the cane plant ends up on top of the bank, or the setts are planted in well defined banks. The height of the banks varies from 10 to 15 inches, and the width of banks from 4 feet 9 inches to 6 feet.

(*c*) Cambered beds are made either mechanically or by hand. Drains are placed at 20 to 24 feet apart and the spoil from the drains thrown towards the centre of the beds, so that eventually a turtle-back shaped bed is formed. Under this system, cane is planted either at right angles to the direction of the drain, and exclusively by hand, or parallel to them. Planting parallel with the drains has become more popular recently, as this permits the use of mechanical equipment for the initial furrowing and subsequent inter-row cultivation. When mechanically formed, the shape of the bed is imparted by using mechanical earth graders or Cuthbertson (or similar) heavy ditchers, or both.

As profit margins become narrower, mechanization of cultivation operations will have to be implemented to a greater degree. The form in which the land is shaped for planting therefore becomes increasingly important. The final land form should be such as to allow of optimum usage of tractors. A bank and furrow system appears to be the most desirable, and it is strongly recommended, that wherever possible this should be adopted. The cane plant should end up finally on the bank and the height of the bank will be governed largely by soil texture and moisture conditions, heavy soils under adequate moisture conditions being put in high banks and light soils under dry unirrigated conditions on a very shallow bank.

(iii) Planting

During the harvesting period, planting material is obtained from the upper immature portions of the stalks; only one sett being taken, usually just above the millable section sent to the factory. Each sett consists of 2 or 3 buds. When planting is carried out in the later months of the year after harvest, seed pieces are cut from 6 to 7 months old vigorously growing cane, and the whole cane is divided into '3-eye' setts.

Cane tops are planted by hand at different angles in the ground, ranging from a horizontal position through various angles to a vertical position. Moisture conditions in the soil determine the angle at which the cane is planted, under wet conditions the tops being inclined more towards the horizontal, and when moisture is limited, a more nearly vertical position is adopted. Pick-axes or mattocks are used for making the holes into which the sett is placed, and the earth around each top is firmly pressed down by the planters' feet.

The number of tops needed to plant an acre varies according to the spacing of the inter-row chiefly, but to a less extent according to the variety also. Under Jamaican sugar estates' conditions between 5,000–10,000 tops are normally used. Selection of the planting material is generally

practised, tops which have damaged buds or are infested with the small moth borer or appear unthrifty being discarded.

Germination usually begins about a week after planting, and in another three weeks all viable buds should have germinated. Inspection of the newly planted fields is made about a month after planting and supplies are put in as quickly as possible wherever necessary. It is not essential to obtain 100 per cent germination in order to achieve optimum yields. Unless large gaps of say, over 2 feet 6 inches occur, there is no necessity to put in supplies.

It is not unlikely that mechanical planting will replace hand planting in the near future and already a few estates have been experimenting with this system. In general, the method consists of dropping the tops, which are piled in containers on a tractor or trailer, in furrows, or in shallow furrows cut in the tops of banks. The tops are covered by earthing up with two small discs mounted at the rear of the same tractor. If bank planting is practised, the banks should be consolidated by heavy rolling immediately after planting unless overhead irrigation is being applied.

The practice of planting cane on a shallow bank 6–8 inches high, and moulding up subsequently in two operations to about 15 inches high, has become more popular recently. The cane is planted in the centre of the banks, which are placed 5 feet 6 inches to 6 feet apart.

(iv) Weeding

Hand weeding by hoes is fast becoming obsolete in the sugar industry. In areas which rely on this method alone, four or five hand weedings are usually carried out in the plant crop before the cane covers over sufficiently to suppress further weed growth. The first hand weeding is carried out about 6 weeks after planting, and subsequently at approximately monthly intervals. For the ratoon crop, usually not more than two hand weedings are necessary.

With the introduction of chemicals for use in weed control, the whole picture has altered, and no doubt will continue to change until weeds are controlled nearly everywhere by chemical and/or mechanical means. A number of different materials have been prepared for this purpose, and may be broadly segregated into the two categories of pre-emergence and post-emergence usage. For pre-emergence work, and this means the stage before the emergence of weeds, the 2-4D compounds are the most popular and cheapest. When weeds have emerged, post-emergence, broad-leaf weeds may be sprayed with 2-4D compounds and grasses with PCP, Dichlorpropene, or CMU. The timing of herbicide application is of the utmost importance and for pre-emergence control, application should be made when the field is free of weeds and immediately after the cane has been planted. At the moment it is possible to control weeds by the means of two sprays and one hand weeding in the plant crop. The first spray is done shortly after planting, the hand weeding at about 8 weeks and the second spray just after the hand weeding.

Mechanical weeding is practised on some estates; this operation achieves two objectives, inter-row cultivation being the other. The implement generally used is two sets of discs on either side of the row, which cultivate and mould up the canes and cut up and uproot the weeds. Sometimes single mouldboard ploughs drawn by mules are used, but these are passing out of use.

(v) Nutrition

Nitrogen is required for optimum growth, and its requirement is largely a question of moisture conditions. Where rainfall is limiting and no irrigation available, as is the case in the drier St. James and Trelawny areas, 2 cwts. sulphate of ammonia per acre or its equivalent appears to be adequate. In the medium rainfall regions with no supplemental irrigation as in upper St. Catherine 3 to 4 cwts. sulphate of ammonia per acre or its equivalent is needed, and in the wet St. Thomas and Westmoreland belt and where irrigation is applied 4 to 5 cwts. sulphate of ammonia per acre or its equivalent is used. The fertilizer is applied to the plant crop when the cane is about six weeks old, and to the ratoon crops as soon after harvesting as possible. Hand application is practised, the material being placed in bands near the cane stools. In a few cases the manure is dropped in small holes dug near the cane stools, and covered with earth.

Phosphate deficiency occurs on about 10% of sugar estates cane lands, particularly on eroded slopes. There is little doubt however, that many cane farmers must suffer from phosphate shortage on the hillsides. Annually, dressings of between 2 and 3 cwts. single superphosphate are adequate, and have their greatest benefit when placed in the soil near to the root area.

Potash application is more general, and there is reason to believe that nearly all cane areas would benefit from this material. The method of application is similar to that for nitrogen, and the average level is about 1½ cwts. muriate of potash per acre, varying from ½ to 3 cwts. per acre. It is likely that potash dressings will be accompanied by an improvement in juice quality.

(vi) Inter-row Cultivation

As mentioned in the section under planting, a certain amount of inter-row cultivation is carried out. This is done for the purpose of earthing up the cane and effects a degree of weed control. In the irrigated lighter land areas, the setts are planted at the bottom of the furrows. In subsequent operations the banks are broken by a mouldboard plough and the cane moulded up, so that the plants end up on a bank.

Where ratoon cultivation is practised, the trash is rowed and placed either in alternate rows or in every 7th row. When the trash is put in alternate rows the trash-free inter-row is cultivated; the following year the process is repeated but in such a manner that the trash occupies the row cultivated the previous year. In the other system, six rows obtain the benefits of inter-row cultivation and the trash is redistributed over the rows after the cultivation has been carried out.

Under some irrigated conditions a form of ratoon cultivation is performed by subsoil knifers placed behind a large disc coulter. Apart from any cultural benefits, the operation recreates a channel for the easy passage of irrigation water. Under such conditions the knifer tines should be set so as not to cut too deeply.

Where cane is grown on Louisiana banks under natural rainfall conditions, 'off-barring' and 'on-barring' is sometimes practised. 'Off-barring' is effected by two single mouldboard preceded by disc coulters, straddling the cane row. The soil near the cane stool is thrown away from the stool on to the trash and after 6 to 8 weeks the banks are reformed. This operation is rarely used in Jamaica today.

(vii) Irrigation

About one-half of the total acreage under sugar estates' cane is fully irrigated. The largest portion of this area lies in the Clarendon and St. Catherine plains and in these regions, there are as well, many cane farmers who make full use of available irrigation water. This water is derived from two main sources:

(*a*) River and spring water
(*b*) Well water.

The largest supply of river and spring water is the Rio Cobre Irrigation Scheme. As its name implies, it is fed by the Rio Cobre, and waters large tracts of the St. Catherine lowlands.

During the past 30 years or so wells have been sunk for irrigation purposes. So successful are these wells that they form the most important source of irrigation water. Most of these wells penetrate deep into the limestone layers and provide good flows of salt-free water.

Surface irrigation is practised almost exclusively, but some estates have installed overhead irrigation systems. Water is carried from source chiefly by earth canals, and to a less extent in concrete canals or galvanized iron flumes. When carried by earth canals, a large quantity of water is lost by seepage.

The method in common use in surface irrigation is that in which water is led along a main irrigation canal at the head of the field and at right angles to the direction of the furrows. This water feeds into field-mains running parallel with the rows and spaced according to the slope of the land. These field mains feed 'twigs' (small canals) placed half chain apart and at right angles to the direction of the furrows, and the twigs in turn feed the furrows. A diagrammatic representation of the system is given below:

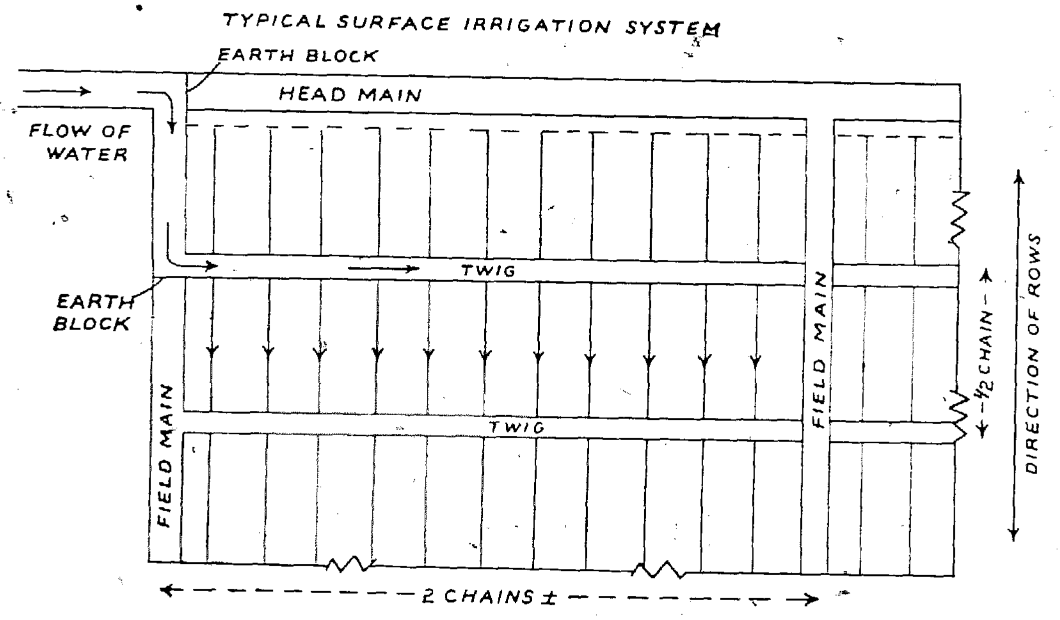


Fig. 1

Long line systems of surface irrigation have been tried on two sugar estates. The maximum length of line was 4½ chains, and in the plant crop proved to be successful, with no reduction in yield and better utilization of water. Irrigation of the ratoons in the long lines suffered from the uneven spread of the trash blanket, and slightly less cane was produced on plots irrigated in this manner compared with those irrigated from ½ chain twigs. It is possible that proper grading of land may help in permitting the use of long irrigation lines, and this is being investigated.

It is estimated that 2 cubic yards per hour per acre are required at the period of peak demand. Cycles vary according to soil texture and time of the year, and range from ten days under very light soil conditions to 28 days of heavy clays.

In certain areas where water supply is limiting, portable irrigation units have been installed. The rainers throw the water in a circle and are placed so that the circles overlap and all parts of the field are wet. The most opportune time to use this equipment is under still conditions of night or early morning. About one-third the amount of water used for surface irrigation is needed for comparable overhead usage.

(viii). Varieties

Sugar cane breeding dates from the discovery in 1887 that viable seeds were produced by the cane plant. In all major sugar producing territories the dominant varieties are the result of hybridization. For Jamaica the crossing of varieties is carried out in Barbados, and the fuzz (true seed) germinated here. At the moment about 40,000 seedlings, each representing a different variety, are produced annually, and are tested in successive stages to determine whether any are worthy of commercial extension. At the same time varieties selected under Barbados conditions, and those reaching commercial importance in other territories, are imported and tried under different conditions in Jamaica.

The variety picture is an everchanging one, as is demonstrated in Fig. 2. From a position of dominance in 1933, BH 10/12 gradually declined until in 1951 it occupied less than 1% of the acreage in estates' cane. This was largely due to its susceptibility to mosaic. Its place was taken by POJ 2878 and POJ 2727 initially and from 1944 by B34104 and B4362. The popularity of these last two named varieties increased rapidly and in 1951 B34104 was reaped from more than a half of estates' acreage and B3439 from nearly a quarter. In that same period B37161 and B37172 occupied most of the remaining area estates' cane, B37172 being particularly suited to the wet west coast. Mosaic once more played an important role in our variety policy, and B34104 which is very susceptible to this disease started to decline; B3439 was also attacked though not to the same extent. Three new varieties B41227, B42231, and B4362 appeared on the scene in 1952 and have dominated the variety picture since then. In 1959 they represented about 80% of the estates' area.

B41227: is an extremely vigorous variety which grows well on all soil types, and is an excellent ratooner. The variety matures late in crop, that is, from March onwards, and its juice quality is mediocre. It is better suited to spring planting.

B42231: has a propensity for arrowing in November and December and should be reaped at the start of crop. It gives good results as a fall plant and should perhaps be used exclusively as such. It ratoons well and gives excellent juice.

B4362: is more suited to well drained areas where its returns are very high. It has a tendency to rot if grown for long periods, and so should be used as a spring plant. It is a good ratooner and gives juice of very high quality.

Mention should be made of the Co-varieties, which are very vigorous, and have been the most successful canes under the poor soil conditions prevailing in certain Trelawny areas such as the Hampshire valley. The most popular are Co331, and Co421 which have high fibre and relatively low sucrose.

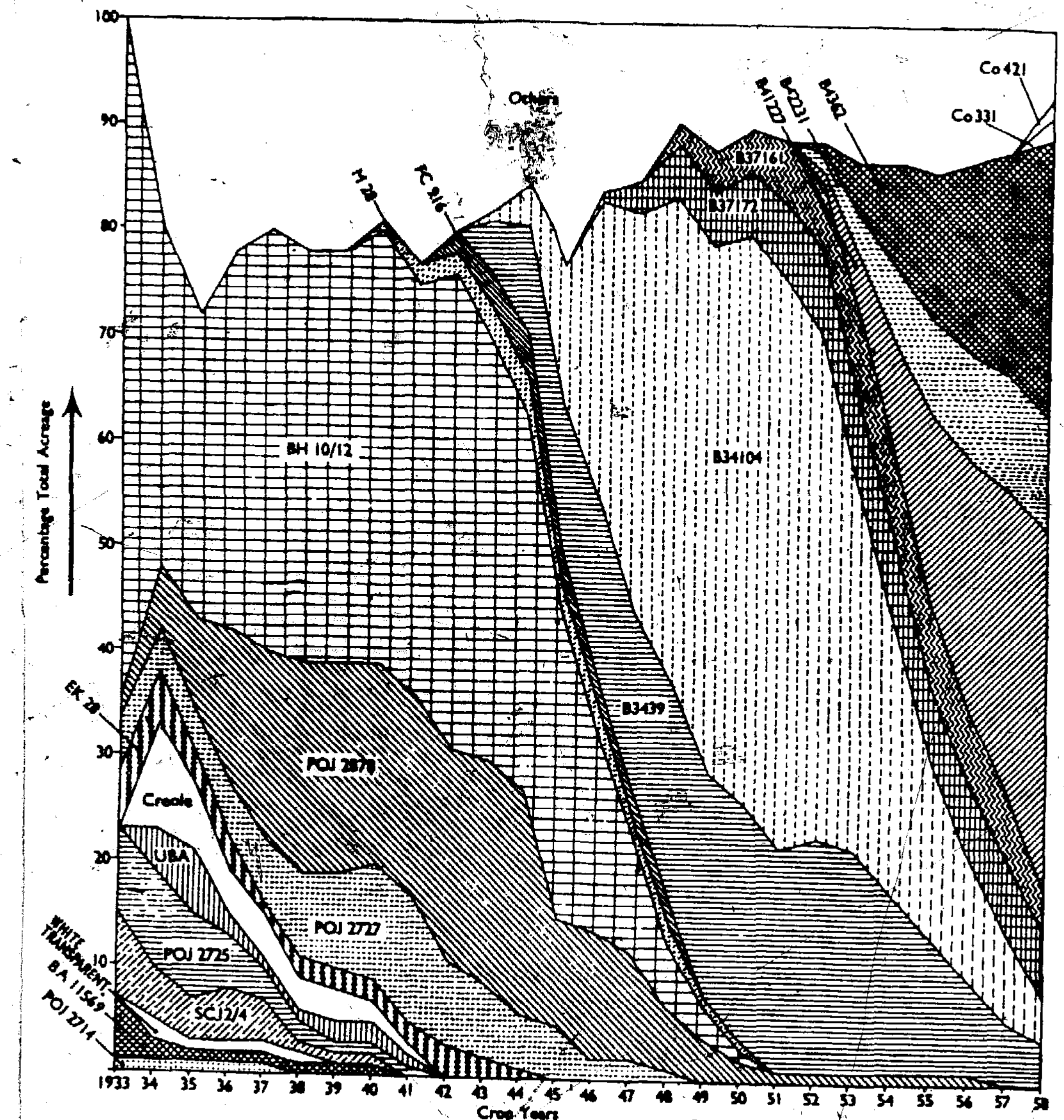


Fig. 2

(ix) Diseases and Pests

The Jamaican sugar industry is fortunate in the relatively small losses sustained from pests and diseases. The diseases of major economic importance, both virus diseases, are mosaic and chlorotic streak, but other diseases such as ratoon stunting (virus), eye spot (*Helminthosporium sacchari*), ring spot (*Leptosphaeria sacchari*), pokkah boeng (*Fusarium moniliforme*) and root rot (*Marasmius sacchari*) cause damage in isolated areas.

The small Moth Borer (*Diatraea saccharalis*) is the major pest in Jamaica, but is kept in control by its natural enemies. The West Indian Cane Fly (*Saccharosydne saccharivora*) has caused severe losses from time to time, and within recent years Caymanas and Monymusk and cane farmers in the Vere plains suffered appreciable losses from its ravages.

Mosaic. This disease occurs in all the sugar growing areas of Jamaica and has been responsible for considerable losses from time to time. In the early days it was customary to grow Uba or POJ varieties which were resistant to Mosaic in order to check the disease. BH 10/12 which was the outstanding variety up to the 40's was severely attacked, and had to be replaced largely by B34104 which was susceptible but apparently tolerant. Later on B34104 started to decline possibly due to Mosaic, and was replaced by B41227, B42231, and B4362, which have proved to be so far immune. One of the objects of variety selection is the elimination of this disease, and no variety showing extreme susceptibility is propagated.

Diseases

Chlorotic Streak. As in the case of Mosaic this disease is a virus. It occurs particularly in areas which are subject to flooding or are badly drained, and when the attack is severe, losses in yield are considerable. B4362 is highly susceptible to this disease and care should be taken in its extension to areas liable to be waterlogged. Chlorotic Streak affected tops should be heat treated at 52° C. for 20 minutes to prevent a recurrence in the succeeding plant crop, but this treatment often results in a decrease of viability of the buds, the ratoon crops may become re-infected by 'dirty' knives at harvest.

Ratoon Stunting. During the past five years it has definitely been established that ratoon stunting, another virus, is present in the island. As the name implies, the ratoon crops tend to be stunted, and the effect is particularly noticeable in canes growing under favourable conditions. The variety most seriously affected is Co421 in the Trelawny area. Heat treatment at 50° C. for two hours eliminates the disease, but impairs germination in most cases.

Leaf Spot Diseases. Eye spot, Brown stripe and Ring spot are caused by fungi and are of minor importance except in areas subject to heavy dews such as St. Mary and Trelawny, where potash deficiency is also common.

Other diseases occurring on sugar cane in Jamaica are hardly worth mentioning, but growers should always be on the alert and report any unusual conditions to the proper authorities.

Pests

Small Moth Borer. This pest is widespread in the cane growing areas, and when its incidence is high, severe losses are experienced. Losses may be sustained in the following ways:

(*a*) a heavy attack early in the life of the crop may result in 'dead hearts' on a large proportion of stalks.

(*b*) the destruction of inner tissues may cause a loss in weight of cane.

(*c*) The juice quality of cane may be impaired.

It is difficult to assess the damage due to 'dead hearts' but this is comparatively small under Jamaican conditions, and since overall joint infestation is about 4%, reduction in cane weight is not very serious. Perhaps the greatest loss incurred is a deterioration of juice quality, resulting from secondary organisms which gain entrance through borer tunnels. It has been estimated that, for Jamaica, percentage borer infestation and percentage loss in juice quality is related according to the equation

$$y = 0{\cdot}226x + 3{\cdot}73$$

where y = percentage loss in juice quality and x = percentage borer infestation.

As stated above this pest is kept under control by its natural enemies such as *Lixophaga*, and surveys carried out by the Government and the Sugar Research Department show that the intensity of joint infestation normally varies from 3 to 5%. Occasionally, higher figures are returned, but these occasions are rare. It has been established that certain areas such as Caymanas are more prone to attack than others, that fall plants generally have a higher infestation than spring plants or ratoons and that B37161 and B4362 are more likely to be attacked than other varieties grown on a commercial scale locally.

West Indian Cane Fly. Early this century it was recorded that there were outbreaks of this pest in the Vere area. Since then there have been sporadic outbreaks, but none reached economic importance until Caymanas was affected in 1953 to 1957. Vere suffered considerably in 1958, and effected control by spraying Malathion.

The pest which is a small green insect lays eggs on the underside of the leaves in white cottony masses. These hatch out into nymphs which go through several stages before emerging as adults. The adults suck the leaves and secrete a sugary substance which induces the formation of sooty mould. In severe attacks the mould covers the leaves and inhibit photosynthesis. The outbreaks of this pest are caused by imbalance of its enemies, probably as a result of small changes in micro climate. It is important to control outflares of the pest effectively and quickly by spraying with insecticides, e.g. Malathion. Where the cane is not tall this can be most effectively done by motor mist blowers. Once the cane is tall and covered in, aerial spraying should be resorted to.

Other pests. From time to time different areas have suffered damage caused by various other pests but none has given any real cause for alarm. Small losses have resulted from Aphis, fall army worm, shot-hole borer, jumping borer and rats, but these are of minor importance.

(x) Reaping

The present commercial varieties of cane in Jamaica mature at about 10–14 months of age depending on variety, cycle and time of year, and great advantage accrues to the farmers who harvest their canes at the optimum time. In this respect B42231 and B4362 are early ripening varieties whereas B41227 is best reaped during the middle of the crop. Ratoons tend to ripen at a younger age than plants.

Strict supervision of the actual cutting should be exercised. Canes should be cut as close to ground level as possible to prevent excessive rotting and fermentation of uncut portions, and thereby damage to the succeeding crop. Loss of cane and sugar will be suffered if stalks are cut some distance above ground level, and especially since the lower joints are usually the sweetest. On the other hand topping cane too high, that is, cutting too near the growing point, is equally undesirable, as this portion is relatively immature and affects the overall sucrose content adversely. This practice is highly uneconomic as it increases the cost of cutting, loading and transport, and the increase in cane weight is more than offset by the reduction in juice quality.

Cane should be sent to the factory in as clean a condition as practicable, with the minimum quantity of trash and dirt. Extraneous matter of any description only adds to the expense of reaping and transport, and reduces the value of the product by lowering the sucrose content.

A factor of prime importance is the time taken from cutting cane to the time it arrives at the factory. Indeed this single factor may mean all the difference between profit and loss. Studies carried out on the two major

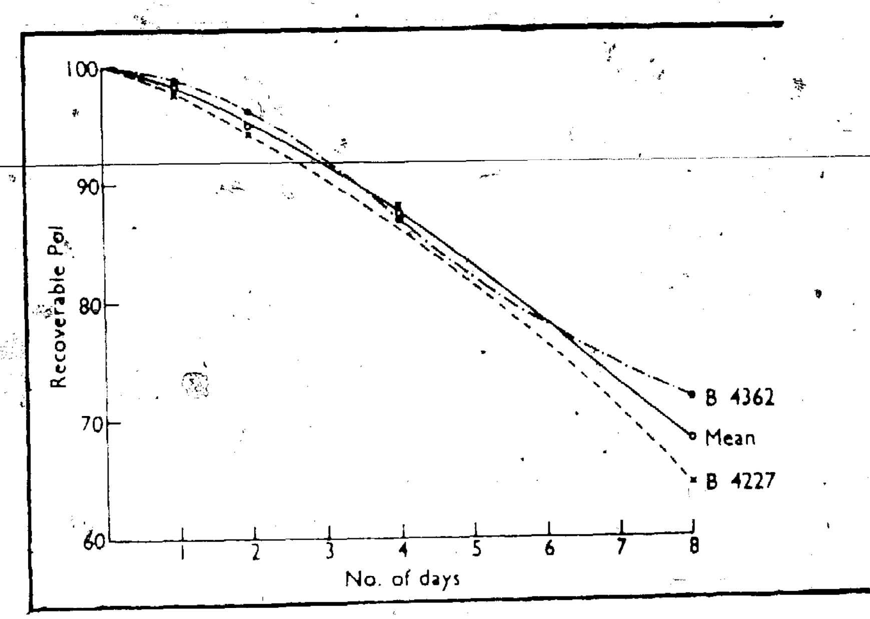


Fig. 3

varieties B41227 and B4362 showed that tremendous loss of sugar is incurred when cane is not sent in fresh to the factory. The loss increases with increasing staleness and accelerates alarmingly with progressive staleness, and is due to a reduction in cane weight from drying out and the deterioration of juice quality. Fig. 3 shows that the drop in recoverable sugar is about 2% after one day's staling, 5% after two days' staling, 12% after four days' and 30% after eight days'. It is obvious therefore that every precaution should be given to seeing that cane arrives at the factory shortly after cutting.

(xi) Conclusion

As in other crops, production costs have risen and continue to rise, and at the same time the price of the commodity is tending to fall. Profit margins have therefore become very narrow, and efficiency will have to be improved to meet this situation. In the sugar industry in recent years steps have been taken to improve efficiency, e.g. chemical weed control has largely replaced hand weeding, and other methods are being considered, one of which is, of course, increasing mechanization.

CHAPTER 20

Bananas

Economic Importance

Until comparatively recently the banana was the principal export crop of Jamaica, and had been so for many years. First place has now been taken by sugar, but the banana is still a healthy runner-up.

Indeed, during the heyday of the industry under the control of United Fruit Company the revenue and income of the Island depended almost entirely on the banana industry. That this was so is indicated by a look at the Export figures.

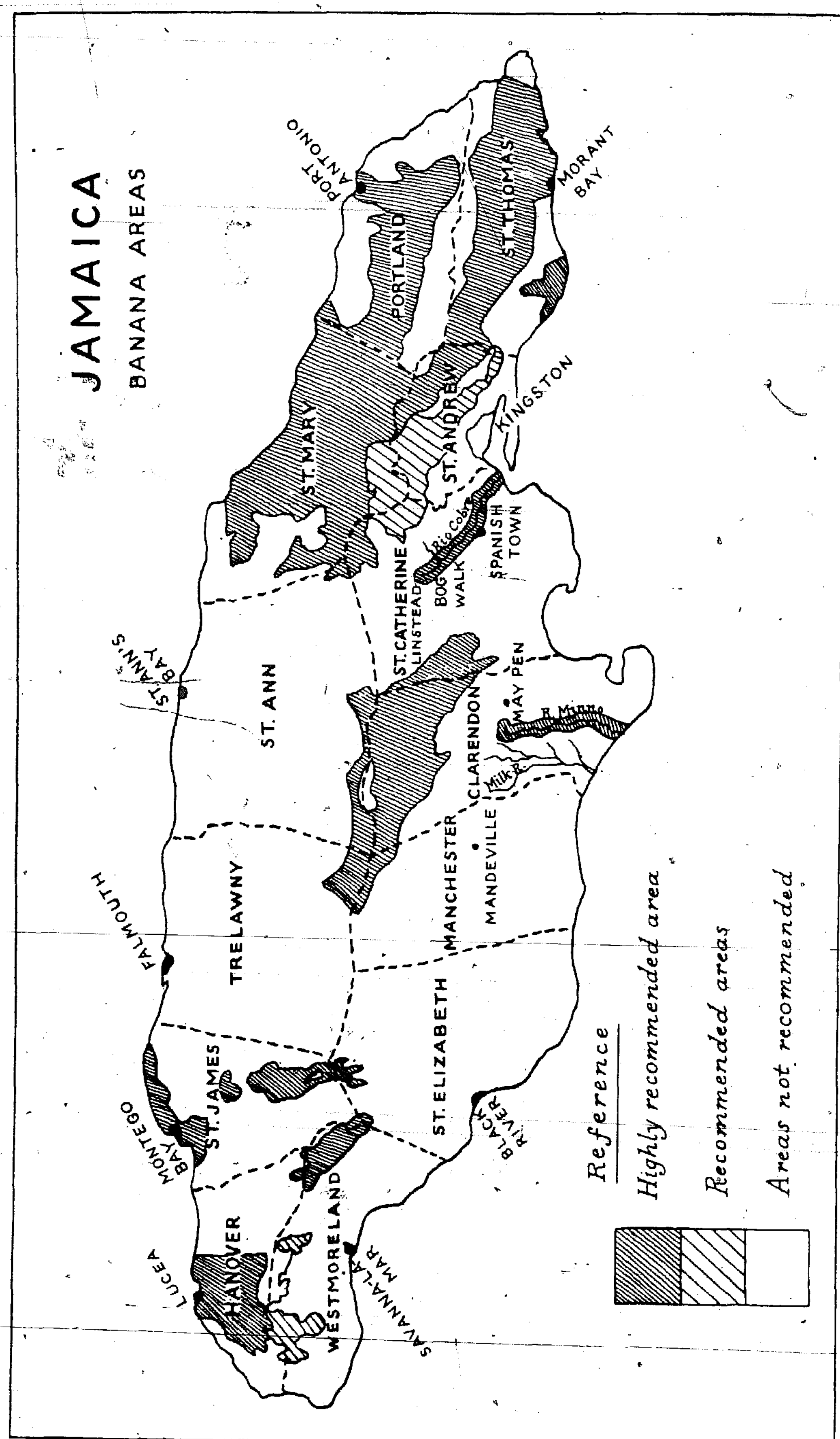
In 1937 the number of stems exported was 27 million—the highest on record. The past seven years' exports show:

	Stems	£
1960	10,175,000	4,614,000 £o.b.
1959	10,274,000	4,813,000
1958	9,918,000	4,749,000
1957	11,369,000	5,400,000
1956	11,216,000	6,086,000
1955	10,896,000	5,020,000
1954	11,637,000	5,231,000

The amount of the value of the 1958 shipments is an indication of the value of this commodity in the economy of the country, especially bearing in mind that 21 per cent of the crops was produced by small farmers owning around an average of 5 acres of land. One other aspect of the value of the banana, but of great importance, is the fact that practically all the fruit incapable of being exported, i.e., either rejects or bunches having less 'hands' than the requirements for export permit, is sold and used locally for food.

Identity and Early History

The name 'banana' embraces a large number of parthenocarpic clones belonging to the Genus Musa of the family Musaceae. Another well-known member of the same genus is Musa textilis, familiar as Abaca or Manilla Hemp. Some other members of the order Scitamineae (to which the family Musaceae belongs) are the Travellers' Palm, Ginger, and the Canna.



The name 'banana' properly includes the starchy cooking varieties widely known as plantains, although in local usage the name is often limited to varieties other than plantains. The word originated from the language of the Guinea Coast in West Africa. Among several tribes of this region, the fruit is known as 'banana', 'abana', 'funana' and 'benena'. In the vernacular of some parts of Latin America, the plant is called 'Guineo' signifying its origin from Guinea.

In India, at the time of the invasion by Alexander the Great (328–327 B.C.) the banana was known as 'Pala', a name which still persists in Malabar. In Tahiti it is known as 'Vudi' and as 'Pisang' in Malaya.

The plant is a giant herb of a very succulent nature with little development of woody fibres. It varies in height from about 5 to 20 feet, according to the variety and environment, and the leaves are expansive and undivided (frequently 10 feet in length by 2 feet in width), but are usually lacerated by the wind. It multiplies vegetatively at a prolific rate by means of rhizomes which give rise to new aerial stems. Each aerial stem bears a single bunch of bananas. The aerial portion is not strictly a stem, but a pseudostem composed of compressed leaf stalks. In commercial practice only one aerial 'stem' is usually allowed to mature at a time for each plant or 'root'. The bunch usually consists of six to twelve 'hands' which bear about a dozen individual fruits each.

How the Banana reached the New World

The Arabs transported the banana and other plants across Africa to the Sudan and Morocco in the course of their ivory and slave trades. Thence it was carried westward and was well established in West Africa when the Portuguese first explored the Guinea Coast (1469–74). From the Guinea Coast the Portuguese took the banana with their earliest cargoes of slaves to the Canary Islands (1482) which they had rediscovered in 1402. This fact is of importance because it has been well established that this is the point from which the banana was introduced into the New World. The fact that the 'head' or rhizome of the banana plant can retain its viability for a long period out of the soil constituted an important advantage in transporting it over long distances.

Varieties

The cultivated varieties of the banana are numerous. According to Rodriquez* there are about twenty-seven edible varieties, not including plantains, known in Jamaica, while in India no less than four hundred have been classified. The variety *par excellence*, however, is the Gros Michel, introduced into Jamaica from Martinique in 1835 by Jean François

* *Bananas. An outline of the Economic History of production and trade with special reference to Jamaica* by D. W. Rodriquez, M.Sc., B.A.

Pouyat, a French botanist. He brought in but one single plant, but it grew and prospered amazingly, and from that solitary source have sprung the plantations in Jamaica, Fiji, Colombia, Central America, Surinam and Australia. Sixty years or so ago bananas were commonly called 'Martnicks' by Jamaica peasants.

The Agricultural Society of the time awarded M. Pouyat in gold for his gift to the country—one doubloon (equivalent to an American twenty-dollar piece).

Unfortunately, with extensive cultivation came the corresponding 'Enemy No. 1', and the incidence of Panama Disease has so decimated the Gros Michel plantations that growers have been obliged to turn to the not so desirable variety, the Lacatan, which is more resistant. The Lacatan was introduced from Trinidad, but is believed to have originated from the Philippines.

The principal factors to be regarded in the cultivation of bananas are: Selection of Site, Preparing the Land, Selection of Planting Material, Planting Cultivation, Manuring, Disease and Pest Control.

Selection of Site

There is a certain environmental condition for optimum production of any crop and departure from this results in a correspondingly decreased return. For this reason the selection of the site should be given first consideration by the grower from the following angles—(*a*) soil type; (*b*) climate; (*c*) topography; (*d*) accessibility.

(*a*) **Soil Type.** A deep loam is required for optimum production with bananas; such a soil promotes extensive root growth. Some authorities claim that roots penetrate to a depth of 6 feet or more in such soils. This may be so, but the really beneficial root zone occurs in the top 10 inch to 24 inch layer.

Bananas in Jamaica are grown on a wide variety of soil types but chiefly on the three most important soils—the Alluvial Soils, the Shales, and the Red Limestone Soils. Each of these varies in performance and consequently different cultural practices have to be adopted to promote good plant growth.

(*b*) **Climate.** This is considered the limiting factor with banana production. Included in the broad term 'Climate' are rainfall, temperature, humidity and wind. Since the banana has a high water requirement it naturally thrives best where conditions are such as to make water available for optimum plant consumption. A regular, evenly distributed supply of soil water is required, with a high temperature and high humidity in the absence of wind.

(*c*) **Topography.** At present 75% or more of Jamaica's bananas is produced on hilly or sloping land. The more sloping the land, the more

difficult it will be to avoid soil erosion and consequent loss of soil fertility. The banana plant does not provide protection against soil erosion and therefore extensive conservation measures have to be adopted, at extra cost, to retard soil erosion and maintain soil fertility on hillside and sloping land. At all times, therefore, it is advisable that level areas should be given priority over the sloping land, provided other requirements are satisfactory.

(*d*) **Accessibility.** A banana field in difficult terrain will cause undue hardship in moving planting material to the area, spray for leaf spot, transport fertilizers, etc., and any mechanized equipment which may be of use in cultivation practices, harvest fruit and transport to the marketing depot, supervise other aspects of banana cultivation that may be required. The net result will be decreased output and loss of money. It is important, therefore, that this aspect should be considered carefully, and in so doing the matter of capital available for investment should be borne in mind, since on this will depend to what extent the difficulties may be overcome.

Preparation of Land

After the site has been chosen its preparation should receive the next most important consideration. Methods and cost will vary according to the condition of the area chosen. Virgin land will cost more than land which has been cropped (grassland included).

In the early days of banana production land preparation consisted of clearing away the undergrowth, removing the heavy logs and burning the area to facilitate planting. No forking or ploughing was done before planting and the 'suckers' were planted in holes, 18 inches deep and wide, lined out on the square. No soil conservation measures were adopted to retard soil erosion appreciably. The practice was one of direct exploitation, with returns from the crop sufficiently good to endorse the practice. Fertility was gradually lost and the unproductive areas were abandoned for new land rather than an attempt made to bring the unproductive land into bearing. This is an undesirable method and one that is not recommended. At the present time the demands on the limited land available in Jamaica for banana production are so severe that these mistakes must not be allowed to recur. Better results will be obtained by having the land well prepared before planting. The land should be properly ploughed and harrowed (in the case of level land), or forked (in the case of sloping and hilly land) before planting material is put into the ground. Good soil conservation principles should then be adopted with the result that soil erosion will be retarded appreciably.

The incorporation of readily decomposable organic material into the soil and the promotion of a good tilth will increase infiltration of water when rain falls and decrease run-off, thus preventing surface erosion. Destruction of the 'bush', through fire, leaves the surface soil exposed to the weathering processes with the resultant destruction of structure and increased surface erosion.

The absorption of water into the soil has its effect on the 'sucker' to facilitate germination and subsequent growth of the plant. Reference will be made to contouring of sloping land under 'Cultivation'; level land will present no problem in respect of contouring, and is confined to other necessary cultivation practices discussed below.

Selection of Planting Material

In the old days of Gros Michel there had been abundant supplies of planting material and consequently insufficient attention was paid to this aspect of banana cultivation. The necessity for this was very clearly observed with the introduction of a new variety (Lacatan) into the commercial market. There was a shortage of suckers and as a result every kind of sucker was used for planting. Poor results in yield of fruit were received and this was blamed at first on the variety.

Planting material will be considered under three heads:

(*a*) Type of Sucker
(*b*) Selection of Sucker
(*c*) Propagation Methods.

(*a*) **Type of Sucker.** The best suckers to plant are large maiden suckers, but, where planting material is in short supply, it has proved satisfactory to plant other types, or bits of maiden suckers. The results of investigations carried out by the Department of Agriculture at Caenwood and Orange River showed that, except for 'peepers', there does not seem to be much to choose between the other types with regards to time, maturity, and yield of fruit. 'Peepers' could form a useful source of planting material, but would be better if started in a separate nursery.

(*b*) **Selection and Treatment of Sucker.** To obtain best results it is essential that the planting material must not be chosen at random. This will ensure uniformity, growth and fruit production. A good example of uniform germination and growth may be seen after wind damage when all plants are cut back; not only is ~~growth~~ uniform here but it is rapid. Growth is rapid because the buds which form the new plants are developing from parent plants which have well-established root systems and supply adequate food requirements. It is for this reason, also, that growth is more uniform than from a newly planted field which includes suckers of varying sizes with their accompanying variation in plant food to support the buds until they can produce their own food supply.

It is considered important at this point that some mention should be made of the treatment of suckers in the preplanting period. When the suckers are ~~being~~ dug every care should be taken to avoid damage to the

corm, which is the source of food supply for the young plant embryo or 'bud'. That portion of the pseudo-stem or trunk above the corm, known as the 'cabbage' in commercial banana parlance, soon dries out and is of no great value in promoting germination of the 'bud'. It is for this reason that not more than three inches or four inches of 'cabbage' need to be left on the sucker at time of planting.

If suckers are being dug for a nearby field then 'cabbage' and 'bud' removal may be done at time of digging; all buds with the exception of two should be removed. Both these buds should be left in such a manner that they are on opposite sides of the sucker; the significance of this will be explained when planting is being discussed below. If suckers are being transported some distance to be planted, then four or five buds should be left at the time of digging and removal done as mentioned above where planting is being done.

The practice of storing suckers in the field for any length of time before planting is not recommended. The results of investigations carried out by the Department of Agriculture at Orange River and Caenwood showed that there was no marked difference in growth and fruit production between suckers stored for different periods up to six weeks. There was some indication that the period of maturity (planting to reaping) was lengthened when the storage period was four weeks and longer. Best results may always be expected from suckers that are planted as soon as possible after they have been dug up.

(*c*) **Propagation Methods.** Whenever planting material is required and there is a shortage of planting material, propagation at a quick enough rate to meet the demands of growers has always been a problem. The results of investigations into the use of different practices for rapid multiplication have shown that:

(i) Where fruit is not required, the best sucker production is obtained by allowing all suckers to grow until the largest number of good-sized suckers has been produced; then the whole stool is dug up as planting material. Any peepers which occur at the time should be established in a nursery for future use.

(ii) Where both fruit and suckers are required, all suckers, except followers, should be headed back to two feet from ground level and kept at that height until harvesting when they are dug out and used. This treatment will have no significant effect on the quality of fruit or its time of maturity.

Planting

Before discussing the actual planting operations the subject of spacing should be given some prominence.

Spacing. Lacatan may be grown successfully at a population per acre of 700 to 750 plants.

The best pattern of spacing to accommodate the population has not been fully investigated. Practical experience has shown, however, that for level land a pattern which allows a wide enough spacing in one direction to enable the movement of mechanical implements gives good results. Spacings of 12 feet by 6 feet and 12 feet by 8 feet have produced fruit satisfactorily. On hilly land a square pattern seems to give good results and should be continued. Spacings of 8 feet 6 inches by 8 feet 6 inches and 9 feet by 9 feet may be used satisfactorily.

Lining. On level land this presents no problem and the principle is so well known that discussion here is considered unnecessary. Lining on the contour, however, and this is recommended for all sloping and hilly land, presents a different problem. Figure 1 illustrates the system recommended.

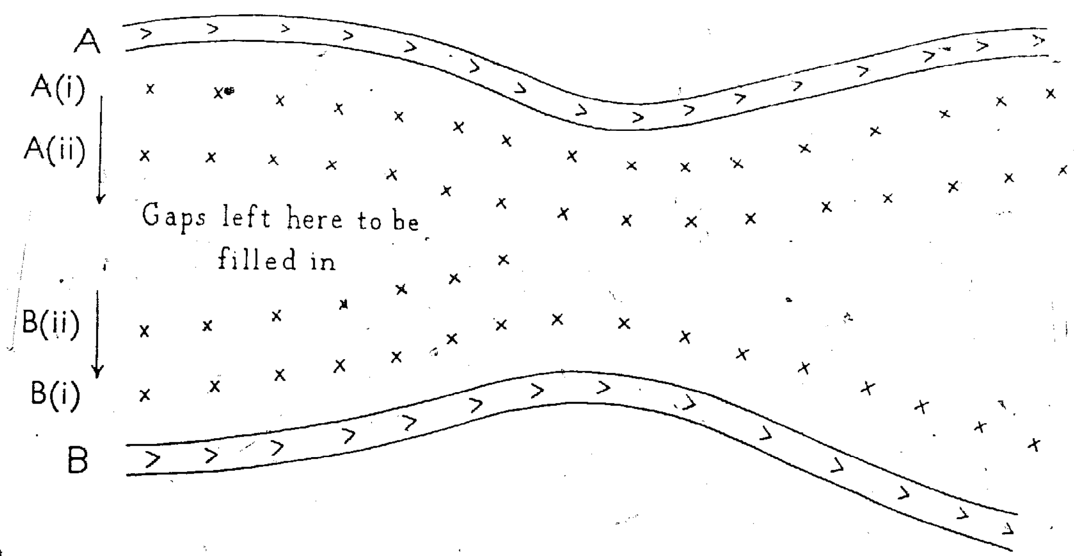


Fig. 1

Holes are lined out starting from contour lines A and B working towards the centre. For example, if the spacing is 10 feet by 10 feet, then the distance from the first row A(i) to the centre of the trench at A will be 5 feet. The distance between rows A(i) and A(ii) will be 10 feet and so on. The same system is repeated for rows B(i) and B(ii) working towards the centre, where gaps will remain to be filled in. This system has been most effective especially where the slope of land permits the use of mechanical implements for cultivation practices.

Planting the Sucker. Suckers should be cleaned, if necessary, to remove surplus buds and 'cabbage', as mentioned previously. The sucker is placed at an angle of 45 degrees in the hole, dug 18 inches wide by 18 inches deep, in such a position that each bud is on the opposite side of the sucker (see Figure 2) and not one below and one above. Both buds are thus given a fair chance to germinate and root readily. Only one shoot

will be chosen, however, to become the parent plant. The sucker is covered with soil and a slight mound made to allow excess water to run off instead of accumulating in the hole and encouraging 'rot'. The sucker should not be placed in an upright position to allow growth through the 'heart', since such a plant will produce poor fruit.

On level land successful attempts have been made to plant banana suckers in continuous furrows similar to those used for planting sugar cane. Provided the furrows can be made deep enough to cover the sucker properly with the second furrow cut, then it seems possible that the system may be used as standard practice on level land suited to mechanical cultivation.

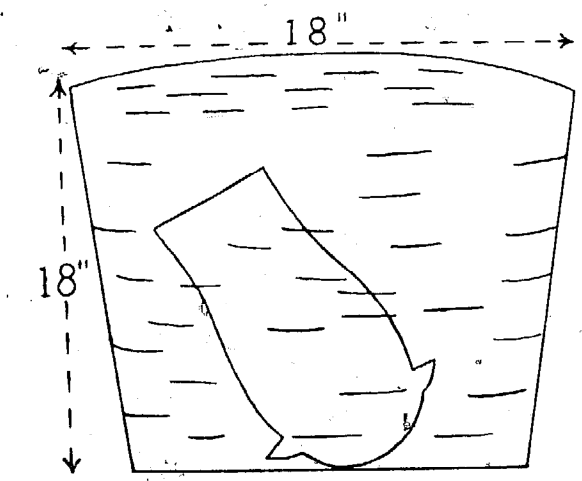


Fig. 2

Cultivation

It has been accepted that the physical condition of the surface layer of the soil is of extreme importance in the prevention of erosion and promotion of maximum water absorption. Any cultivation operations will, therefore, be aimed at achieving a satisfactory physical condition. In the discussion which follows each treatment is considered separately but they are all inter-related and form the cultivation practices.

Weeding and Cover Cropping. Clean-weeding is undesirable. The controlled use of weeds, where they can be utilized without sacrificing needed ground moisture and plant food, has been recommended as an advantage rather than a detriment. Where nutrients are competed for, this can be offset by applications of the particular nutrients.

Selective weeding is practised on certain banana plantations in Jamaica—spanish needle (*Bidens pilosa*) and water grass (*Commelina elegans*) have been regarded as harmless weeds and allowed to remain. This is a commendable practice since the surface soil needs protection from sun and rain.

Ideally, leguminous cover crops would fill this role; overlook bean (*Canavalia ensiformis*) has been giving good results. However, until such time as there are adequate supplies of suitable legumes the controlled use of weeds (grasses excluded) will give beneficial results. Grass has a harmful effect on the banana plant and should be eradicated; the use of cover crops will assist in achieving this.

The banana plant should be circle weeded at all times and in areas which have a marked dry season the weeds may be cut back, just before the dry season starts, to form a mulch and at the same time reduce competition of the weeds for soil moisture. Utilization of harmless weeds in such a manner will help to provide organic matter which is so lacking in the majority of banana soils.

Forking and Harrowing. The results of extensive work done have shown that moisture control and crop yield are considerably less influenced by cultivation than was hitherto supposed and that intensive harrowing in excess of what is required to control weeds depresses crop yields. Recent research has proven that soil moisture moves only in vapour form to the soil surface and this movement cannot be prevented by pulverization of the surface soil to form a mulch, except where the water is within a few feet of the surface. These conditions are rare and under dry-land farming the water table is usually very far down and thus a soil mulch will not be able to check loss of moisture by evaporation to any extent. The more important function of soil mulch is that rain water is absorbed much more effectively and penetrates more rapidly into the deeper soil layers where evaporation is less intensive.

Forking is done whenever mechanical cultivation is not feasible and this operation aims at aerating the soil. It does much damage to the banana roots, however, and this is spectacular by the yellowing of the leaves and apparent 'diseased' condition of plants after land has been forked. The plants use up much energy in recovering instead of in continued growth and fruit production. It is clearly, therefore, an operation which should be carried out only when necessary to improve soil structure, and not as a routine practice which many farmers have grown to accept.

Irrigation. Only a limited area of land suitable for banana cultivation is irrigated. Of this area the larger section occurs on the Clarendon and St. Catherine Plains, where the production of bananas has now assumed an important role and some sections previously planted in sugar cane have now been established in bananas.

Flood irrigation is the system used and approximately fourteen irrigations are given per annum. After each irrigation the field is harrowed to break up a crust which usually forms and becomes quite tough if allowed to remain. Unless great care is exercised during subsequent irrigation there will be scouring of the surface soil and the crust will become even

tougher when reformed. From the results of field trials with different cultural practices that limit the extent of harrowing, and from practical observations, there are indications that excessive harrowing is unnecessary.

The value of overhead irrigation for the successful growth of bananas has not yet been investigated. There appears to be no good reason why this system should not prove useful with banana cultivation.

The importance of contour irrigation for sloping land should not be overlooked by the grower, since the absence of such treatment may result in a soil fertility decline which may prove difficult and expensive to correct.

Drainage. This is a very important practice in banana cultivation but one that has been overdone during the years. The root of the banana plant is very susceptible to excessive soil moisture or waterlogging. For this reason drains are required in such a manner as to remove all excess water as efficiently as possible. But, where the soil is naturally free draining and excess water is not a danger, there appears to be no good reason for laying down a drainage system. The theory that drains are necessary in such soils for aeration has yet to be proved; they appear to do little more than increase the cost of cultivation and reduce the farmer's net profit.

On hillside land, it is absolutely necessary that drains should be dug in such a manner as to retard rapid run-off and thus aid soil conservation. In laying down the drainage system for a banana field in a hilly area, it is important that the water-ways should be well defined and established before the drains are dug to lead water into them. Different soil types require drains to be dug in different ways for best results. This is a matter that should be discussed thoroughly with the area Agricultural Officer before a start is made, since a single small mistake may have serious repercussions.

Pruning. Pruning in a newly planted field should commence not later than three weeks after germination. This first treatment is known as the 'selective pruning' and at this stage the parent plant is selected. Suckers which are growing through the 'heart' at this stage should be cut back below ground-level to allow the 'buds' to germinate, except in the case of suckers that have been heavily trimmed to clean them free of nemotates. The pruning cycle is about six weeks and only one plant is allowed to grow at first.

The main pruning tool used is the machete. In an adult field the blade of the machete should be inserted between the sucker and the parent plant with the cutting edge towards the sucker and away from the parent plant. Then, with a pushing wristy action, the sucker is cut transversely below ground-level. If the position of the machete is reversed, then the parent tree usually gets damaged and this may not show up immediately but after some weeks of growth when the plants may have an unusual appearance. Other aspects of pruning are too well known to require further discussion here.

Mulching. Where rainfall is erratic and variable and it is difficult to establish a growing vegetative cover, the use of a surface mulch in the form of leaves, straw and other organic material (readily decomposable material preferred) has long been recognized as being of much value in conserving the soil. There are several banana areas in Jamaica in which mulching would produce good results, but such difficulties as availability of mulching material, accessibility for mechanical transport to reduce costs, have not been overcome satisfactorily to enable the practice to be adopted as a standard one on a large scale. Whenever mulch is being applied it must be remembered that depth of material is important; there is an optimum depth for best results. Too heavy a cover, for example, will prevent any but the very heavy showers from reaching the surface soil. Over a long period there will be a drought effect on the plant. Too thin a cover will not prevent air movement over the soil surface sufficiently to retard evaporation, thus uniform soil moisture will not result. Too thin a cover will also expose the top-soil to the effects of the sun more than is necessary. Specific information on amount of mulch to apply, etc., is not available at present but it is hoped that the general discussion above will arouse some interest and thought on the subject.

Manuring. The major nutrients—nitrogen, phosphate and potash, which are essential for the plant to grow, are constantly being lost from the soil and it is necessary to add these nutrients in a readily available form so that the banana plant may produce satisfactory results from the same soil over a period. To do this manures are used—one group is called *organic* and the other *inorganic*. *Organic* manures originate from plants, animals and microbes. When offered for commercial use some of these organic manures are 'concentrated' by the addition of limited quantities of artificial manures.

The terms *artificials*, *inorganic manures* and *fertilizers*, mean the same thing. They are chemical materials used as a means of supplementing the natural food supplies of the soil for the economic production of crops as well as the proper maintenance of soil fertility. The value and behaviour of organic manures compared with artificials is a controversial matter and it is not proposed to discuss that here. It is emphasized, however, that where soil organic matter is at a high level the use of artificials produces best results. Therefore, the aim should be to combine the use of artificials with organic manuring.

An excellent organic manure for use in this combination is farmyard manure which can be efficiently produced by every grower who keeps animals on his farm. The All Island Banana Growers Association has been encouraging the production of farmyard manure by offering subsidies to growers. It is suggested that every grower should contact the area Supervisor or Agricultural Officer to find out the details in order that he might take part in the scheme (the Pen Manure Factory Scheme).

Time of fertilizer application is important in order to get good results. As soon as the suckers have germinated the first fertilizer application should be made and thereafter at such intervals as to maintain uniform growth. No marked response in growth and production has been obtained as yet from different fertilizer placement methods and therefore surface application in a circle or semi-circle should be done with the necessary modification, depending on the topography of the land and the age of the plants. Three applications per annum should be made in the spring, summer and autumn, except for the irrigated plains where two-monthly applications should give better results.

The All Island Banana Growers Association operates a soil fertility scheme which enables growers to obtain fertilizers at a reduced rate. Growers should, therefore, contact the All Island Banana Growers Association's Supervisor, or the Agricultural Officer for the area to obtain full details of how to take part in the scheme.

Soil Conservation

Soil Conservation, for many reasons, is more important in banana cultivation than perhaps in any other crop. Banana cultivation in Jamaica is generally a clean weeded cultivation and until a suitable cover crop is proved and established the soil is easily subject to wash and scour. Then, banana is unfortunately a one-crop cultivation; it is not practicable to provide regular rotation for banana fields in the majority of cases. Bananas are not like sugar cane which belongs to the grass family and therefore continuously enriches the land with a lot of trash to make humus. Further, sugar cane covers and protects the land; bananas do not. So then, not only is soil conservation most vital for banana cultivation, but at least three of the well-known and accepted soil conservation procedures are difficult to practise in banana cultivation, and experimental work has got to be carried out in them. These are as follows:

(*a*) it is not generally practical to rotate banana fields with other crops;
(*b*) there is no experience in strip cropping banana fields;
(*c*) a generally suitable cover crop has not yet been found—one which will grow under shade of banana fields and not stultify the growth of the bananas.

Another difficulty is that although it is known that trenching is an essential practice in banana cultivation, the size, length, shape and distance apart of trenches cannot be fixed. So far no general agreement has been reached on the kind of vegetative growth that is really satisfactory for barrier strips. Badly placed and constructed trenches, even on the contour, might speed up instead of lessen soil erosion.

The popular notion is that soil conservation work consists merely of contour trenches, run-off trenches and barrier strips. This, of course, is not the case. Soil Conservation should be accepted to mean all of those practices which are essential to prevent the valuable top-soil of the land being washed away and to improve the fertility of soil generally. It is the top soil which is so important and it is vital for it to be kept in place and prevented from being moved down the hillside by water.

Another popular idea is that Soil Conservation must be undertaken only on soils which have deteriorated or are being eroded. This is not the idea. It is not only the badly eroded soils which should receive consideration in Soil Conservation practices, but also the good soils.

An important point in banana cultivation in Jamaica is that most of it is situated upon hillside sloping land, and it is this type of land which under cultivation becomes so easily eroded—not that flat lands do not also become eroded; they are eroded by wind, by poor systems of trenches, and by bad systems of irrigation, such as putting water upon the land without a good system of trenches to take it off.

Basic Principles. The first principle of soil conservation is to adopt a pattern of cultivation of land that will keep soil erosion and scour to a minimum.

The second principle is the adoption of a pattern of cultivation that will secure the use of the maximum area of land for occupation by the crop cultivated in order to produce the maximum possible economic yields.

The best pattern for banana cultivation combines the first principle with the second—a pattern that will stop loss of the top soil, prevent scour and wash, and at the same time make available as much of the land as possible with all the banana plants possible planted upon it and getting the best yields from them, not only for one crop, but for crop after crop, year after year with a minimum of expense.

The pattern of cultivation for any plot of banana land must be designed so as to develop as easy sloping terraces as possible on which the cultivation will be maintained, with suitable trenches both for aerating the soil and for taking off flood water, without, at the same time, having any loss of top soil; from breaking of the trench banks or from scouring of the trench sides and bottom or from washing or scouring of the terraces. The successful result of these practices should be to maintain a healthy top soil condition throughout the plot of land cultivated.

This objective sounds simple enough and would not be so difficult to attain in practice were there not three important variations:

(*a*) variation in soil types
(*b*) variation in slopes
(*c*) variation in rainfall

plus the problems which arise in dealing with flat or level lands.

Flat or Level Lands. Taking the easiest first—flat or level lands.

It is recognized that banana cultivation requires trenches for aeration and for normal drainage. In addition, there might be trenches for supplying irrigation water. When irrigation water is applied to the land there must be an adequate drainage system for disposal of it. Bananas will not be sufficiently aerated on badly drained land.

Limestone Slopes. This type is the next easiest. Light, open soils, of limestome formation, are not very difficult to conserve. However, not much bananas are cultivated on these soils. Here no trenches might be necessary except for laying the foundation for the stone barriers. There are always loose surface stones lying about upon these lands and the accepted practice is to build stone barriers to check erosion. Loose stones should be collected and packed as low, inexpensive dry-packed walls on the contour across the hills. These low, dry-packed walls will hold up surface wash and in time terraces will be gradually built up above them. As this type of soil is loose and friable, erosion results mostly from high wind and driving rain and therefore some form of soil cover, either by bush mulch or suitable cover crop is an important item in the soil conservation programme.

Shale Slopes. Shale slopes present the greatest difficulty for soil conservation work. On these soils, especially those of the Blue Mountain series, there is little experience of what is the right type of conservation practice. Care must be exercised in constructing contour trenches in order to avoid their holding in the water as this tends to cause the layers of soil to slide off each other and break away. Simple strip cropping, that is to say, strips of banana with strips of grass or natural bush and trees, a half chain at least, between the strips of bananas appears to hold out the best promise, but there is little or no experience in this system with bananas. In areas such as the higher reaches of the valleys of Portland and inland St. Thomas, the land should not be denuded of trees. Great care should be exercised in cutting contour trenches or drains of any kind on the 'brogudo' soils of Hanover.

Clay Slopes. Slopes of heavier soils, called clay slopes for purposes of this article, represent the major problem, as most of Jamaica bananas are grown on this soil type. The main problems here are the contour trenches, their frequency, their depth, slope and shape and length before they empty themselves into run-off trenches. There will always be variation according to the incline of the slope, the degree of heaviness of the soil, and the amount of rainfall. As to the size and length of contour trenches and the distance between them, the aim is for the trenches to be able to collect and take off flood water without causing break-away of the trench banks or scouring of the terraces of cultivated land between them and yet at the same time not to take off water so fast as to dry out the land too quickly.

So then, the trenches must be laid out and dug along the contour; they must be flat enough just to take the water off into the run-off trenches. If they are too flat they will overflow and break at the lower lip causing scour across the valuable cultivated bed or terrace of the land; if the pitch is too small, the trenches themselves will scour in the bottom and undermine the land and cause breakways. As to the size and shape of the trenches themselves, they should not be more than one foot wide at the bottom with the lower sides cut vertical while the upper side must be sloped back to an angle which will allow this side of the trench to be established at the safe angle of repose. The soil from the trench itself when newly dug should be used firstly to strengthen the weak places in the trenches on the lower side so as to prevent break-aways before the trenches set, and the remainder should be spread above the upper side of the trench to start and support the foundation of the bund against which nature will begin to build up the terrace on which cultivation is to be maintained.

Along the upper side of the trench bank, in the soil from the trench that is packed above it, there should be planted an appropriate barrier strip of grass or some suitable vegetation. The sloping face of the upper part of the trench should be planted with one of the creeping grasses—crab, pimento or Bahama grass or anyhow left unweeded to enable its becoming covered with natural vegetation. Economic trees could also be planted at suitable intervals along the upper banks. In time, especially in the early stages, the trenches will require regular cleaning and the soil from the bottom should be scraped out where necessary and used firstly to strengthen any weak spots on the lower trench lip, and the balance of soil spread over the upper half of the terrace below each trench which has a tendency to become impoverished during continuous cultivation. When the trenches are well set and are working the test will be that little or no soil erosion should take place; and the terrace which is to be used for cultivation gradually becomes flatter and is maintained throughout at a uniform standard of fertility. The trenches themselves should not be required to be cleaned too often. In fact it is best to encourage grass and vegetation to grow in the trenches especially on the side of the banks. The sides of the trenches should be brushed by a machete and not clean-weeded.

Unfortunately a type of vegetation entirely suitable for barrier strips in banana cultivation has not yet been found. The type of vegetation to be used will vary according to the crop cultivated. Khus-Khus grass and Napier grass have been used. Whatever vegetation is used for the barrier strip, care must be taken to see that there are no gaps through which water can flow. Napier grass has been in popular use, but it has been found that it spreads rapidly throughout the cultivated terrace and is expensive to keep under control although after bananas develop a good thick canopy shade, Napier grass tends to die. For small plots of banana,

however, it is still the best original vegetative barrier, because in these cases, the grower can cut it regularly for feeding his cows (in his Manure Factory) care being taken to prevent it encroaching on the cultivation.

Much the greater proportion of Jamaica agricultural land consists of ~~slopes of varying degrees. Some of these~~ slopes are so severe that normally they should be left in woodland and not cultivated at all, but such is the pressure of the population upon the land that much of this steep sloping land has to be cultivated and used. As they consist of different soil types and varying slopes under varying conditions of rainfall, no specific advice can be given which could be applied to all of these conditions save this, that the greatest care must be taken in the choice of type of Soil Conservation practice to be applied to them, bearing in mind always the basic principles stated before.

Run-off Trenches. Light soils with stone barriers require no run-off trenches. Porous soils with trenches largely put in for aeration—blind trenches—will need scarcely any run-off trenches. Heavy soils or medium with clay sub-soil must have run-off trenches. The chief aim is to collect flood water in the contour trench and empty it into the run-off trenches which should take this water as quickly as possible down the hillside so that the run-off trenches must be cut practically straight down the hillside. They should be located in the natural outlet water or gully courses. As the contour trenches should not be too long, the number of run-off trenches, the distances apart and their location are quite important. It might be found that there are not enough natural water courses on the land and additional run-off trenches will have to be cut.

The run-off trench is not an ordinary trench; the shape is important. It is much wider than the ordinary trench and is saucer shaped at the bottom with creeping grass in the bed or bottom of it. This grass should never be weeded. Run-off trenches should have a lot of vegetation in them but not tall grass or bush growing across the trench as this provides obstruction and creates a series of small waterfalls and cataracts which lead to scour. Vegetation can be planted on both sides of the run-off trenches but not at the points where the contour trenches enter.

Lining. Banana fields should be lined on the contour parallel to both the upper and lower contour trenches of each bed or terrace so that any false rows will fall in the middle of the terrace. It is important that each first, second and third row of bananas should be lined alternatively parallel with the upper and then with the lower contour trenches, first one and then the other, until the lining distance cannot be kept and short or false rows have to be put in.

Contour trenches, barrier strips, run-off trenches, stone wall barriers and strip planting are all aids to Soil Conservation and are essential, particularly on sloping land.

These practices do not, however, by any means cover the art of keeping the top-soil on the land; they form the foundation or framework on which to build the art of cultivating the land. The application of mulch, compost and all other forms of organic material, planting cover crop, careful planting of trees, application of fertilizer, rotation of crops and leaving the land to fallow, are all part of the mosaic which make up the whole picture.

Above all, Soil Conservation is an attitude of mind towards the land. It involves the planning of cultivation so that the forces of nature can be utilised to assist in the development of improved soil fertility and more profitable crops—with appropriate contour trenching, barrier strips and run-off trenches, the inevitable washing that must occur during rainfall can be utilised to build up more gradual slopes on which to cultivate and develop more uniformly fertile lands to produce more profitable crops.

Cover Crops. The problem of clean banana cultivation is in a worse form than in the Gros Michel days, for if virulent Winter Leaf Spot scorching is to be prevented, we will have to insist in the future that in the Fall of the year all dead leaves are cut from banana trees and along with all other diseased material lying about the field, taken right out of the field, if they cannot be completely buried or covered with bush; thus the supply of organic matter to the soils of banana fields will be depleted further. The use of cover crops is believed to be one way of helping to solve the problem.

Cover crops, in a way, have almost gone out of fashion in Jamaica. Not long ago, Bengal Beans, Edua Peas and Overlook Beans were grown in most districts of the Island. Today it is difficult to get the smallest supply of seeds of any of these heavy leaf-producing leguminous plants. In the meantime other varieties of leguminous plants, used as 'cover' in other countries have been imported and tried out—the two most well known of them being Indigophera and Kudzu. The main drawback with cover crops for banana fields is that suitable plants will not thrive under heavy shade in a banana walk; as soon as the banana leaves form a heavy canopy, the cover crop dies out.

The creeping variety of Indigophera has given good results as to the actual cover itself, but a first impression is that it ties up the land too much and that bananas do not seem to thrive so well with it.

Kudzu of the right variety has not had a good trial in Jamaica. Seeds have been imported and distributed and additional supplies are being imported. Kudzu is used as a cover crop, with excellent results, in Costa Rica under rubber and in many other tropical countries, and it is known that in the Cameroons a variety of Kudzu (Pueraria), has been used in banana fields with continuous good results. There, it is understood, the plot of land is planted out with Kudzu well ahead of the time for planting the banana suckers. After the land has been well bedded down with Kudzu it is lined out, a circle is cleared in the Kudzu cover and the banana

holes dug. As the suckers grow, they are circle-cleared and forked, and the Kudzu cover opened in widening circles round each root or mat of banana as cultivation continues. It is understood that the Kudzu continues to grow and cover the land under the banana trees for years afterwards, even when the banana trees have grown a heavy canopy.

It is believed that it is not going to be possible to establish cover crops under old ratoon banana trees where the land is already heavily shaded, but that it will be possible to do so through young and newly planted banana fields where the shade is not dense, and certainly, in advance of actual planting upon land to be re-planted or planted.

Bengal Beans and **Edua Peas** grow and cover rapidly, producing a lot of green material. Seeds need not be planted too closely as the plants grow vigorously and run over a wide area. One drawback with these two cover crops is that they climb; however, if one or both of them can be kept growing on the land in fields of newly planted or young banana trees for a year or two, they would produce enough material to bed down and cover the land for a long time; they could be chopped back at suitable times and completely billed down when they begin to give trouble by climbing the banana trees.

Overlook Beans are erect growing and do not cover the land completely as they do not 'run', but each plant grows into a fairly large bush and produces a heavy supply of green material. It takes a lot of seeds of Overlook Beans to cover an acre of land, but single seeds planted here and there soon grow into lusty plants. The technique is to swish the plants across with a cutlass as soon as they begin to blossom. They soon recover and produce more and more leaves and green material, and the swishing process repeated at regular intervals will deposit an unbelievable amount of mulch upon the land.

Overlook Beans planted for cover should not be allowed to produce pods as when they do, they die down. Twenty plants or so left to produce pods will give ample supplies of seeds so that in two seasons a large acreage could be planted out. Were three seeds of Overlook Beans stuck in round each newly planted banana sucker, enough green material would be produced to mulch down that root of banana for a long time.

The land for sowing **Kudzu** seeds should be forked and broken up and the Kudzu seeds sown either broadcast or alternatively planted in the forked land in between each square of banana trees 6 or 8 seeds in each hole about 10 to 12 feet apart. The seeds should be given every chance to germinate so that sowing them in the late afternoon of a wet day during the rainy season should be best.

Some simple precaution such as a little kerosene oil or dusting agrocide over the sown area after sowing would keep ants off and give the seeds a chance to survive.

The percentage of germination of Kudzu seeds can be increased by soaking them for half an hour in a solution of half hydrochloric acid and half water. The seeds should then be washed and dried on a piece of sacking, not in the sun, but in a cool place.

Kudzu begins life as a fine, tender plant and might require at least one early hand-weeding to give them a chance to get away. With a good start they will soon cover the plot of land and smother weeds.

The idea is to plant Kudzu seeds through young banana fields or on newly planted land or on a piece of open land, (well prepared, of course) where it is intended to plant bananas later on.

Trees through small fields. All over the Island, on the hill-sides, it will be observed that wherever there are trees on the land the soil underneath them seems to be all the better for their being there. For instance, coffee 'walks' thrive under Guango trees; so do plots of bananas. In fact, plots of bananas interplanted with trees, on hillside land, always look better than those on naked land, and they do thrive better.

It is well known that banana trees under some form of shade do not suffer severely from Leaf Spot disease as those in the open. Apart from the shade aspect of the question, trees help to hold the top-soil on hillside land, to enrich it with fallen leaves and to prevent too rapid loss of soil water.

It would not be good agricultural practice to plant trees indiscriminately through banana cultivation, and it would not be sensible to plant them through banana fields in which implements such as ploughs, harrows and trailer-sprayers are used, but it is believed to be practical and to be sound practice to plant economic trees here and there through small banana holdings on hillsides, and that small growers could improve their land and their banana cultivation by doing this. This is a long-term project. Seedlings take a long time to grow into useful trees, but a start should be made at some time.

It is agreed that the best spots in the field to establish trees are at suitable distances along the upper banks of contour trenches.

Some growers like **Guango** trees and if a Guango seedling comes through in the field it should be cared and allowed to grow. If any grower wants to grow a Guango tree specially he has only to put one seed into the ground at a stake. It would soon germinate and grow quickly. Some thought should be given to the kind of timber tree to be planted as some of those trees have large surface-feeding roots which suck the goodness from the land and starve the banana plants.

Hillside banana plots, on bare ground without trees, look most unhappy and produce poor, low-grade fruit, whereas those plots which are interspersed with suitable trees look thriving, stand up better to dry weather and produce fruit with a bloom on them. Moreover, Leaf Spot disease is more easily controlled.

Chemical Control of Grasses in Banana Fields

It is well known that the true grasses, belonging to the family of plants known by botanists under the name of *Gramineae*, constitute the bulk of the noxious weeds in nearly every kind of plantation in Jamaica. Perhaps this is largely responsible for the tendency to refer to all weed growth as 'grass'; it is, however, required here to make a distinction by roughly defining a grass as a plant with simple, relatively narrow, parallel-veined leaves, jointed stem and abundant fibrous roots. Bamboo, sugar cane and rice are grasses but the ones of most concern here are those grasses which are weeds in banana fields—Para grass, Bahama grass, Seymour grass, flat grass and the like. It should be particularly noted that *water grass* is not really a grass.

Grasses are notoriously heavy consumers of soil water and nitrogen, two most important requirements of the banana plant, and so create serious competition in the field when they are present. The same type of composition is offered by deep-rooted, broad leaved weeds. Water Grass and Shine eye, however, are two broad leaved weeds, which are so shallow rooted that they do not compete with the banana for soil moisture and they provide an excellent preventive against erosion due to their close coverage of the soil. They are also drought resistant. Progressive farmers encourage water grass and shine eye on non-irrigated land. In all types of weeding practices, however, getting rid of true grasses is vital for successful banana production.

It was early observed in the experiments conducted on suckering behaviour of Lacatan by our Crop Physiologist, E. A. Tai, that cutlass weeding damaged a high percentage of young crop suckers at each operation and could be responsible for serious losses in yield of fruit and he thereupon commenced investigation of the possibility of using chemical herbicides to replace the cutlass and hoe. For the same and other reasons experienced banana growers, notably E. Hopwood of Belvedere Estate, St. Thomas, were also interested in reducing the reliance upon hand cutlassing for grass control.

Search of the relevant literature revealed that among herbicides tested in banana fields with success in Australia and Hawaii was the noted grass-killer Dalapon, known chemically as 2, 2-dichloropropionic acid. A drenching spray on the leaves killed several grass species without appreciable harm to bananas. This information stimulated experiments by E. Hopwood at Belvedere; he commenced in July 1959, by using 5 lbs. of Dalapon in 40 gals. of water per acre applied by pneumatic knapsack sprayers to dense Para grass in a derelict banana field and gradually introduced variations in the technique of application until today his practice consists of using 2 lbs. Dalapon in 2½ gals. of water applied with a knapsack-mounted mist blower.

Dalapon kills grasses by causing at first a cessation of growth then death of the roots of individual plants; this results in ultimate collapse without regeneration so that Dalapon spraying may be used effectively for complete eradication. The first effects normally begin to show up as a slight yellowing of the leaves after about two weeks, often in a much shorter time, then the leaf tips and edges begin to become brown until the entire blades are dead and finally the remainder of the aerial portions of the grasses dries up, never to show any green again. Some time before the end of the process, which usually requires 10 to 12 weeks, the roots die and rot underground.

Because Dalapon has little lasting effect on weeds other than grasses a Dalapon-sprayed field gradually becomes invaded by broad leaved weeds. Among these are water grass and shine eye which are to be encouraged; if others are pulled out as they appear the desired cover crop can be established relatively easily, this being a simple operation which forms part of the general procedure at Belvedere.

Grasses are most susceptible to Dalapon when they are growing vigorously prior to seeding and that is the best time for the spray application. It is recommended that, in the first place, three sprayings be done per year, using either—

(*a*) 5 lbs./acre in 40 gallons of water applied as high-volume spray, or

(*b*) 2 lbs./acre in 2½ gallons of water applied as low-volume mist spray

depending mainly on the availability of equipment. These quantities should be regarded as subject to modification when the grass has been brought under control.

Manure Factories. Some growers have become confused in mind about fertilizers on one hand and manure on the other, and heated arguments are possible in favour of one or the other. The problem can be sorted in a very simple way if we accept the following.

Fertilizer should be taken to mean all the different chemicals which supply food quickly to the plant. Quick-growing crops like bananas need fertilizer all the time and should get it regularly and often—three times each year at least.

Most soils are deficient in one or more of the essential plant foods or some vital element. By analysis of the soil this can be found out. The way to remedy these deficiencies is to use the right kind of fertilizer.

Manure means farm-made stuff: dung, litter, farmyard sweepings and refuse well rotted down; grass, leaves and bush mixed up with dung and urine and well rotted down; sludge, filter-press muck and such things.

Manure has to do more with the soil itself first rather than the plant. It acts on the soil making good living conditions for plants so that they can grow a lot of long, strong roots and take up plenty of plant food.

Manure helps soils to hold water for a longer time; it keeps the soil alive by providing food for the millions of live things (visible and invisible) which live in it—things such as worms and bacteria which will only live and thrive in a good soil and thereby help to make it still better. Manure also supplies food for plants but not so much all at once nor as quickly nor as completely as fertilizers.

It is quite wonderful what a good thing manure is. But to contend that one is better than the other—fertilizer than manure or manure than fertilizer—is just one of those things we can argue about for ever. One knows from experience that both of them should be worked together for the best results, provided we bear in mind two important points:

(i) Manure is fool-proof and growers can apply it to land at any time and put on any amount and need not have special advice about it. Manure can be applied to land irrespective of the kind of crop growing on it. Farmyard manure has not got to be changed to suit different crops growing on the same land. It is useful for all crops.

(ii) Fertilizer should be applied at special times; it has to be put on in definite quantities; it is to be used only after advice by some expert who has tested the soil and knows just what it lacks and what kind of food the special plant growing upon the land requires. Fertilizers have to be made up in different mixtures according to the crop, even for the same soil.

They are essential for providing balanced food for plants and for putting back into the soil certain elements which might be deficient or in short supply.

Farmyard manure alone will give results, although it takes a longish time to do so. Fertilizers will give results, rather quickly, much more quickly than farmyard manure as they supply food immediately to a greedy, quick-growing crop like bananas. But the very best results are obtained by working both together—farmyard manure to improve the texture of the soil and create good living conditions for plants with the added fertilizer pushing on growth and production at top speed and supplying those elements which the crop needs but in which the soil is deficient.

In times past farmers just depended upon the raw farmyard litter and dung and sweepings for fattening up their land. Sometimes they saved it up in a heap or in a pit or under a shed. Later on it was found out that unless the stuff was kept in a special way most of the goodness was lost. This led to an improvement in storing. Still later on it was found out that by mixing dung (fresh horse dung being best) with grass, trash, leaves and bush in a certain way and leaving it to 'cure' farmers could get a lot more manure. The method is called 'composting'. But compost heaps take a lot of time and hard work to stack, water and turn at special times; and it costs quite a lot to cart manure out to the fields. Nowadays a new way is used to get a lot of strong manure, in quick time, close to the fields. In this new way it has been proved that one cow can make more than 8 tons of manure each year.

The method described below has been in use at the Agricultural College in Trinidad for some years on a number of experiments on small farms. Reports are issued from time to time and the results are most encouraging. In Dominica one grower had increased the yield from his grove of limes by 8 barrels per acre per year. In Trinidad a small grower brought his cane production up to 60 tons per acre per annum by using this method.

The basis of the scheme is that cows and steers want little or no exercise, although bulls do; and if they get water regularly they can be fed under a shed constantly by day and night with just a couple of hours sunshine each day. The system is really a kind of stall feeding.

Simply put, one or two, or three, or six, or as many cows or steers as the farmer can cut feed for are fed constantly in a shed and after six months or so the manure is dug out and put on the field. But the shed must be constructed in a certain way, as follows:

Select a good site—dry and near to water and grass, and near to the banana field. Line out the shed so that breeze will blow against the long side of the shed and not through the end. Dig the standing floor to about 1 foot or 18 inches below ground and bank up the earth round the sides so that the floor where the cows (cattle) will stand on is now 2 feet to 2 feet 6 inches below the top of the bank.

The length of the shed will depend upon the number of cows to be fed. See that this 'standing' is quite dry. Dig a trench round it. Use round wood to put up a shed over it. The shed must have a steep sloping roof so that it will hang down almost over the piled-up earth and the building will have no sides but little or no opening for the breeze to blow through and dry out the manure. Cover the roof with grass or cane trash. Thatch is best, but that is expensive. The main point is to get a cheap, cool roof.

If all the cows to be fed were polled, there would be no necessity to divide up the shed. As they are likely to have horns and would gore each other, divide the shed with round wood into as many loose stalls as may be necessary to avoid them injuring each other. Give good space—about 10 feet by 10 feet per cow. She is going to spend most of her time in the stalls; she will eat in there all day; she will sleep in there at nights. Have a central way down the middle—4 feet wide if there are to be double-row stalls, which are best for more than four cows.

Bed down the bottom of the floor with grass and weeds to a depth of about 6 inches for the cows to lie on. Get the cattle in and feed them in the shed. Each day, every day and regularly twice a day, grass must be cut and put in for the cows to eat and the important point is that much more grass and weeds than the cattle want to eat must be put into the stall.

Every morning the stale grass left over from the previous day (and there must be a good lot of it) is spread evenly over the floor. The cattle will trample it; they will lie on it and dung on it and it will catch and hold the urine. Each day the left-over grass when spread down will make fresh, clean bedding for the cows to lie on. There will be no smell; no flies. Each day the trampled pile will grow while the bacteria will be hard at work below breaking down the grass and dung into rich plant food.

At the end of six months or so the whole mass should be dug out and spread over the land.

Regular Watering. As very few persons can afford to have running water in the shed the cows must be taken to water or given a lot of water twice a day at least, and they must be let out to get some sunning for a couple of hours each day but not kept out so long that they waste dung and urine outside. Alternatively, they can be let out from Saturday morning to Monday morning each week so as to avoid having to cut grass over the week-end. And always—they must get a lot more grass than they can eat so that enough will be left over to bed down the stall.

The cows must live in the stalls by night and day save when they go to be watered or are out to get sunning.

If only fresh, lush grass is available, some grass should be dried and used in the bedding down.

It is important to make sure that the bedding down is done every day and that enough grass is spread to catch the dung and hold urine because the mass of manure must not be allowed to get too wet or soggy as the bacteria would not work. On the other hand the manure must not be allowed to dry out.

Salt lick and minerals must be kept in the yard and shed for the cows to lick. For convenience in handling the cattle the shed-yard should be fenced but lack of fencing should not prevent anyone making a start.

In the way described above one or two or many cows can be stalled to make manure. The ideal thing would be to have two sheds so that when one is being dug out the cows can be fed in the other; and it might be best to begin with a few cows, to learn by experience, and then either extend the first shed or build another one on a new site and increase the number of cows later on.

Wind-Breaks. The popular notion on wind-breaks is lines of slow-growing, powerful trees, side by side surrounding a field; so far in Jamaica, mango, otaheiti apple and other similar trees have been used. These trees do not 'give' in strong wind. They branch irregularly and when bashed about by a hurricane, cause much damage to nearby cultivation and involve heavy expenses for clearing up. This conception of a wind-break is believed to be wrong.

Some of the latest ideas on wind-breaks are that they should consist of a mass of quick-growing trees with straight, supple stems and horizontal branches; that these trees should be willowy, swaying in the breeze; that they should be easily controlled by pruning for height and denseness; that they should have strong, deep tap-roots, and not a lot of surface-feeding, secondary roots which encumber the land and suck out the goodness. Moreover, they should not cast too much shade.

Wind-breaks need not of necessity surround individual fields. They may be planted in special cases on sites away from fields in the paths of prevailing winds and in many cases gaps in ridges might be the correct location.

The smaller islands of the West Indies are really small parcels in the open Caribbean sea and Atlantic ocean. By day and night, winds of high velocity sweep up their valleys and over them; without wind-breaks the crops grown on these islands would be badly blown about and battered. So that in Dominica, for instance, there are wind-breaks everywhere—across the valleys; in the path of the prevailing winds; around individual fields.

In these islands a tree, Galba, is commonly used. It is tougher, but very similar in appearance to Santa Maria.

Wind-breaks are established in two ways. Galba seeds are planted either direct at stake, one seed in a hole 6 or 7 feet apart, staggered in two rows, or are sown in nursery beds or bamboo pots first, and then set out in staggered rows at the above distances. In some cases the seedlings are planted fairly close together and as they grow into straight poles, are thinned out from time to time for use as yam sticks, poles, shafts and timber. Young *Galba* trees would make good supports for bananas.

As Galba grows with wide horizontal lower branches and shorter limbs further up, the wind-breaks are wider and thicker nearer the ground and narrower higher up, as wind-breaks should be.

Where the land cannot be spared for wide wind-breaks one or two rows should be planted as shown in the diagram in this article.

One quite important point is that wind-breaks are not planted in one continuous straight line but are themselves staggered with the ends overlapping so as to leave gaps for entry to and exit from fields for trucks, carts and workers, and yet provide a continuous break for high winds. This simple sketch illustrates this point:

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          xxxxxxxxxxxxxx     xxxxxxxxxxxxxx
          xxxxxxxxxxxxxx     xxxxxxxxxxxxxx
xxxxxxxxxxxxxx          xxxxxxxxxxxxxx
xxxxxxxxxxxxxx          xxxxxxxxxxxxxx
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The Galba seeds should be broken out of the hard cover and as there

is not an unlimited supply, they had better be sown in nursery beds or bamboo pots at this stage, and transplanted at 6 inches or so high.

Recently another, and apparently successful method has been tried, and is in practice in one of the larger plantations. This is the use of a particularly very tall and hardy variety of banana—the Whitehouse (*Bachycarpa*), the fruit of which, happily is not relished. Established lines, five or six deep, seem to give good results.

Disease and Pest Control

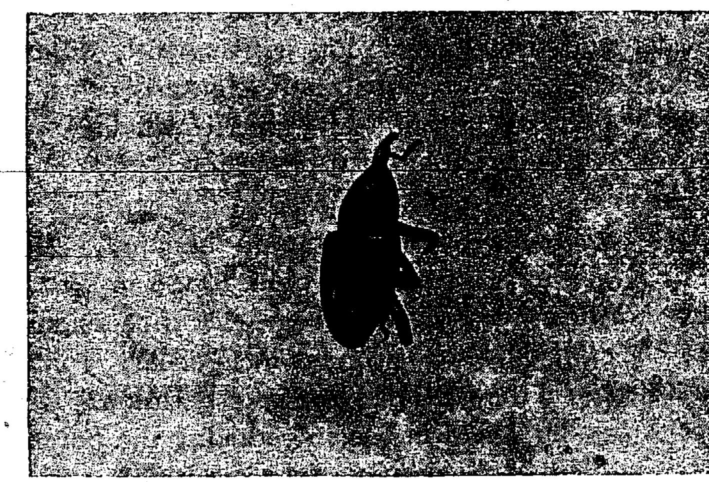


Fig. 3. Banana Borer (*Cosmopolites sordidus*)

The Banana Borer. A major pest of economic importance is the banana weevil borer (*Cosmopolites sordidus*). It is effectively controlled by rigid field sanitation.

Do not leave old 'heads' or bits of pseudostem lying around the field; chop them up so that they may dry out quickly. Field sanitation in banana cultivation is an essential routine practice and should never be overlooked by any banana grower.

Borer traps have been used for a long time with good results in banana cultivations throughout the island; their continued use is recommended.

Successful control has also been obtained by the use of Dieldrex (**Dieldrin**).

Dieldrin Remedy. The modern specific remedy for the control of banana borer, usually recommended in other countries, is an application of Aldrin or Dieldrin in water to mats of bananas, at the rate of approximately $1\frac{1}{2}$ lbs. of the active ingredient to the acre. Dieldrin is considered to have a more lasting effect in the soil than Aldrin.

Dry Dieldrin Test. As the application of Dieldrin in water is likely to be somewhat difficult in many localities in Jamaica, an experiment was designed to test the effect of applying the Dieldrin in a dry form. This was done by mixing the 50% wettable Dieldrin powder with—

(a) Local Gypsum Powder

(b) An artificial fertilizer.

The quantities used were:

(a) 4 lbs. of Dieldrin (50% W.P.) mixed with 96 lbs. Gypsum powder (2nd Grade) applied to the soil, after removal of trash, close around the base of each mat of bananas at the rate of 4 ozs., this being equivalent to approximately 2 lbs. of active Dieldrin per acre.

(b) Dieldrin (50% W.P.) mixed with an artificial fertilizer—sulphate of ammonia—in such proportions that 21 lbs. of Dieldrin were applied per acre close around the banana roots as frequently done during the process of adding fertilizers to banana plants. Latterly this treatment was changed in this experiment to apply the Dieldrin divided between four applications of the A.I.B.G.A. mixture C per year.

Experiments. Six plots in all were used in this experiment consisting of three replicated one-acre plots of ratoon bananas. The treatment included (a) and (b) as above and also plots receiving no Dieldrin as a check or control. Fifteen traps were laid on several occasions during the year following the start of the experiment in February, 1957. Each trap was located at the base of the same plant on each occasion.

The effect of the dry Dieldrin test in reducing the borer population has been so striking that, at the request of the A.I.B.G.A. and the Jamaica Agricultural Society, the results of this experiment are submitted here for the benefit of interested growers. (See Table 3.)

Smaller dosages, for instance 2 ozs. of the above Dieldrin/Gypsum powder per plant, would probably suffice but the effective duration of the treatment is likely to be shortened.

Mixing. To mix small quantities of any dry materials, such as Dieldrin powder and Gypsum, use can be made of empty 20 to 40 gallon drums through which an iron shaft is welded eccentrically, as shown below.

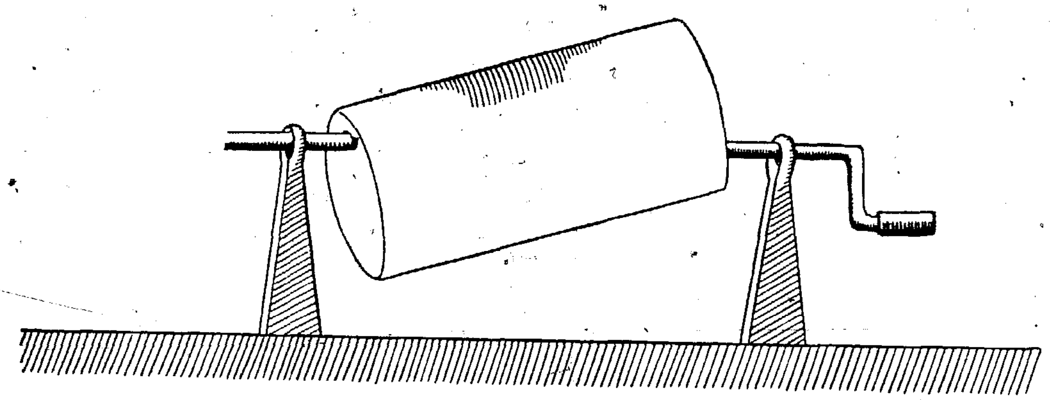


Fig. 4. Sketch showing simple mixing drum

An opening is made on the side of the drum large enough through which to put and empty the ingredients. Any simple seal can be tied over the opening before rotating the drum which need only be done slowly for a few minutes to ensure thorough mixing.

Precaution. Dieldrin powder should not be mixed with any other dry ingredient except in a closed container. Workers should wash their hands after working with Dieldrin mixtures, should not touch their mouths with their hands, should not smoke cigarettes or eat, until they have done so.

Soil Absorption Necessary. The Dieldrin is required to become absorbed by the soil after its application. This is best achieved by applying the mixture either at a time of year when dew is seen to be heavy on the ground each day or when the soil is wet after rain. In very dry weather much of the Dieldrin ingredient may get blown away if left uncovered.

Although the Banana Board Research Department is unable, at this stage in its investigations, to predict the level of borer infestation warranting an expensive control measure, the French in Guadeloupe consider that an average of more than one borer per trap after three days warrants it.

During a recent survey, using borer traps, in over thirty estates in Jamaica at various altitudes, this figure has been surpassed in nearly every case. It would therefore seem likely that borer control is required on most estates.

The present cost of Dieldrin 50% wettable powder is about 14s. per lb. and the local 2nd Grade Gypsum powder is about £7 a ton so that the treatment will cost approximately £3 10s. per acre in materials. The above experiment when completed will show the effective duration of the treatment.

Use of Borer Traps. Incidentally, a new type of borer trap has been found to be more effective than the old method of laying on the ground, at the base of a banana plant, a portion of pseudostem cut in half lengthwise. The new method was tried after following the instructions given for the application of B.H.C. gamma isomer mentioned above.

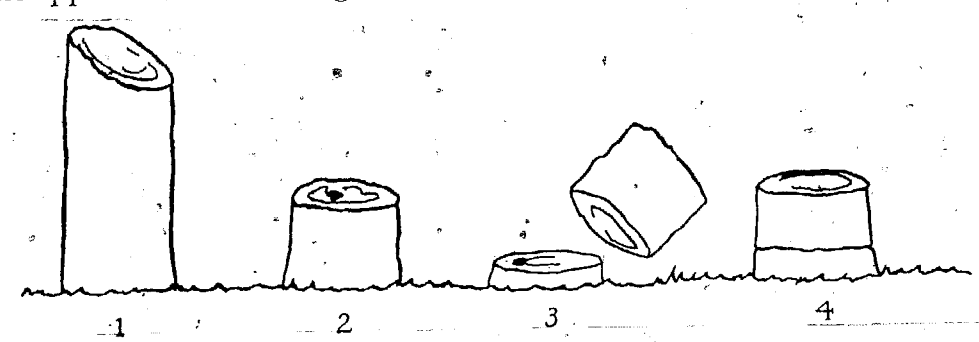


Fig. 5. Borer Trap

1. Strings of plant.
2. Portion cut across.
3. Two sections for trap.
4. Trap in position.

A fairly recently harvested pseudostem is cut across at a height of 6 inches from the ground. It is then cut across again at ground level. The severed portion is then just replaced in its original position. Borers collect freely between the cut surfaces at ground level. A comparison between the number of borers found in the new and old type of trap is given in Table 1 (borers counted each day and replaced) and in Table 2 (borers counted and killed each day).

Table 1

Total Number of Borers Counted and Left Each Day 'Undisturbed' (15 Traps)

Date	*Old Type Traps* Fresh	Medium	Old	*New Type Traps* Fresh	Medium	Old
16/7/57	15	10	8	47	51	26
17/7/57	29	16	9	96	75	46
18/7/57	33	13	15	133	82	66
19/7/57	42	11	11	151	91	57
20/7/57	38	24	8	162	96	53
21/7/57	39	18	10	171	119	60
22/7/57	45	22	12	154	96	48

Table showing daily catch of borers (1) when using old type traps (2) when using new type.

Table 2

Total Number of Borers Counted and Killed Daily (15 Traps)

Date	*Old Type Traps* Fresh	Medium	Old	*New Type Traps* Fresh	Medium	Old
6/8/57	40	29	20	65	45	24
7/8/57	29	17	11	79	60	42
8/8/57	10	12	14	24	47	24
9/8/57	8	9	6	29	22	23
10/8/57	19	8	8	45	24	35
11/8/57	14	2	7	32	16	12

Table showing daily catch (and killed) when using (1) old type traps (2) new type.

In very small plantations regular trapping, alone, might well assist in reducing borer infestation of banana mats.

Recent work in India has shown that the pseudostems should not be cut to ground level immediately after the bunches are reaped. It is claimed

that stems left cut halfway down or not cut at all favour the growth of followers more than those cut to ground level. It would seem advisable therefore to use pseudostems, for trapping, which have just started to dry and die back below the original cut surface.

How to use Dieldrin. Any grower wishing to use Dieldrin in water should add 1 gallon of 'Dieldrex 15' to 100 gallons of water (1·5 lbs. Dieldrin active ingredient). This is then adequate to water round the base of every mat in one acre of bananas, the quantity per mat depending upon the number of plants per acre.

Stronger concentrations of Dieldrin have been applied by mechanical knapsack mistsprayers such as those now used for applying oil for leaf spot control. This method is claimed to be quicker than any other and has the added advantage that the airblast from the nozzle is powerful enough to blow away the trash from around the base of a plant. In practice, however, this method is hazardous for the operator owing to possible inhalation of the misty droplets of Dieldrin.

If suckers, required for planting, are found to be heavily infested with borers they are best not used but, if they are, the outer layers of the corms may be trimmed off leaving a few eyes undamaged. If this is done it is important to dig out the heart of maiden suckers.

The Dieldrin/Gypsum powder mentioned above may be used at planting time, the powder being sprinkled into the planting hole but at a rate of only ½ oz. per plant.

Table 3

Number of Borers per 15 Traps

Treatment Applied February, 1957		June 24th	Sept. 5th	Sept. 7th	Sept. 13th	Sept. 13th	Jan. 58 10th
Dieldrin (50% wettable powder) In Gypsum	Plot 1	4	1	2	1	4	1
	Plot 5	4	0	4	1	1	0
Dieldrin (50% wettable powder) In Artificial Fertilizer	Plot 2	0	0	0	0	0	0
	Plot 6	3	1	2	2	1	1
None	Plot 3	24	8	12	22	14	9
Control	Plot 4	40	23	35	18	29	15

Table showing results from dry Dieldrin powder mixed with (1) gypsum (2) fertilizer.

Leaf Spot Disease.* Leaf Spot or Sigatoka† is a fungus disease which attacks banana cultivation throughout the banana areas of the Caribbean Islands and Central America. It was first identified in the West Indies in 1934. Spraying banana fields with a copper fungicide for the control of Leaf Spot disease has been a regular cultivation routine in banana cultivation in Jamaica ever since the disease became virulent in 1936. The *Gros Michel* variety of bananas is highly susceptible to Leaf Spot disease; so is the Lacatan variety.

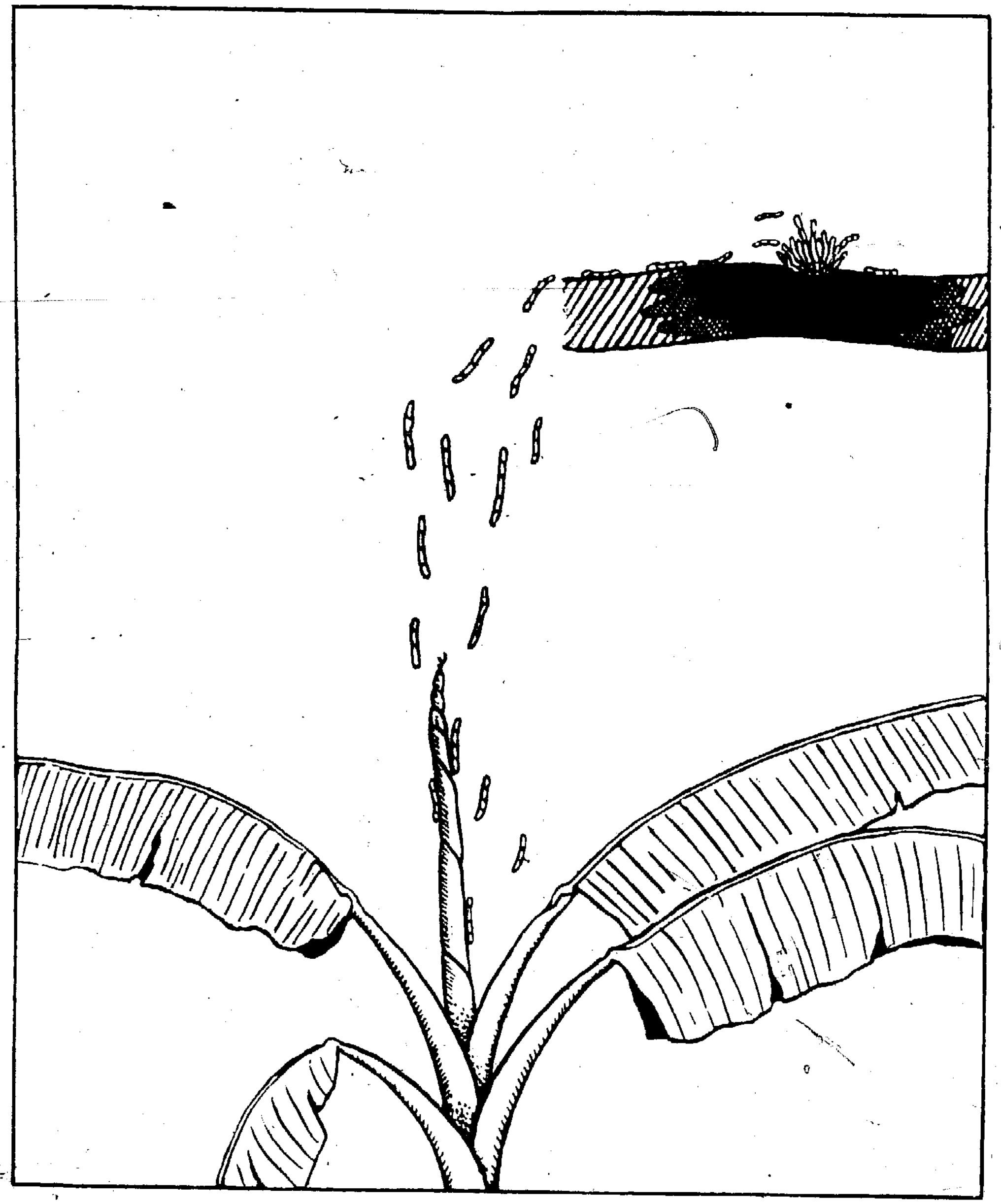


Fig. 6. How conidiospores are spread

* By courtesy of ALL ISLAND BANANA GROWERS ASSOCIATION LTD
† *Mycosphaerella musicola—Cercospora musae.*

The research programme for breeding a banana immune to Panama disease has been widened to embrace a banana also immune to Leaf Spot disease.

It is impossible to produce healthy bananas of good quality suitable for export without control of Leaf Spot disease in the field. This control is effected by regular, three-weekly spraying cycles of banana fields with Bordeaux mixture (the copper fungicide in popular use) applied at high pressure to the plants in order to obtain a suitable leaf cover as a protective measure against the spread of the disease; nowadays oil spraying. Bordeaux mixture is not a *cure* for Leaf Spot disease, it is a *preventative*, the objective being to keep all the leaves healthy and free from infection during the growth of the plant and to maintain these leaves in a healthy state so that the plant can carry the fruit and bring it to maturity.

When spotting or any other evidence of Leaf Spot disease appears on a banana leaf, that leaf is already doomed to destruction and the technique is therefore to cover the leaves with Bordeaux *before* the fungus establishes itself in it, that is long before there are any signs whatsoever of infection. For this reason the youngest open leaf of the banana plant becomes the most important leaf in the control campaign.

The recurrence of the spraying cycle is based largely on the rate of production of new leaves.

Investigation of the disease* showed that there are two types of infection. Two types of spore are produced by the Leaf Spot fungus. Conidiospores are borne by rain and dew drops down on to the folded edge of the heart leaf (see Fig. 6). Ascospores are dispersed in air currents. The spores enter the leaves where they develop and grow, destroying the leaf tissues as can easily be seen in the sunken, dark brown spots on diseased banana leaves. They enter the upper surface of the leaves and later produce spores which are washed on to other leaves and thus carry on the infection.

A single leaf spot goes through six stages. Firstly, it can be barely seen by the naked eye as a yellowish-green speck; then the speck increases in length, keeping the same colour. Thirdly, the speck grows in breadth as well as in length and turns rusty-red near the centre. At the fourth stage, the spot is clearly recognizable. It turns dark brown with a light brown, water-soaked halo around the spot, now increased in size. In the fifth stage, the dark brown part of the spot shrinks, appears sunken and the water-soaked halo turns a darker brown. In the final stage the spot is fully developed, the sunken area turns grey, with the halo, now very dark brown or black, forming a well-defined ring round the spot.

By and large, the above describes how the disease develops from water-

*References: J. Leach, *Banana Leaf Spot on the Gros Michel variety in Jamaica*, 1946; Martyn & McIlwaine, *Banana Leaf Spot Disease Control in Jamaica.*

borne spores. There are of course slight variations. For instance, on sword suckers the shapes of the spots are longish instead of round, while those on water suckers and young plants are larger and rounder than those on ratoons.

No one spot spreads in size over the leaf surface but when a large number of spots are formed closely together on a leaf or when a line of spots cuts off part of the leaf from the mid-rib the leaf appears to be scorched or burnt.

Particularly in areas where drainage is poor and fields not well cultivated the areas surrounding the spots turn yellow, especially in winter months.

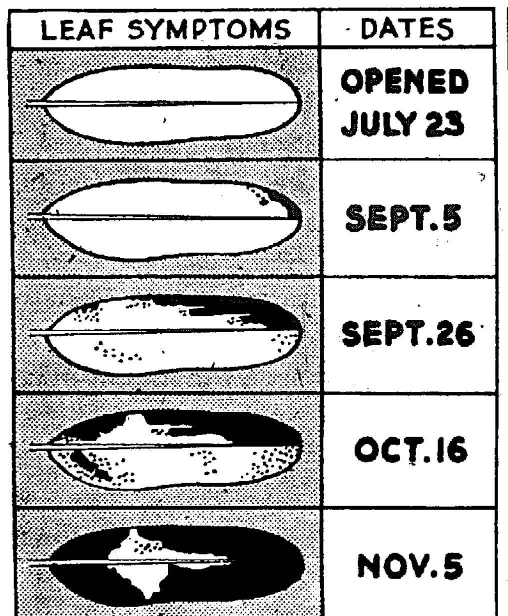


Fig. 7. Rate of development of line spotting

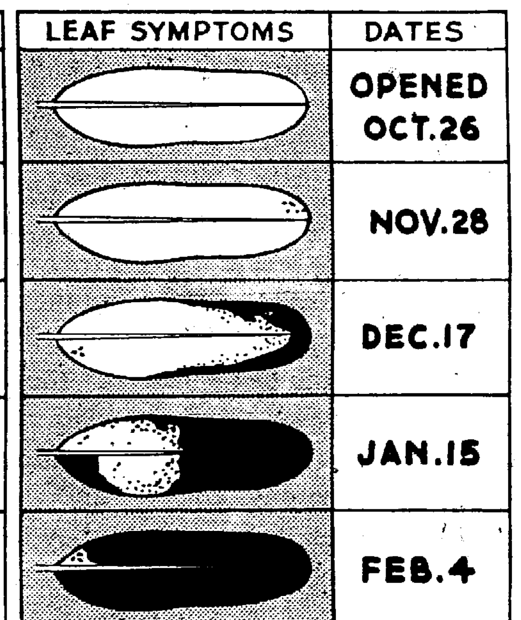


Fig. 8. Rate of development of tip spotting

Conidiospore infection results in 'line spotting' (see Fig. 7), while ascospore infection causes 'tip spotting'.

Ascospores, unlike conidiospores, are produced in the spots inside the leaf itself on living and dead trash. They are then shot out under wet and humid conditions, in upward currents of air, even when the air is very still, and they rise and strike the under surface, settling most towards the tips of the youngest leaves (see Fig. 9).

The **control** of Leaf Spot disease has been based upon regular three-weekly cycles of spraying with a copper fungicide plus sanitation of banana fields. Standard 4:5:50 Bordeaux has been the fungicide predominantly in use but Perenox, copper oxy-chloride and other proprietary fungicides have been used on a smaller scale.

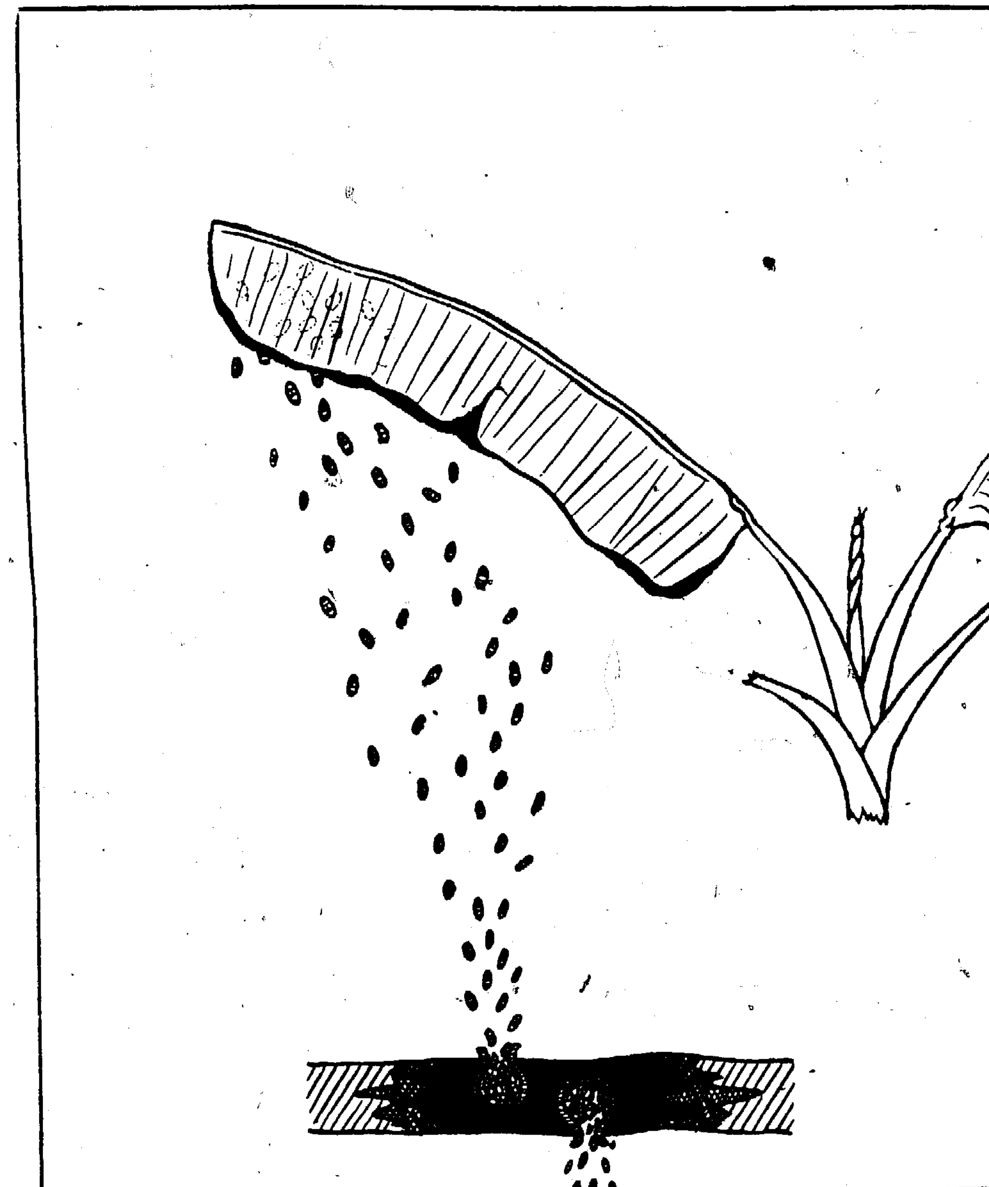


Fig. 9. How ascospores are spread

Experiments laid down for testing varying strengths of Bordeaux, other copper fungicides and stickers have shown that 4:5:50 Bordeaux to which Triton-X114 is added at the rate of 4 ozs. per 100 gals. is most satisfactory.

A new and very effective method of controlling the disease is that discovered in the French West Indies, namely, spraying with a light mineral oil, 'banana spray oil', at the rate of ½ to 1½ gals. per acre per cycle, depending on the amount of spotting present and the prevailing climatic conditions. The oil spray must not be directed at any special leaves or at the fruit but simply be allowed to drift amongst all the foliage.

A later method of Leaf Spot control by spraying with oil has been developed and is now recommended in place of Bordeaux.

For 18 years control of leaf spot or Sigatoka disease of bananas, in Jamaica, was confined to spraying with Bordeaux mixture (copper sulphate, lime and water) and in the first ten Gros Michel was the only variety sprayed. Today the acreage under Gros Michel is less than 10% of the total, now mostly Lacatan and Robusta.

Spray Action. Leaf Spot was originally well controlled by Bordeaux, without the inclusion of a wetting agent, because it stuck well to the older banana leaves on which the spots are formed. When the upper surface of these Gros Michel leaves was covered with Bordeaux the poisonous dew killed any germs produced on the spots overnight and thus prevented spread of the disease to the young leaves, except under certain conditions not mentioned here.

The same Bordeaux spray was not nearly so effective when first used against Lacatan and Robusta. To obtain control of Leaf Spot on these varieties Bordeaux must be sprayed on to the waxy, undersurface of the youngest leaves. When a wetting agent, Triton-X114, was added to the Bordeaux, Leaf Spot control was much more effective.

To maintain control on Lacatan and Robusta with Bordeaux the spray must be directed upwards at the youngest leaves and this requires careful supervision. Any breakdown in control results in serious effects on the fruit because Bordeaux is unable to stop the spots developing once the disease organism (fungus) has got inside the leaves.

Spray-oil acts in an opposite way to Bordeaux, being unable to prevent infection of banana leaves but being able to stop the Leaf Spot organism developing inside the infected leaves.

The first banana spray oil used was rather damaging to banana foliage and could scorch fruit badly. As a result of trials undertaken by the Research Department in conjunction with the three Oil Companies (Esso, Shell and Texaco), the new spray oils now used are less damaging to the plants. This is fortunate as Bordeaux spraying has deteriorated so badly that, apart from some estates with pipelines, Leaf Spot has become all too common in Bordeaux sprayed fields.

Oil spraying is now as indispensable to the banana industry of Jamaica as to that of the Windward Islands, French Antilles and elsewhere. Even should spray oil cause a slight loss in fruit weight per bunch, the loss is nothing compared to that of fruit rejected for purchase due to the ill-effects of Leaf Spot.

Symptoms. Four distinct stages are recognizable in the development of a leaf spot. A minute to small, narrow, yellowish streak gradually lengthens to form a broader, yellowish-brown spot, $\frac{1}{4}$ to $\frac{1}{2}$ inch long. This turns dark brown and, finally, the mature spot has a grey sunken centre surrounded by a well defined black ring.

The rate at which streaks and spots appear on a leaf depends on the number of germs of the Leaf Spot organism which have infected it. When infection is heavy, on unsprayed leaves, yellow streaks can start appearing within ten days, whereas when infection is very light no streak will develop for perhaps 2 or 3 months. New spots therefore continue to appear on a leaf throughout its life depending on the amount of infection which occurred on different parts of it when it was young. As germs settle mostly towards the tips of the youngest leaves, spotting nearly always appears there first on Lacatan and Robusta, giving rise to the well-known symptoms of 'tip-spotting' and the leaves become increasingly spotted throughout their life.

Most of the spotting seen in a plantation gives no indication of recent infection but records infection which occurred several weeks previously.

Spray oil is particularly effective in stopping the production and development of the yellow streak stage of Leaf Spot. If present in sufficient quantity the oil can also slow down and even stop growth of the yellowish-brown spots but it is unable to prevent reproduction of germs in mature spots.

Spraying Cycles. *Growers, naturally anxious to lengthen cycles to the limit of safety, should continually watch for the first signs of increasing infection.* This is best done by examining the youngest leaves for the presence of yellow streaks because these appear at least two weeks sooner than mature spots.

Followers are often less heavily infected than their parents.

The following schedule may assist growers to adjust their spraying cycles, based on symptoms of Leaf Spot visible in their plantations, on non-fruiting plants only:

Intensity of infection	*Youngest, open leaf on which several yellow streaks are visible*	*Youngest, open leaf on which mature spots are visible*	*Oil-spraying schedule*			
			Aerial		*Knapsack*	
			Cycle	*Gall/acre*	*Cycle*	*Gall/acre*
Heavy	2nd	3rd	2-weekly	1	2-weekly	$1\frac{1}{2}$
Medium	4th	5th	3-weekly	1	3-weekly	$1\frac{1}{4}$
Light	6th	8th	3-weekly	$\frac{3}{4}$	3-weekly	$1\frac{1}{4}$
Very light	8th	10th	4-weekly	$\frac{3}{4}$	4-weekly	1

Only where Leaf Spot is almost eradicated should spraying cycles be extended beyond 4 weeks, except in times of prolonged dry weather, in Jamaica.

Leaf Spot is often more difficult to control in plant crops than in ratoons because the older spotted leaves are so much closer to the young, susceptible ones on small plants. Mulching young plants with banana trash encourages Leaf Spot for the same reason, especially if the trash is heavily spotted. New plantings should be sprayed from the time the small broad leaves appear. *An early attack of Leaf Spot is serious because the number of hands a plant shoots is governed by the health of the plant in the first half of its life.*

If adequate oil spraying is maintained throughout the wet seasons, Leaf Spot may well become almost eradicated over large areas of Jamaica to the same extent that it has been by aerial application on the St. Catherine Plains. In districts notorious for Leaf Spot, such as Bog Walk, Great River Valley, Cave Valley, Guys Hill and parts of Portland, lengthening cycles beyond 3-weekly/1 gallon/acre is dangerous, especially in unshaded plantations, except in prolonged drought.

When morning dew is very heavy, knapsack and low-level aerial spraying should be delayed until after the dew has dried considerably or much of the oil may be removed in the water falling from the shaken foliage.

When large numbers of bananas are planted per acre to yield an increased weight of fruit, knapsack spraying becomes difficult and more damage to the foliage is likely to occur from the spray oil. To overcome these drawbacks definite spray paths, about 12 feet wide, should be made between every two rows of bananas planted 7 feet by 7 feet, or closer.

Leaf Spot control is financed through a cess per count bunch of bananas; the work of administrating and effecting this control is delegated to the A.I.B.G.A.

Types of equipment employed vary from pipeline installations to small hand-operated units for Bordeaux mixture.

Detailed information with respect to various types of equipment in use, the supply of materials, the mixing of Bordeaux, instructions on spraying and other information are available in Department of Agriculture Bulletin No. 46 (New Series—*Banana Leaf Spot Disease Control in Jamaica*, by Martyn & McIlwaine.

The following notes on mixing Bordeaux and on the use and care of hand-pumps and equipment should prove helpful to the smaller categories of banana growers.

The materials for mixing Bordeaux. Blue Stone and Lime are supplied free of cost to the grower by the A.I.B.G.A., and the pump, hose, lance and strainer are lent to him. These materials and equipment are available to the grower free of charge after he has completed and signed certain forms of application.

The grower has to provide for himself:—

Two barrels for water and Bordeaux
One kerosene tin
One condensed milk tin and a stirring stick
Water to mix the Bordeaux.

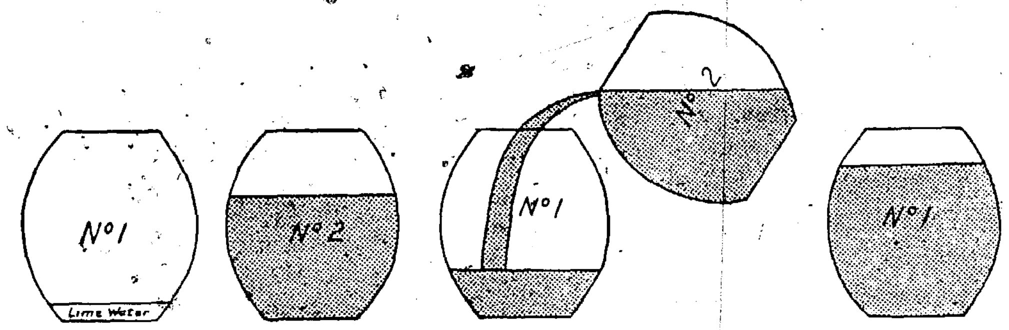
It is of the utmost importance that Bordeaux be mixed properly. Firstly, six condensed milk tins of white lime should be mixed in a kerosene tin containing about one gallon of water. This lime water should then be poured through a strainer into one barrel.

The other barrel should be at least half-full of clean water. Into this second barrel with water two condensed milk tins of Blue Stone should be put and stirred well until all the Blue Stone has dissolved.

Now comes the most important part of the mixing operation. *The Blue Stone water must be poured through the strainer into the lime water*—the contents of the second barrel into the first barrel—not the other way round; there must be continuous stirring while the Blue Stone solution is being poured into the Lime solution. One ounce of Triton-X114 is then added to the Bordeaux solution before the mixture is used.

The first barrel with the two mixtures in it, should be filled with clean water and stirred finally. There is now approximately 25 gallons of Bordeaux in the barrel which, with proper use, will be enough to spray a quarter acre or so of banana trees. The mixture must be continuously stirred and never allowed to settle while the trees are being sprayed.

The diagram below (Fig. 10) illustrates the entire operation. Unless the mixture is prepared in the correct way it will have no effect on the



Stage 1
No. 1 Barrel: 2½ lbs. or 6 Condensed Milk tins of Lime in 1 Gallon of Water.
No. 2 Barrel: 2 lbs. or 2 Condensed Milk tins of Blue Stone in 20 Gallons Water.

Stage 2
Pour the Blue Stone and Water in No. 2 Barrel on to the Lime and Water in No. 1 Barrel, stirring the mixture as you do so.

Stage 3
Now fill No. 1 Barrel with Clean Water.

Fig. 10

REMEMBER:

1. Always use a strainer.
2. Keep the mixture well stirred while you are spraying.
3. Wash out your Pump, Hose and Lance with FRESH water after you have finished work for the day.
4. Cover Every Part of Every Leaf of Every Tree with a Fine Coating of Spray.
5. NEVER use more than the quantity stated. You will only be wasting valuable materials.
6. To be effective, Spraying must be done REGULARLY AND THOROUGHLY.

disease, and all the efforts at spraying will result in a waste of time, labour and money.

The pump must be placed into the barrel of Bordeaux mixture so that the four wedge-like clamps fit the rim of the barrel snugly. If the stirrup type of pump is being used, the suction hose is put in the barrel and the pump placed firmly alongside.

One end of the hose is attached to the pump. This end of the hose should have a washer on it so that it can be screwed tightly on to the pump to prevent leaking—thus losing pressure which is so necessary for good coverage.

The other end of the hose should also have a washer and should be screwed firmly to the spraying lance.

When the hose has been attached to the pump and the lance to the hose, everything is ready for use. The pump is worked by moving the handle up and down, giving a *full stroke* each time so as to prevent uneven wear of the plunger tube.

In order that a reasonably large acreage may be sprayed without having to move the barrel of Bordeaux, a long line of hose is supplied to the grower. It is very unwise to have the hose longer than 100 feet for hand-pumps, and more than 200 to 250 feet for power-driven pumps. The longer the hose the less the pressure at the nozzle. The spray lance is made long so that the topmost leaves of a banana tree may be sprayed.

On the bottom end of the lance is an attachment for turning the spray on and off. Turning the handle to the right starts the spray and to the left turns it off. Whenever the sprayer is moving from one stand to another, the lance should be locked off so as to prevent waste of the mixture.

The lance issued with hand-pumps is equipped with an adjustable nozzle, very similar to that on a garden hose. The *knurled knob* which can be seen at the top of the nozzle is for regulating the amount of Bordeaux which comes through the nozzle during spraying.

This is a very important part of the nozzle. The hole is so small that it becomes clogged very easily. When this happens it should be removed and cleared by blowing hard through it. On no account should the sprayer enlarge the size of the hole. Clogging of this part can be prevented, however, if sufficient attention is paid to the straining of the mixture during the preparation of the Bordeaux.

Bordeaux should never be sprayed on to the leaves of a banana tree in a heavy stream; it must be applied as a mist. Using a heavy stream instead of a mist spray is bad spraying practice. It will waste the mixture and greatly reduce the number of trees that should be covered with a barrel of Bordeaux. Further, if the Bordeaux is applied in a stream, the mixture will bounce off the leaves and will not stay on and provide a protective coating against the spores when they attack the leaves.

The knob should be adjusted until the mixture issues forth in a fine mist. When sprayed in this way, Bordeaux mixture will form a thin coating which will protect the youngest leaves against the spores causing the disease.

The nozzle should be held at least 4 feet from the leaves so that the mixture will not hit the leaves too heavily and run off.

To make sure that the trees will produce good stems of fruit **every** portion of **every** leaf of **every** tree should be entirely covered with Bordeaux mixture throughout the entire life of the tree.

It is of the utmost importance that a thorough job of spraying be done as the disease will quickly seize the opportunity of striking at those leaves and portions of leaves of trees left unsprayed. Neither does it serve the purpose for a grower to spray today and not repeat the process until months later. Spraying should be done at regular intervals. Banana trees should be sprayed at least once every three weeks, all year round.

To get the best results from the spraying equipment, the pump, hose and lance should be thoroughly washed out with clean water at the end of each day's work.

Special care should be taken to see that no Bordeaux mixture is allowed to remain in the hose or lance. The best way to ensure this is to adjust the knob on the nozzle until the water leaves it in a heavy jet, and most important, until clean water is pumped through it.

Inner and outer cleanliness of a pump are essential if it is to be of lasting service.

All the moveable parts of the pump should be properly oiled after each use. If the pump is not properly cared for, it will soon become defective. This is bound to have an adverse effect on your spraying operations.

The hose should be coiled up when not in use and stored in a shady place. Long exposure in sun and rain will result in cracking and bursting of the hose.

Various types of pumps are in use in the Leaf Spot control campaign in Jamaica ranging from small stirrup pumps to large diesel-driven pumps, used with a permanent pipe-line system. Every banana grower is entitled to a pump and equipment (or to share in the use of them) adequate for him to undertake the spraying of his banana field on a regular recurrent three-weekly spraying cycle.

A recent development is the use of oil spraying to control Leaf Spot. It was discovered by French scientists in Guadeloupe that applications of Orchard Spray Oil in the form of a mist could arrest the development of the disease and prevent its further spread. This has led to the practice of mist-spraying with oil in many areas in Jamaica. On the larger estates the spray is applied by fixed-wing aircraft and on uneven terrain small motorized knapsack mist-blowers are used.

Storage diseases of the banana are **Anthracnose, Finger-Stalk Rot** and **Main-Stalk Rot.** These occur after the fruit has been cut, and accordingly have nothing to do with the growing plant. They are of importance, however, as they have particularly to do with the handling of the fruit between the time of cutting down and stowing on the ship. The point to be emphasized, therefore, is that extremely careful handling of the banana after reaping has to be observed, if financial loss is to be avoided, arising from blemished fruit and lower market prices.

Anthracnose. Anthracnose is a most unsightly disease which affects the fingers of Jamaican bananas, being characterized by large, black, wet, slightly sunken, oval to elongated lesions on which the fruiting bodies of the fungus, *Gloeosporium musarum*, are usually present as a pink encrustation. The most conspicuous feature of Anthracnose, especially on green fruit, is a prominent **orange-yellow border** up to a quarter of an inch wide all round the black rotted central area. Anthracnose does not enter the fruit more than skin deep, so that the pulp is not affected but no customer is going to be persuaded to buy such badly disfigured fingers except at reduced prices.

Experimental work has demonstrated that the Anthracnose fungus infects slight wounds or abrasions on green fruit. Rotting is slow for the first 7–8 days on shipboard, but becomes very active afterwards. It has also been shown that Anthracnose of this form does not occur on unwounded fruit. It is obvious, therefore, that considerable care must be taken in handling fruit in order to reduce the amount of this disease.

Finger-Stalk Rot. Finger-Stalk or Santa Marta Stem-End Rot is caused by a fungus entering the stalk at a finger when it is bent sufficiently by rough handling or excessive weight to damage the squeezed tissues of the stalk. *The rot may pass down the short stalk, enter into the cushion and thence pass into and rot the base of adjacent fingers so that many fingers of a hand may be affected.* Santa Marta Stem-End Rot is the main cause for fingers dropping off or coming loose in the polythene bags at the end of the voyage. Again, it is evident that careful handling should reduce the incidence of Santa Marta Stem-End Rot.

Main-Stalk Rot. Main-Stalk or Soft Stem-End Rot ultimately gives rise to loose fingers in much the same way as Santa Marta Stem-End Rot but, instead, the fungus rot passes into the cushion of a hand from a rotted stem, and thence into the finger-stalks. The correct application of polyethyline sulphide, a fungicide, to the freshly severed main-stalk butt and tip provides good control of Main-stalk rot.

Scarring. Scarring results from any superficial blemish which turns the tissues of the fruit skin black without causing active rotting.

Latex Stain. This is caused by the sap or juice (latex) which flows from the cut main-stalk or from damaged fingers on to other fingers. On

drying, the latex develops a dark brown colour resulting in unsightly fruit.

In the case of both Scarring and Latex staining, there is usually no detrimental effect on the pulp, but the price realized for such fruit is often lower than for clean fruit.

Both blemishes may be prevented by careful handling, trucking, and trimming.

Speckling. Recent investigations by Dr. D. S. Meredith, Banana Board Research Department, have shown that a common fruit spot, variously known in Jamaica as 'speckle' or 'swamp spot', is caused by a fungus—*Deightoniella torulosa*. The very small black spots are smooth and can be distinguished easily from those caused by thrips which are raised and therefore rough to the touch. Speckle was formerly believed to be a physiological disorder brought about by factors such as heavy and prolonged rainfall, high atmospheric humidity and poor soil drainage inside the plantation. These climatic and soil factors are, indeed, most important for the development of speckle, since the process of infection by the fungus is favoured by them. Thus, it is almost common knowledge among growers that heavy attacks of speckle may be anticipated in certain areas during the rainy seasons.

There is evidence to suggest that speckle is, in general, more severe on the lowland plains of St. Catherine and Clarendon than elsewhere in Jamaica. The reason for this distribution is not yet clear but is being investigated at present.

A method of controlling speckle is suggested by the fact that the causal fungus is a common mould on dead or dying banana leaves, either hanging from the pseudo-stem or lying on the ground. Chopped-up pseudo-stems are also a source of infection. In fact any form of banana 'trash' may be suspected of harbouring the fungus. Several growers have remarked upon the fact that removal of as much 'trash' as possible before heavy rains resulted in almost perfect control of fruit spot: weed removal was also beneficial. Uncleared plantations downwind of clean ones showed a high incidence of spotting. Arrangements have now been made to test the effect of detrashing and plantation hygiene on the incidence of fruit spot. It is of importance to assess for each area the amount of extra labour costs and to compare them with expenses involved in using possible alternative control measures such as fungicidal treatment or bunch-protecting plastic bags.

Premature Yellows. A banana disorder, first reported at Woodstock, Portland, in 1953 and subsequently found widely scattered throughout the island, was investigated by N. W. Simmonds and P. B. Hutchinson of the Imperial College of Tropical Agriculture, Trinidad. It was found invariably associated with low soil potash. E. A. Tai, Crop Physiologist in the Banana Board Research Department, has since designated the condition as Premature Yellowing from its chief symptom. It is, however, now to be re-named Premature Yellows. Tai's experiments have conclusively demonstrated that it can be cured by suitable applications of potash fertilizers.

Symptoms. There are two characteristic visible symptoms by which premature yellows can be clearly distinguished from other banana maladies. Firstly when leaves are starting to die they turn bright orange-yellow in colour compared to the yellow of normally ageing banana foliage. Secondly, when the leaves die back from the tips and, to a lesser extent, from the margins they turn brown and remain erect. Usually at least two dead leaves remain upright but frequently three or more do so. The affected leaves do not usually yellow progressively from the oldest upwards and one or more completely green leaves may sometimes occur within a group of yellowing leaves.

Other causes of yellowing, such as Leaf Spot, wintering, faulty drainage, drought, etc., can be clearly distinguished by the leaf stalks collapsing, frequently before the leaves are dead.

When plants suffering from Premature Yellows are viewed, especially from a distance, the dead upright leaves can give a mistaken impression of severe Leaf Spot. Leaf Spot can, of course, attack plants affected by Premature Yellows. Now that Leaf Spot is being progressively reduced throughout the island by successful oil spraying, Premature Yellows is tending to become more easily noticed.

Premature Yellows most frequently appears first with the commencement of shooting of the plant crop and the suddenness with which it can appear throughout a field often gives the impression of an epidemic spread.

The severe loss of foliage adversely affects the development of the fruit and may even result in the complete absence of commercially acceptable bananas in the crop, despite the occurrence of good 'grades'.

A third and interesting symptom of premature yellows can be a useful check on diagnosis, although unfortunately for that purpose it only occurs on ratoon plants and, even then, usually near the time of shooting. If a mature ratoon plant affected with Premature Yellows is cut down at ground level there are nearly always a number of brown patches visible, scattered in the white ground tissue of the head. In these brown patches there is no evidence of rotting and the tissue is hard to the touch.

Cause. Banana plants suffering from Premature Yellows contain an insufficient supply of potash for their normal development. This is the main, if not only, cause of this disorder which tends to be more in evidence in the dry than in the wet seasons.

Treatment. With the exception of very few soils, notably the deep rich alluvium of the St. Catherine plains, those on which bananas are grown must be fertilized with potash for the consistent economic production of good quality fruit. Where soil analysis indicates medium to high available potash (250 ppm K_2O), the use of the A.I.B.G.A. Mixture C fertilizer, 10 : 5 : 15, normally supplies adequate potash for satisfactory prevention of Premature Yellows. In cases, however, where available potash is less than 250 ppm the use of A.I.B.G.A. Mixture E fertilizer, 14 : 0 : 20, is recommended.

It is simpler to avoid Premature Yellows than to correct it once it has appeared in a banana field. Where required, potash fertilizers should be applied from the time of planting. In the presence of Premature Yellows it is necessary to supplement the regular fertilizer with extra dressings of potash. In this connection it has been found that frequent applications of relatively small amounts of potash are more effective than less frequent applications of larger quantities. In a severely affected field, in St. Thomas, 8 dressings of ¾ cwt. muriate of potash per acre yielded superior results to 2 dressings of 3 cwt./acre or 4 dressings of 1½ cwt./acre where no other potash was applied.

Comparisons between symptoms of Leaf Spot and Premature Yellowing

	Leaf Spot	*Premature Yellowing*
Colour of dying leaf	Yellowish	Orange
Dead leaves	Brown area containing some spots with lighter coloured centres and often surrounded with clearly defined, thin, black lines	Uniformly brown
Position of recently dead leaves	Hanging down beside pseudostem	Not breaking at base. Base of leaf remaining upright, blade frequently breaking near the middle
Number of dead leaves	One, just before falling	Frequently two or even three dead leaves remain upright. Sometimes one or two dead leaves occur in the middle of the green foliage, i.e. not always in the order of age

Leaf Spot symptoms are exaggerated where Premature Yellowing occurs and there is some evidence that under such conditions curing the latter improves the efficiency of Leaf Spot control.

The Nematode Problem

Several nematodes (eelworms) attack banana roots. The burrowing nematode (*Radopholus similis*) is the most serious one in Jamaica. It attacks the thick, fleshy banana roots and the fine feeder roots; it also attacks the outside of the head into which it may penetrate quite deeply. Wherever it invades banana tissues, these first become orange-yellow and then quickly turn dark purple, after which they soon become black due to rotting caused by other organisms. Severely attacked roots may die right back from the tip to the nematode infected area. Heavily infected root systems reduce the absorption of nutrients from the soil so that the grade and weight of fruit may be adversely affected. When several of the large roots are rotted near the head, a plant is so poorly anchored in the soil that it can be uprooted and topple over very easily, especially when bearing a bunch. The burrowing nematode can therefore do a tremendous amount of damage in a banana plantation.

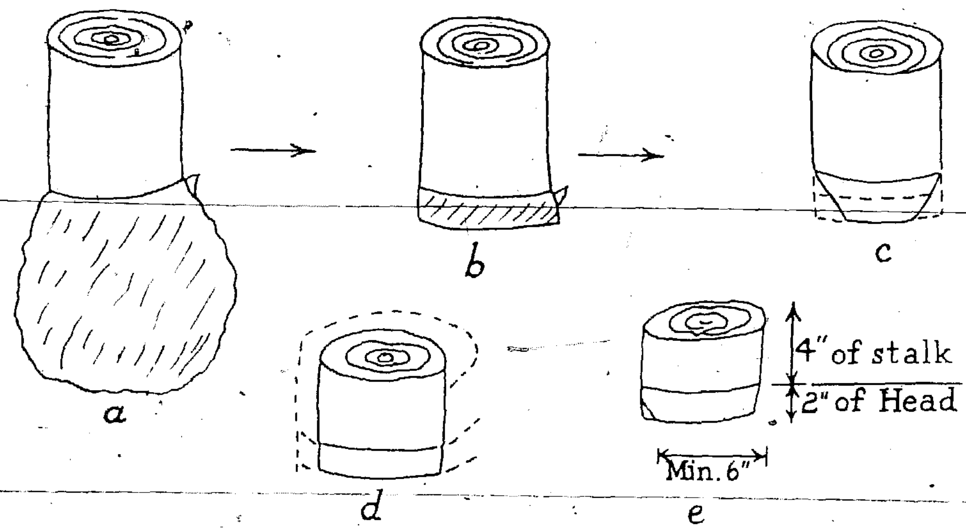


Fig. 11. Preparing clean suckers

(*a*) Sucker
(*b*) Head cut off to leave 1 to 1½ inches
(*c*) Sides cut removing outer buds
(*d*) Stalk cut and bark stripped to leave clean sucker
(*e*) Clean sucker after inspection by paring with knife. Ready for dipping and planting

Mats gradually become more and more heavily infected with nematodes with the result that the effective life of a plantation may be so shortened as to enforce re-planting. On the irrigated plains, for instance, experience is showing that this should be done about every three years. In general, Lacatan and Robusta bananas are riddled with the burrowing nematode throughout Jamaica and loss of fruit for export must be considerable.

Extremely few nematodes are known which attack individual economic crops without attacking some form of weed as well. As a result nematodes are usually very difficult to eradicate from a soil although a rotation of crops and good husbandry may assist in reducing nematode populations. In recent years soil fumigants have been used for controlling nematodes. One of these has been used successfully against the burrowing nematode

on bananas in West Africa but it has proved disappointing when applied to bananas in Jamaica both by the Research Department and by the manufacturers.

Mr. C. A. Loos, recently nematologist in the Department, has just concluded work on the burrowing nematode which he started three years ago when working with the United Fruit Co. in Central America. He made the following important discoveries:

The burrowing nematode is by far the most serious nematode attacking bananas in Jamaica.

Banana suckers can be cleaned, free of nematodes, by severe trimming.

Plants developing from the central heart bud of a trimmed maiden head make as rapid and strong growth as those developing from side buds. Thus suckers can be trimmed very much more heavily than has ever before been thought possible. Bull-heads are unsuitable suckers for cleaning because too many side buds have to be cut away and there is no central heart bud.

The banana burrowing nematode does not attack any other plant in Jamaica as far as is known.

The banana burrowing nematode cannot survive in the soil for more than two months after the last trace of banana tissue has been destroyed and killed. This nematode can therefore be eradicated from old banana plantations. For safety, fields can be considered free of this nematode six months after the last trace of banana growth has been seen in a cleared plantation.

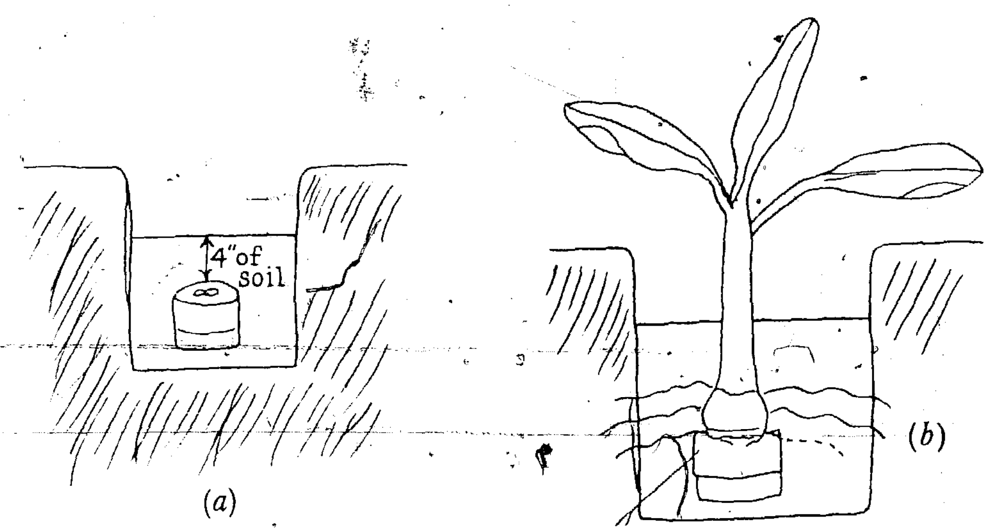


Fig. 12. Planting

(*a*) Normal Banana hole with clean sucker set for heart growth.
(*b*) Shows how heart growth is formed. This is reason for not planting too shallow.

Growers are faced with the problem of how they can best benefit from these discoveries. In order to build up plantations free of the burrowing nematode it is obviously essential to plant absolutely clean suckers in land free of this nematode. To be done thoroughly this needs expert supervision; information is obtainable from the Banana Board Research Department.

Advice to Growers. Cleaning of suckers can be done on commercial cultivations, at little extra cost to the grower, to give satisfactory results immediately. Remember that this method will carry some infection to your fields with your first planting, but subsequent plantings from this one, only with suckers showing no infection and *also carefully cleaned*, will mean that your second planting will be practically free of infection. The third planting must be with suckers taken from the second planting. *All plantings must be done on clean land.* Following normal replanting practises your entire cultivation can become nematode free in a few years to give you increased production and longer ratooning from your bananas.

Important Points in the Cultivation of Nematode Free Bananas

1. Clean suckers will give good germination in good cultivations.

2. It will take only a little longer time, if any, to reap the plant crop.

3. Heart growth gives just as good results as other plantings, but gives better germination in a shorter time when using well trimmed clean suckers.

4. Experience elsewhere has shown that in very good soils there is little or no difference in the results of the plant crop, the big difference is in the ratoons.

In poorer banana soils better results should show up from the plant crop because of better fertilizer utilization.

5. Ratoons last longer saving the big expense of replanting often.

6. A good root system means better utilization of fertilizer.

7. There is less uprooting and so less damage from light winds and heavy rains.

8. Clean suckers do not carry borer into new plantings.

9. There is no high costs involved in planting clean suckers, but it needs *very careful attention.*

10. It is no good putting 'clean suckers' in infected land. *Clean suckers must be put in clean land.*

11. The Banana Board will be pleased to arrange demonstrations and provide further advice on application.

Clean Land. First you must have *clean land*. This means land that has been free of banana or plantain growth for six months before planting.

The land must not be liable to flooding with water from diseased areas bringing in infection.

Clean land can be obtained in the following ways:

1. **Rotation:** Plant another crop for income but be sure all banana growth is dead six months before replanting in bananas.
2. **Fallow the Land:** Dig out all bananas and chop up thoroughly. Repeat at short intervals to make certain that all banana growth is dead. Allow grass to grow, use repeated discings if possible to destroy all growth six months before replanting.
3. **New Land:** Pasture, wood or ruinate land that has had no bananas for a long time.

Preparation of land. Follow your usual practice except when the land requires heavy trenching, try and do it before planting as the heavily cleaned suckers are a little delicate. Early cultivation will pay.

Clean Suckers. Use only *Maiden* suckers. The suckers must be large to allow for trimming to not less than 6 inches in diameter for best germination. They are easier to clean well if they are fresh and not bruised. Do your trimming away from your field to avoid carrying infection and be sure to *dip* the suckers immediately after cleaning.

It is better to 'over trim' than leave one nematode in the sucker. The work goes better and easier with very sharp machetes or knives. *First*, split a sucker to see how badly they are infected. Any type of *discoloration*, *cut* or borer is a source of infection so, to be safe, cut at least ½ an inch below it.

A good machete man can do this in one operation; but it is better to let another man or woman pare the sucker with a knife to make sure all infection is cut away and no nematodes are carried into the field. Discard all small, cracked or cut suckers. The finally cleaned sucker should have 4 inches of stalk (cabbage) and 2 inches of head.

You now realize the heavy trimming necessary, so do not waste time with paring, but cut deeply with the machete to complete the job quickly. Use the knife only for inspection.

Now dip the suckers in a nemagon mixture for 3 to 5 minutes, allow to dry in the shade. Plant next day. Treat the suckers very carefully.

One man will soon learn to do over 500 suckers per day.

Dip Mixture. In 100 gallons of water:

44 lbs. Copper Sulphate	All in 100 gals. water
44 lbs. Lime	
12 oz. Triton	
2¼ pts. Nemagon (75% E.C.)	

Planting. Plant upright in hole to allow for heart growth. Do not cover with more than 4 to 6 inches of soil. Remember that heart growth will bring the new head above the planted sucker, so do not plant too shallow.

Fertilizing. Fertilize young plants with 2 to 3 ozs. of fertilizer (of your normal mixture) every month for the first six months. After that continue your usual fertilizer applications and cultivation practices.

CHAPTER 21

Citrus

(i) Economic Importance

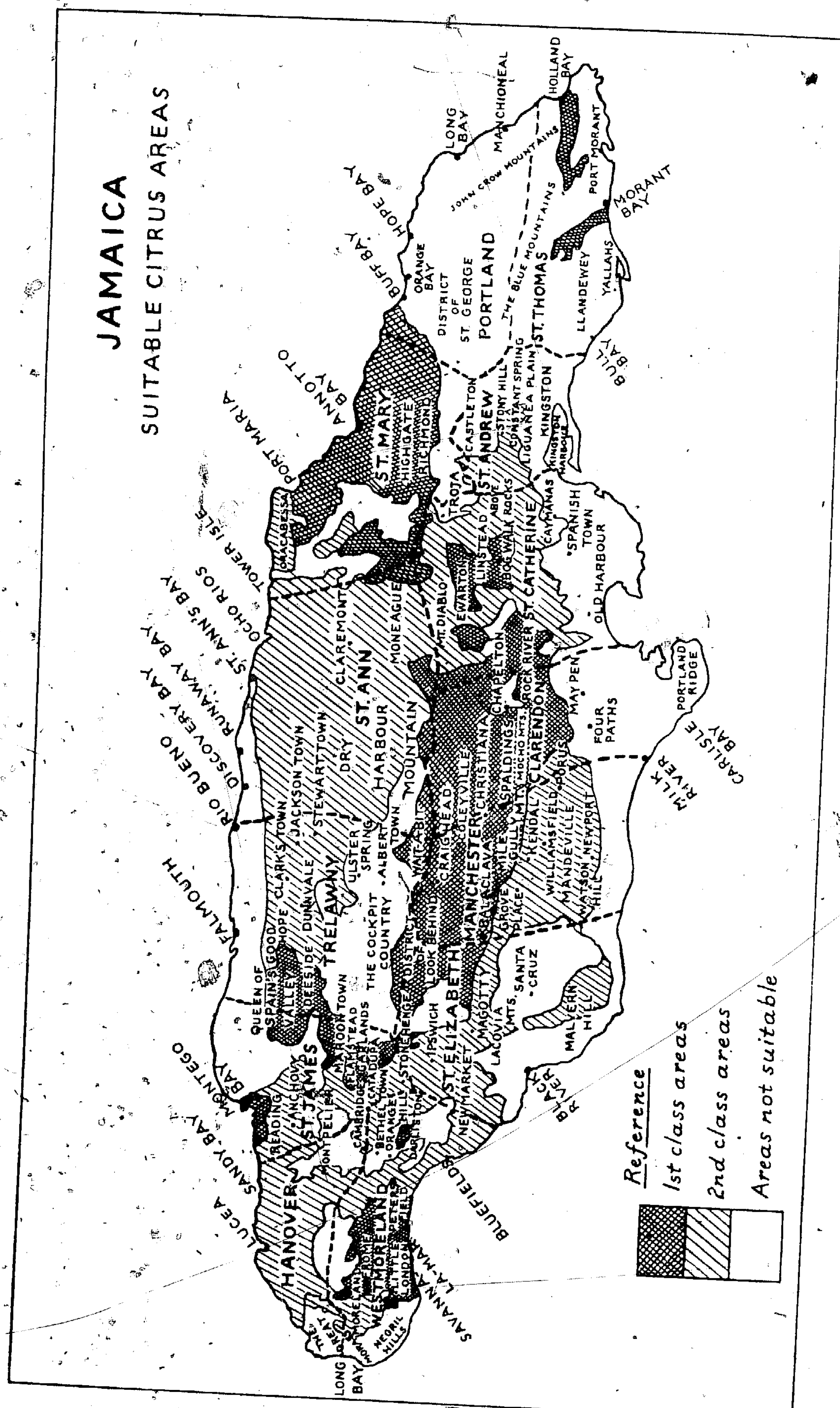
Citrus ranks third among the export crops, the total value of exports of this commodity exported processed and fresh in 1957 being £1,728,297. Of the total value of the crop exported in that year, citrus juices followed by preserved fruit, mainly grapefruit segments, valued at £675,709 and £633,813, respectively, were the most important items.

Fresh fruit exports in 1957, comprising oranges, grapefruit and other citrus fruit (mainly ortaniques and uglis), in that order, valued £303,230. New Zealand and the United Kingdom remain the important markets for this commodity. The average price for oranges is in the region of 9s. 11d. per box for export fruit and 6s. 11d. per box for processed fruit, while grapefruit prices average 6s. 7d. per box for export and 5s. 6d. per box for processed fruit.

The local market demand is for fresh oranges, which fetch wholesale prices in the field of 12s. to 25s. per box and retail prices at 30s. to 90s. depending on the supply. Estimates of current local consumption of citrus fruits range from 300,000 to 400,000 boxes and a potential market in 1965 of half a million boxes.

Based on a 1956/57 survey of citrus in Jamaica, the population of bearing trees of oranges and grapefruit total just over 3,300,000 with an estimated yield of 1,400,000 boxes. Yields are therefore extremely low by standards achieved in Florida and other citrus producing areas of the United States of America. The major factors responsible have been the poor methods of husbandry practised by most citrus growers with particular respect to regular and adequate fertilizer application and control of pests of which the Fiddler Beetle and Slugs are of major importance, particularly in young groves.

From the present orange and grapefruit population of bearing trees correction of poor fertilizer practices alone can, within three years, raise the average yield to at least three-quarter box per tree, and the implementation of good husbandry practices generally can, within five years, achieve 2½ million boxes of oranges and grapefruit for the export market.



(ii) Selection of Crop, Variety and Site

Selection of Citrus. A farmer considering planting citrus should ask himself the following questions:

(i) Is citrus the best crop for the piece of land I intend using for this purpose?

(ii) Could I make more money off one or more other crops over a period of ten years?

(iii) What is the cost of growing citrus and how can I finance this cost for at least 5 years?

(iv) How costly will it be to get the crop to the market or packing house?

(v) What will be the market price of citrus when the trees start bearing 5 to 6 years from now?

If the farmer has questioned himself and his Extension Officer on the above points and is satisfied that citrus, which costs him in:

	£
(*a*) cash	x x x
(*b*) his own labour	x x x
(*c*) hired labour	x x x
(*d*) use of his land or rental	x x x
(*e*) debts for fertilizer, etc., that must be paid	x x x
	£200 – –

£200 per acre, at the end of 5 years will pay him in the long run sufficiently to warrant him planting citrus, then his next important question to decide is what type or variety of citrus he should plant.

Selection of Variety. Citrus is divided into types or groups:

(i) oranges;
(ii) grapefruit;
(iii) hybrids, such as ortanique and ugli.

Oranges. The important varieties are:

(*a*) *Parson Brown.* This variety is very seedy, matures early and can be reaped in most parts of the island in October and November.

(*b*) *Hamlin.* This variety matures slightly later than Parson Brown.

(*c*) *Pineapple.* This variety matures about the same time as Hamlin.

(*d*) *Valencia.* This variety is much less seedy than the Parson Brown and is the latest in maturing and in most of the island is not ready until January and February of the following year, after blossoming in April and May.

Grapefruit

(*a*) *Marsh Seedless* is the most important grapefruit variety grown throughout the world and enjoys the widest acceptance by consumers in the important temperate markets. Unlike oranges the local demand for grapefruit is negligible and this crop is almost entirely dependent on foreign markets.

In the north coast parishes of Portland, St. Mary and St. Ann, oranges and grapefruit mature their main crop earlier than in most other parts of the island. The Parson Brown crop in Portland, for example, matures as early as August and in parts of St. Mary, grapefruit will start maturing from July. This is particularly important to the grower as he will enjoy a lucrative local market for the oranges, and export market for grapefruit between August and October.

Hybrids

(*a*) *Ortanique*. Ortanique is the most important citrus hybrid grown in Jamaica. From one of its parents, the tangerine, it has inherited a preference for cooler climates with moderate rainfall such as occurs in the higher areas of Manchester and parts of St. Ann. In hot, low-lying, high rainfall areas the fruit tends to be of poorer colour and quality.

Ortaniques are grown primarily for export to England and New Zealand. The supply to these markets is relatively small at present and therefore fruit of good quality fetch good prices as they enjoy something of a luxury status in the market. As the supply of this fruit grows it will come into greater competition with oranges and may have to be sold at prices comparable with oranges.

(*b*) *Ugli*. This is another citrus hybrid grown on a limited scale in Jamaica. It has a very limited export market and is of little or no importance on the local market.

Selection of Site. The first and most important fact that the farmer must bear in mind with regard to the question of selecting a site for planting citrus is that it is not he who selects the site that citrus is to grow on but the citrus that selects the site it will grow on. In other words citrus can, and will, refuse to grow satisfactorily on soil and in a climate that is not suitable for it. Farmers setting out citrus in areas not suitable for it can only expect half or less than half the yield they could get on suitable land and the cost per acre of maintaining these trees will very often be much higher than in good citrus areas. In other words, much less fruit will cost much more per acre.

Soil. The most suitable soils for citrus are light medium to medium loams which possess free surface and internal drainage to a depth of at least 4 feet.

Such soils possess the ability to retain both moisture and nutrients at satisfactory levels even during periods of excessive rains and moderate droughts.

Excessive rains seep fairly freely through these soils yet they resist washing out of fertilizer added to the soil and retain sufficient moisture to maintain the trees in good growth for as much as two months of drought.

Heavy soils are easily water-logged, are hard to drain and exert great resistance against the plants in their effort to extract moisture during droughts. Roots are stifled, and because they cannot breathe, root development in these soils is usually very poor.

In very light, sandy soils fertilizers are readily washed out and in the shortest drought plants begin to wilt.

Shallow soils with less than 4 feet of good 'top-soil' must be avoided at all costs. Trees may grow successfully on them for the first 5 to 6 years but cease further development and begin declining due to the roots extending into a high water-table or underlying flatrock or marl. In the case of marl nutrient deficiencies develop due to the high incidence of calcium and the absence of most of the important nutrients.

Rainfall. Areas in Jamaica with:

(*a*) suitable topography;
(*b*) protection from winds; and
(*c*) suitable soils for citrus

that can be effectively and economically irrigated from rivers, streams or underground water sources are very limited. The annual rainfall should be 60 inches and over with distribution averaging not less than 1 inch in any one month.

Slope, Gradient. Citrus may be planted on land having up to 25 degrees of slope. Very steep slopes should be avoided as these present difficulties in soil and water conservation and cultivation. Very steep slopes are usually heavily eroded, shallow, and rocky and should be used for forest crops.

Flats and basins which collect flood waters and are difficult or impossible to drain should be avoided.

Sites located on deep, gently sloping land well protected from winds by hills, mountain ranges or natural forest, are the ideal location for citrus groves.

Elevation. Areas 1,200 feet in elevation above sea-level should be used for ortaniques in place of oranges.

The ortanique is a much more vigorous and prolific bearer than the orange on the more elevated areas of Central and South Manchester.

Ortaniques do not do as well in higher rainfall areas below 1,000 feet elevation. Under these conditions fruit quality tends to be poorer in colouring and flavour.

Protection. Sites exposed to strong prevailing winds should be avoided.

Apart from the damage to fruit trees are more susceptible to drought conditions due to the drying action of the winds.

In addition, infestation of trees by scale and mites is particularly severe and the greatest severity of attack can always be noted in the most exposed side of orchards.

Wherever possible, orchards should be located on the leeward side of hills or woodland, and where this is not possible windbreaks of mango, otaheite apple, or some other suitable thick-foliaged, quick-growing and sturdy tree should be planted closely in relation to their normal planting distance along the exposed side of the proposed site.

Below are outlined areas or zones in five parishes which provide the best conditions for the different citrus varieties.

The zones or areas listed are based on soil, climatic conditions (mainly rainfall) and proximity to the two major packing and processing plants located at Bog Walk in St. Catherine and May Pen in Clarendon. While there are a number of areas along the southern and north-western coastal portions of the island with very good soil for citrus, these have been excluded because of low annual rainfall, poor rainfall distribution or winds. Other areas located in the western section of the island with good soil and climatic conditions have been excluded because of the distance to the two important packing and processing plants.

In the central portion of the island with areas above 1,200 feet, new orchards should be limited to the Ortanique variety only, owing to the relatively poor performance of oranges and grapefruit above this elevation.

St. Mary. Areas recommended for citrus in this parish stretch roughly from the border of Portland south-east of Annotto Bay, a distance roughly 4 miles inland, and extend west along the coast to Port Maria and inland west of this point to Pemberton Valley, turning south and east to Brimmer Hall and Tryall then south to Highgate and Richmond and east back to the Portland border.

Soils. With the exception of a small area surrounding Annotto Bay (Agualta Vale, Gray's Inn to Fort George) with soil No. 23 (recent alluvial plains), the entire area is occupied by the No. 6 soil type. These are moderately sloping, well-drained soils on shale of Richmond bed.

Rainfall. Annual precipitation ranges from 62½ inches to 87 inches. There is a slight dry season of 2 to 3 months' duration with less than 4 inches of rain.

St. Catherine. Areas recommended for citrus include the entire inland basins of St. Thomas-in-the-Vale and Lluidas Vale.

The St. Thomas-in-the-Vale area extends from Bog Walk east to Dove Hall, north to Riversdale, south to New Hall, north to Dover Castle, west-north-west to Balm and Strathdown, south-west to Ewarton and south-east through Orangefield, Banbury, to Wakefield and east back to Bog Walk.

The Lluidas Vale area extends from Worthy Park in the south, north-west to Coco Ree, north-east to the Pedro River cave, and south to Rio Cobre sink and Worthy Park.

Soils. Both inland basin areas are soils No. 27 comprising imperfectly-drained gently sloping basins.

Rainfall. The annual precipitation ranges from 62½ inches to 75 inches with a slight dry season of 2 to 3 months with less than 4 inches of rain.

St. Ann. Citrus expansion in this area does not lend itself to concentration. Areas south from Retreat, Brown's Town and Thatchfield into the Dry Harbour Mountains, comprise No. 14 soils which are not only considered second class for citrus but are situated in elevations above 2,000 feet and therefore limited to expansion of the Ortanique variety. A very good quality Navel orange is produced in areas of the Dry Harbour Mountains.

Clarendon. Areas recommended for citrus in Clarendon extend from Grantham, north almost to Borobridge, west to Corner Shop, north into the Cave Valley and Aenon Town, south and east along the base of the Bull Head and north-east to Kellits, then south along the Pindars River valley into the Rio Minho valley to Sevens. The area then extends west roughly 2 miles, north and parallel to the May Pen/Porus main road enclosing the Mocho Mountain areas.

Soils. This area comprises soils Nos. 8, 15 and 16. Soil No. 16, roughly 2 miles north-west and 2 miles south-east and 5 miles east of Chapelton, is *not* recommended for citrus.

Soil No. 8, described as centrally hilly areas of conglomerates, tuffs and shales, comprise most of the Pindars River, Thomas River and Rio Minho valley areas.

The Mocho area is occupied by soil No. 15—rocky, limestone hills with brown soils on slopes and valleys.

Rainfall. The annual precipitation ranges from 50 inches in the southern areas to 75 inches in the more northerly or central areas of Frankfield, Kellits and Crofts Hill.

The distribution is fair with a moderate dry season of 4 to 5 months with less than 4 inches. Drought effects tend to be harsher in the more southern areas particularly on soil No. 15 owing to the lower moisture retaining capacity of these soils.

Manchester and St. Elizabeth. Areas suitable for citrus extend from Williamsfield in a narrow one-mile strip widening from Mile Gully to Oxford where it extends north to include the district of Epping Forest, Auchtenbeddie, north-west into Trelawny as far as Belmore Castle and Inverton and south-east through Aberdeen and Ringtail Hall to Williamsfield (St. Elizabeth) then west to Bagdale, south to Appleton and east roughly along the railway to Greenvale.

Soils. Most of the area is made up of soil No. 15. One small inland basin area occupies the south-western finger from Appleton, east to Union and another extends from across the border in St. Elizabeth into Manchester from Oxford in the north-west corner to New Hall in the south-west. These are No. 27 soils similar to those of St. Thomas-in-the-Vale and Lluidas Vale.

Rainfall. Annual precipitation ranges from 60 inches in the eastern section to 87 to 100 inches in the Appleton/Maggotty areas in the west. Large areas of the Appleton/Maggotty areas are established in sugar cane or have serious drainage problems.

In the central section of this zone (Grove Place, Mile Gully), elevations are mostly above 1,500 feet and therefore primarily suited to ortaniques.

Other areas in Manchester, south of the railway stretching to Spur Tree and Newport, tend to be progressively drier and are mostly above 2,000 feet, and from experience are suitable only for ortaniques and mandarins.

These areas are occupied primarily by No. 14 soils—rocky, limestone hills, red bauxitic soils on slopes and valleys.

(iii) Preparation of Site

Preparing the land. Two important considerations should constantly be in mind—avoidance of pests as far as practicable and creation of conditions which will enable the citrus plants to resist or tolerate attack by pests. In other words, every effort should be directed towards ensuring that all the conditions under which citrus is grown are favourable to the development of the plants. If favourable conditions do not exist, naturally those that are present must be modified by measures applied to the environment or to the plant itself. Selection of the orchard site, preparation of the land, elimination of sources of pest infestation, use of good plants, satisfactory methods of setting out and orchard management must be given very careful attention.

In preparing land to receive citrus much can be done to prevent serious trouble with several pests. Slugs and beetle borers, which often infest land left to grow up in weeds for some time, can be destroyed by folding pigs on the area for one or two months prior to commencement of tillage operations. It is recommended to grow annual crops for at least a year before citrus planting is to take place; weed suppression and the state of tilth thus brought about aid materially in increasing the ability of the citrus plants to resist attacks by pests.

Frequently citrus pest problems can be avoided entirely by eliminating potential foci of infestation. Old citrus trees of little economic value should be destroyed; in this respect scattered lime trees near to orchards of orange and grapefruit ought to be eliminated or kept free of insects. Heaps of stones and debris which may harbour slugs should also be cleared from

citrus groves, and certain plants—banana, coco, sugar cane—should not be grown with young citrus trees.

The objective must be to accomplish complete clearing of the land of stones, logs and stumps, slugs and other pests before the mounds are made and to bring the site into good tilth, through the cultivation necessary for initial catch crops or direct forking and refining in preparation for making the citrus mounds.

Where no catch crops are planted the entire site must be cleared, forked or ploughed, then allowed to weather and refined by hoe or harrow before starting to make mounds. This is particularly important on the heavier soils and initial forking and ploughing may be as long as 6 months or more before making mounds to permit sufficient weathering to bring the site into satisfactory tilth.

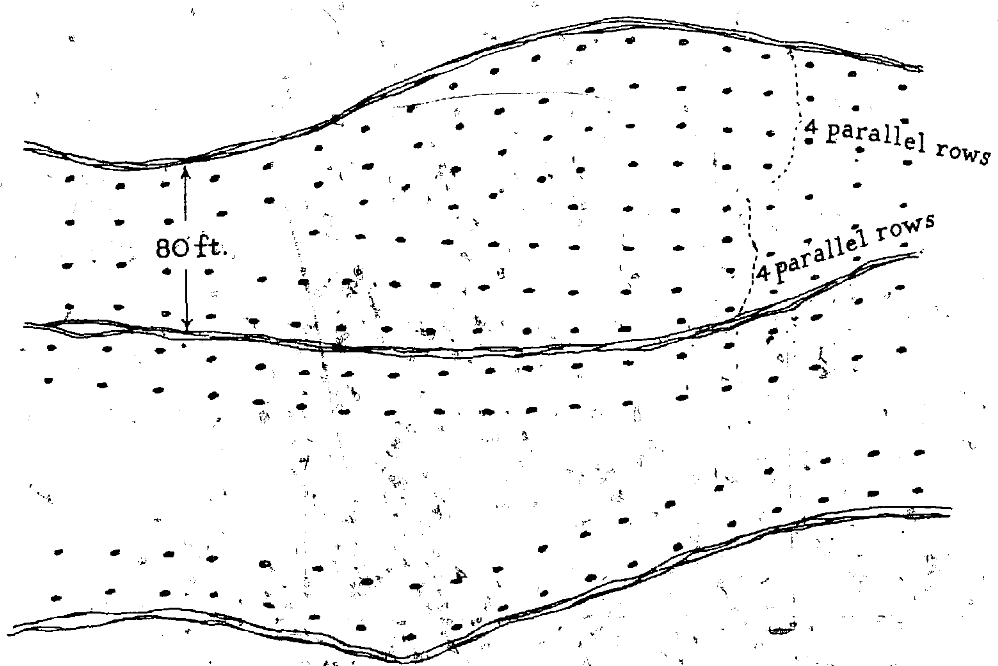
(iv) Lining Out and Preparation of Mounds

Lining Out. Lining out and spacing should be:

(*a*) 20 by 20 feet for oranges; and
(*b*) 22 by 22 feet for grapefruit.

Trees should not be closer to borders or fences than half the distance between plants.

Where citrus is planted on slopes of over 5 degrees, plants should be lined out along contour beds. Contour lines of bunds and/or drains should be completed before lining out mounds. Mounds are lined out half the planting distance from the adjacent contour line. If the narrowest point



of the contour bed is 80 feet, 2 rows of mounds will be based on each contour line to run parallel to each line. If widest point is 160 feet short rows are shared as evenly as possible to run parallel with adjacent contour lines. (See diagram.)

Preparing the Mound. Well-made mounds are required for satisfactory establishment of all citrus. Digging a hole prior to making the mound must only be done on stony land where it is necessary to remove all the stones below the site of the mound. Topsoil is scraped from the area surrounding the position the tree is to occupy and heaped up to form a rounded cone 4 to 6 feet in diameter at the base, and up to 2½ feet high on soil where extensive shrinkage may be expected, as on clay lands. The top of the mound is levelled off to encourage collection and retention of moisture, to hasten weathering of the mound. Weathering for 3 to 6 months is advisable before the trees are planted. Larger mounds and longer weathering as a rule are essential for the more clayey soils.

It is most important that planting should be done as follows:

(1) Keep plants protected from sun at all times and cover the plants, particularly the roots, with wet sacking while opening mounds.

(2) Provide 1 to 2 gallons of water for each plant even while raining.

(3) Add ½ lb. of Dieldrin to the water used for 25 plants. This will mean ½ lb. Dieldrin in 25 to 50 gallons of water to plant 25 plants or 1 to 2 gallons of Dieldrin and water mixture per plant.

(4) Continually stir the mixture of Dieldrin and water.

(5) Provide a fine nozzle watering pan for applying the Dieldrin and water mixture.

(6) Remove one plant at a time from the shaded bundle for each planter.

(7) Open the mound with a fork or spade wide and deep enough so that the plant can rest in the mound without bending the main roots.

(8) The uppermost roots should rest just about 1 inch below the surface of the mound.

(9) Thoroughly stir the mixture of Dieldrin and water and use about one-quarter the amount of mixture per plant to wet the sides and base of the hole in the mound.

(10) Cover carefully the lower roots in their natural position with soil, then add some stirred Dieldrin and water mixture.

(11) Continue covering and watering each layer of roots until planting is completed. Remember the uppermost root at the trunk should be only 1 inch below the mound surface when the planting operation is completed.

The trunk of the plant above the roots must not be buried deeper than 1 inch in the mound.

(12) Leave about half the mixture for watering the entire surface of the mound after planting is completed.

(13) Cover the entire mound with mulch but not closer than 3 inches from the trunk.

(14) Tie the plant carefully to a stake to prevent wind damage.

(15) Water with plain water every 4 to 5 consecutive days if no rain falls.

Note. Dieldrin is poisonous; handle with care. Avoid inhaling or injesting the powder or mixture. Wash hands and clothes carefully after use. Do not leave carelessly around the house in the reach of children or where it can be mistaken for something harmless.

(v) Fertilizing

The use of fertilizers should begin *as soon as plants have started to grow.*

The increase in production of citrus depends to a large extent on the proper use of manures and fertilizers, but the other essentials of sound farming, soil conservation, drainage, proper planting, and control of pests and diseases are also of great importance. The maximum benefit from application of fertilizer and manures can only be expected when the other factors have received attention.

The Ministry of Agriculture and Lands is in a position to make fertilizer recommendations for the various citrus growing districts based on the analysis of leaves from bearing trees and on knowledge of deficiencies of plant foods in the different soil types.

It is essential that fertilizer applications to citrus should begin early in the life of the plants. Trees that are properly fertilized grow much faster, maintain their growth rate better, and come into bearing earlier than trees which do not receive proper fertilizer treatment. Furthermore, neglect in the early life of citrus trees can never be completely put right later on. It pays to begin using fertilizers as soon as young plants commence to grow.

Fertilizers should be applied to a young tree in a circle about one foot away from the stem of the trees: In the case of mature trees, fertilizers should be applied in a band about 6 to 12 inches wide immediately beneath the drip circle of each tree. Whenever possible, on red bauxitic limestone soils phosphate fertilizers should be mixed with decaying mulch or compost. On steep slopes, fertilizers should be applied in a semi-circle at the side above the plant, in a shallow depression to prevent washing by rain.

Fertilizer applications are best made during three periods of the year, as follows:

(1) In early spring, after reaping of the main crop. At this time one-third of the annual dressing of nitrogen, one-half of the annual potash dressing, and the entire phosphate dressing should be applied.

(2) Around June to July one-third of the annual nitrogen dressing and the other one-half of the potash dressing should be applied.

(3) About mid-October, at the beginning of the autumn rains, the remaining one-third of the annual nitrogen dressing should be applied.

(vi) Intercultivation

Where, for economic reasons, intercropping is necessary this will provide sufficient tillage or intercultivation for the first 3 years.

If intercropping is not done, forking, ploughing or harrowing may be done once a year on the heavier soils between the rows. This first tillage operation should be done about 12 months after planting and should not be closer to the trees than 4 feet.

At the end of the second year one more forking, ploughing or harrowing may be done. This should be confined to a strip not more than 8 feet wide between rows 20 to 22 feet apart or in closer spaced citrus not closer than 6 feet from the trees.

At the end of 3 years intercultivation by forking, ploughing or harrowing should be done with extreme caution and wherever possible discontinued for the remainder of the life of the trees.

On limestone soils and some of the other light soils which are free draining and highly porous no intercultivation is necessary following the initial forking or ploughing that is done prior to planting. This may be necessary only for the benefit of intercrops planted in the first 2 or 3 years.

On medium to heavy soils the programme of intercultivation given above is of considerable benefit to the young trees. It is designed to prepare good tilth ahead of the advancing roots.

It is for this specific reason that the distance of tillage from the trees must be progressively increased from year to year.

At the end of 3 years it is anticipated that the network of roots has completely covered the space between trees. At this stage forking, ploughing and harrowing to effectively improve tilth must destroy considerable amounts of the roots in the areas tilled. Light (shallow) harrowing is effective only for the suppression of weeds. When this is done frequently the ramming by the tractor and harrow can do more harm than good.

(vii) Intercropping

Intercropping should not be done for more than 3 years after planting. Intercropping has certain advantages in that the crops planted between the rows of citrus will pay for the expense in keeping down weeds. Also, the tillage required for these crops will be of benefit to the citrus plants when the roots extend out into the inter-row areas.

There are, however, certain important rules which should be followed.

(1) The intercrops should not be planted in the first 6 months closer than 3 feet from the trees.

(2) The distance of intercropping from the base of the mound should be progressively increased every 6 or 12 months.

(3) Do not plant permanent or semi-permanent crops which grow to a greater height than the citrus plants, such as sugar canes and bananas.

In some highland limestone areas yams may be planted as an intercrop. However, this is on condition that the yams are heavily mulched and that the yam rows run from east to west to allow the trees the maximum sunlight throughout the day.

If, after 3 years, there is sufficient space between the citrus rows to admit of the continuation of intercropping, it is a sign of poor citrus husbandry and continuation of intercropping will only aggravate the poor development of the trees.

Crops that may be planted with citrus are:

(*a*) peas on any soil type in the 1st, 2nd or 3rd years;

(*b*) peanuts on any suitable soil type for this crop in the 1st, 2nd or 3rd years;

(*c*) yams on highland limestone or other highland light soil in the 1st year;

(*d*) corn on any suitable soil for this crop in the 1st or 2nd year.

(viii) Important Pests and Diseases and Their Control

Pests

Scale Insects. These are found according to the species on stems, twigs, leaves and fruit. The important species in Jamaica include:

(*a*) Florida red scale (*Chrysomphalus aonidum* (L.))

(*b*) Purple scale (*Lepidosaphes beckii* (Newm.))

(*c*) Snow scale (*Chionaspis citri* (Comst.))

(*d*) Green scale (*Coceus viridis* (Green))

(*e*) Black scale (*Saissetia oleae* (Bern))

(*f*) West Indian Red scale (*Selenaspidus articulatus* (Morg))

The above scales are controlled by spraying the trees thoroughly with a light to medium emulsifiable orchard spray oil, at concentrations ranging from $\frac{1}{2}$ to $1\frac{1}{2}$ gallons of oil in 100 gallons water. The higher concentrations are employed in the cooler months of the year.

Mites. Of the mites occurring in Jamaica the citrus rust mite—*Phyllocoptruta oleivora* (Ashm.) is the most important. The typical injury is brownish to bronze discoloration of older fruit and silvery blotches when younger fruit are attacked. Injury to young fruit becomes quite pronounced as the fruit enlarge. Control is mainly by sulphur sprays such as 5 to 10 lb. wettable sulphur or 1 to 2 gallons lime sulphur in 100 gallons water, the lime sulphur being used in the cooler months of the year.

Zineb (Dithane) has given very effective control and, as this miticide possesses good residual and fungicidal properties, it is becoming increasingly popular especially as a low volume spray.

Aphids and Thrips. Aphids and Thrips are comparatively of minor importance to scale insects. They both attack young shoots causing distortion of the young twigs and leaves through localized cessation of growth at the points where the insects feed. The damage can be particularly important in young trees.

Severe attack of young trees can result in stunting of growth and, in the case of Aphids, leaf function may be further impaired by the copious growth of sooty mould on the honeydew excretion of the Aphids.

Apart from the stunting and distortion of young shoots, Thrips cause scarring of fruit. This injury is characterized by a fairly uniform and distinct ring of scarred rind around the stem.

Sulphur used in mite control usually provides sufficient control of Thrips. Aphids are controlled by a mixture of 3/4 pint nicotine sulphate (40% nicotine), ½ lb. calcium caseinate in 100 gallons water or ½ pint malathion in 100 gallons water. This insecticide can be used as a supplement to sulphur mixture in mite control.

Fiddler Beetles (*Prepodes and Pachneus Species*). The Fiddler Beetle is among the two major pests of citrus in Jamaica. It has been a major cause of the high mortality of young trees and the poor yields of older trees throughout the island. The two readily recognized species are the larger Fiddler Beetle, *Prepodes vittatus* (L.), measuring about ⅜ of an inch or more in length, easily recognized by the red and pale green stripes running length-wise along the wing covers; the rest of the body is black in colour. The other species, *Pachneus litus* (Germar), is much smaller in size and the entire body is light blue or bluish green in colour.

The adults may cause serious damage through feeding on the young leaf shoots but the important damage is caused by the legless larvae which feed on the bark of the roots. Severe ringing of collar and root bark often results in death of the trees.

The adult lays its eggs between adjacent leaves or within the folds of a single leaf. These leaves or leaf folds are glued together and remain so until the eggs hatch in about 7 days.

The young larvae fall to the ground and burrow into the soil where they remain feeding on the roots for 6 to 9 months when they emerge as adults to repeat the life cycle.

Symptoms of Fiddler Beetle attack are similar to any severe form of

root damage and include wilting, leaf fall, yellowing of the leaf veins and sometimes a heavy crop of small fruit preceding death of the trees.

The most effective control is at present obtained by inclusion of ⅓ of an ounce Dieldrin 50% wettable powder per plant in one or two gallons water applied with a fine nozzle watering pan in the course of the planting operation. One-third to half the mixture is watered over the entire mound when planting is completed. This treatment will give protection to roots in the area of the mound for 2 to 4 years. Only the powdered form of Dieldrin insecticide should be used when planting.

In already established groves the Dieldrin may be preferably applied in the liquid form (Dieldrex) at a concentration of 1 up to 3 gallons Dieldrex in 100 to 200 gallons water (depending on the water supply) per acre. This is best applied to the entire soil surface with a Bean or Hardie pump using a broom type multiple nozzle spray gun. Where this equipment is not available the treatment can be applied with a fine nozzle watering pan from the trunk to 2 feet outside the drip of the tree canopy. In general, higher concentrations of the insecticide give longer protection.

Other methods of control include:

(*a*) exposure of the main crown roots to a distance of 18 inches from the trunk;

(*b*) collection and destruction of adults;

(*c*) collection of egg masses. These should be removed to the borders of fields and left in open jars or other containers to allow development and escape of parasites from the eggs.

These methods of control, singly or together, are supplements to chemical methods (using Dieldrin) described above, but are not substitutes.

Slugs. These are of major importance in young groves over-run with weeds, bush and on trees located near to stone heaps and stone walls. They are nocturnal in feeding habits and can be found feeding on young shoots and leaves during the night. Where they exist in large numbers, young trees and even larger trees are often killed as the trees are kept defoliated for prolonged periods resulting in die-back of twigs and roots.

Control is by means of regular intercultivation—weeding and light forking to maintain the grove in a clean, sanitary condition, removal of stones, logs and other hiding places from the grove and applying every 7 to 14 days:

(*a*) Metaldehyde (2 ozs.) and bran, cornmeal or flour (16 ozs.) bait sweetened with molasses; or

(*b*) Sluggit, commercially prepared bait

until control is accomplished. The shorter interval of bait application may be employed in the wetter months. Both baits may be applied at the base of the trunks or in a band around the trunks of the trees.

Citrus Black Flies (*Aleurocanthus woglumi* (Ashby)). These occasionally become serious in drier localities. Injury results from the large quantities of sap extracted and the development of the unsightly black sooty mould growing on the excretions of these insects over the leaves and fruit.

This pest is normally controlled very effectively by the parasitic insect *Eretmocerus serius* (Silv.) (Eddie wasp) and entomogenous fungi but occasionally conditions become very favourable to the Black Fly and serious build-up of the pest results. When control by spraying becomes necessary 2 pints Malathion or 1 to 2 gallons light to medium orchard oil in 100 gallons water will give control.

Diseases

Gummosis (Foot-rot, Brown-rot or Collar-rot). Gummosis is a rather loose term describing the oozing of gum from broken or injured bark tissue. In the sense used here, it refers to basal trunk and crown root rots caused by several species of Phytophtora fungi. Patches of bark are killed through to the wood including the cambium. This is frequently associated with the exudation of large quantities of gum. The bark remains firm when first killed but shrinks and cracks longitudinally when dry.

Citrus species show considerable variablity in susceptibility to attack by the organisms of the species known locally. The Sour Orange is the most resistant while the Cleopatra Mandarin, Rough Lemon, Sweet Orange, Grapefruit, Limes and Lemons, in that order, are more susceptible.

Gummosis occurs on trees located in damp locations resulting from either poor drainage, crowded weed-infested groves and farmyard manure placed in contact with the trunk and collar roots. Untreated injuries to the trunk will allow entry of the fungi and the disease is sure to develop, particularly under damp conditions within the grove.

Where the above condition exists any of the commercial varieties of citrus will succumb to the disease, particularly the more susceptible varieties.

Budding on the more resistant stocks is not an absolute safeguard against the disease as where conditions are favourable to the disease, even if the stock survives attack, the scion trunk above the bud union may be affected.

Control includes certain basic precautions such as:

(*a*) Use of resistant stocks particularly on damp, wet locations.

(*b*) Maintenance of the grove in a clear, sanitary and well-drained condition.

(*c*) Avoiding placing manure and other organic matter against the base of trees.

(*d*) Disinfecting bark injuries and pruning wounds with Bordeaux paste made up with copper sulphate—4 lbs.; lime—4 lbs.; water—8 gals.; common salt—4 ozs.

(*e*) Regular inspection of trees to locate and treat lesions by cutting away dead and infected bark tissue and treating with Bordeaux before extensive damage occurs.

(*f*) Regular washing of trunks and lower limbs with Bordeaux paste.

Melanose. Melanose caused by the fungus *Diaporthe citri* (Wolf) is probably the most important disease responsible for lowering the grades of grapefruit and oranges in Jamaica. The disease attacks immature foliage, twigs and fruit of citrus trees.

On leaves the disease appears as minute, round pin pricks which with time become enlarged, water-soaked, sunken and dark-centred with yellowish halos. Later these spots become corky and raised, further enlarged to $\frac{1}{32}$ of an inch in diameter, from amber to dark brown in colour, and sandpapery to touch. In severe cases leaves become twisted and otherwise distorted, lose their green colour and drop prematurely.

On twigs the lesions resemble those on leaves but are more raised.

On fruit the spots are circular, light brown and sunken, later becoming raised and reddish brown to black. The lesions are characterized by a sandpapery feel which distinguishes Melanose injury from rust mite injury and surface stains caused by Anthracnose. The nature of the spots is usually used to describe the disease—'Tear Stain Melanose'—resulting from washing of the spores over the fruit by rain or dew; 'Shark Skin Melanose' resulting from aggregations of spots to form crusts, and 'Mudcake Melanose' developing from irregular cracking of scar tissue.

The spores are produced on dead and decaying branches on the tree and on the ground. These are disseminated mainly by water (rain and dew) on to immature twigs, leaves and fruit.

The pre-requisite to control is therefore:

(1) the maintenance of all such cultural practices that will reduce the incidence of branch die-back resulting from poor nutrition, moisture supply or drainage, pests or diseases;

(2) the removal from the tree and groves of all dead or decaying branches so as to substantially reduce the number of spores in the grove.

The above cultural practices, combined with a 3 : 3 : 100 Bordeaux between two-thirds petal fall and 1 to 3 weeks after fruit set, will give good control.

Greasy Spot (Greasy Melanose). This is distinguished from Melanose as described above by much larger lesions, developing after the leaves have matured and the greasy feel of the lesions compared to the sand-papery feel of Melanose caused by the fungus *Diaporthe citri* (Wolf).

The spots vary from small dots to $\frac{1}{4}$ inch in diameter developing from a slightly blistered appearance on the under surface of leaves. These ultimately turn to an oily chestnut brown colour. Severe attacks may cause up to 80% premature defoliation.

The cause of Greasy Spot Melanose is not known with certainty but new evidence suggests that a fungus of the genus *Mycosphaerella* is responsible.

Effective control is obtained with Bordeaux sprays. Zineb, a non-copper containing fungicide, has given very promising results at concentration of 2 lbs. Zineb per 100 gallons water.

Anthracnose. Anthracnose, as covered here, refers to the disease caused by the fungus *Colletotrichum gloeosporioides* (Penz) which occurs on mature or weakened twigs, leaves and fruits of grapefruit, orange, lemon and other varieties of citrus. The disease is also referred to as 'Withertip' where it results in a die-back of weakened or injured twigs. The term 'Anthracnose' refers more particularly to the disease injuries on leaves and fruits.

Injury to twigs is characterized by slow or rapid die-back of twigs (depending on predisposing factors) accompanied by yellowing and abscission of leaves. Gumming of the affected portions may occur at the sharp line demarcating affected and healthy tissues. Following death of the diseased portions the minute black pimples of fruiting bodies develop.

Anthracnose spots on fruit vary from minute spots to $\frac{1}{4}$ inch or more in diameter. These are circular, sunken, reddish brown at first, becoming darker to black when fully developed. The infection may extend through the rind into the pulp beneath causing a disagreeable or bitter taste.

Re-setting of fruits sometimes occurs from the washing of spores from fruiting bodies on the twigs on to fruits where on germination they cause large blotches or faint tear staining effects.

On leaves, invaded tissue die and dry out and with time the fruiting bodies appear as minute black spheres arranged in concentric rings on the papery dried-out affected portions.

The disease is common on weak growing trees of any age in over-crowded shaded groves or groves exposed to the wind and pest injury and severe moisture stresses.

The disease is rarely of importance on trees maintained in a vigorous breathing condition. Control is therefore correction of whatever factors are responsible for weakening or injuring the tree.

Scab. Of the three diseases of citrus known under the name of Scab the important one affecting grapefruit, Sour orange and lemons in Jamaica is caused by the fungus *Elsinoe fawcetti*.

This disease is found attacking the leaves, fruit and twigs. It is serious in susceptible seedlings where growth and consequently budding operations may be retarded as much as 50%. Scab lesions take the form of elevated warts above the normal surface on affected twigs, leaves or fruit. On the fruit of grapefruit the buff- to olive drab-coloured lesions tend to be flat and scurfy rather than warty.

Scab attacks only young host tissue but once these are infected the warty outgrowths tend to keep pace with the maturation of the affected leaf, fruit or twig.

The disease is prevalent in susceptible varieties located in areas of high rainfall and humidity and is particularly important when these conditions exist at the time of flushing.

Losses from scab result mainly from the reductions in grade suffered by affected fruit.

Satisfactory control is obtained by spraying with a 6 : 6 : 100 Bordeaux mixture properly timed to cover old scab lesions before the susceptible spring flush occurs. A second spray application may be necessary especially where heavy rains occurred early after the first application. This application, comprising a 3 : 3 : 100 mixture, should be done as soon as two-thirds of the petals have fallen.

Commercial Control of Citrus Pests and Diseases

In all the important citrus producing countries of the world a regular spray programme is undertaken as a vital orchard operation to improve the quantity and quality of the fruit and to protect and increase the life span of the trees.

There is a vital correlation between the number of leaves on a citrus tree and the number of fruit that it produces from year to year. Scale insects, mites, Fiddler Beetles, Slugs and the fungal diseases destroy leaves by either eating them or cause premature leaf fall by reducing the vitality of the trees and leaves.

Up to 1950 more attention was given to the effects of pest and disease control on the quality of fruit produced than on the quantity. As progressively more of the crop was marketed for processing rather than fresh fruit, quality (clean, unblemished fruit) became of less importance and many growers ceased regular spraying. Within 3 or 4 years trees declined in health and vigour and the production of these groves fell by up to 50%. This experience brought into full focus the importance of pests and diseases on the quantity of fruit produced and the health and longevity of the trees.

A simple spray schedule involving 2 to 4 applications per annum can be formulated for each grove by members of the Citrus Growers' Association Field Staff and the Plant Protection Division of the Ministry of

Agriculture and Lands. The spray schedule and formula are based on the incidence of pests and diseases in the grove during any year.

Virus Diseases of Citrus in Jamaica

Psorosis and **Tristeza** virus diseases have been recently shown to have existed here for several years.

Psorosis. Psorosis disease of citrus trees is spread by using infected bud material on nursery or top-worked trees.

The symptoms of the disease generally develop when the trees are between 15 and 25 years old. This is seen on the trunk and main branches as a flaking-off of thin layers of outer bark which curl upwards from living bark underneath. These lesions are associated with no gumming or very little gumming during active growth. This is unlike common gummosis in which the dead bark does not lift to any pronounced extent and there is profuse gumming. The trees enter a phase of gradual decline, become uneconomic, and eventually die.

Tristeza. Tristeza virus disease is spread by the use of infected budwood material on nursery or top-worked trees. In addition, it is spread by a number of Aphids, the most important of which, namely, *Aphis citricidus* (Kirk), is fortunately not known in Jamaica, but is to be found in nearby South America where it was responsible, in Brazil alone, for the spread of this disease which destroyed several million trees within 10 years.

Authorities in several countries where the disease exists now associate the virulence of Tristeza with:

(i) different strains of the same virus; and
(ii) the efficiency of the Aphid species in transmitting the disease from tree to tree.

In Jamaica the disease has been found to occur only on sweet orange and grapefruit trees budded on Sour orange rootstock.

Trees affected with the disease remain stunted compared with similar trees in the same orchard, for no reason that could be associated with cultural practices, pests or fungal diseases. There is usually a very pronounced over-growth of the scion at the bud-union. The bark immediately below the bud-union is usually very tight and when lifted show minute honeycomb-appearing holes which are visible to the naked eye on the inner surface of the lifted bark.

In other countries the trees tend to die more rapidly. As the disease exists in Jamaica at present an occasional tree dies, but usually, affected trees are to be found spotted through the occasional grove where it has remained in its stunted condition for 10 years or more yielding very poor and uneconomic crops.

The immediate threat to the industry, therefore, lies in the introduction

of an efficient Aphid vector and, probably, the introduction or development of a virulent strain of the virus.

Since serious spread of Psorosis is dependent on use of infected bud material and the spread of Tristeza is dependent on either or both the use of infected bud material and the presence of an efficient vector, the Ministry has taken steps to:

(i) determine the distribution of the Brown Citrus Aphid (*Aphis citricidus* (Kirk)) throughout the world with the object of taking special quarantine precautions with ships and aircraft arriving from these areas; and
(ii) is now actively surveying suitable groves of orange and grapefruit varieties budded on Sour orange rootstock, with a view to testing and selecting trees over 25 years of age with no Psorosis lesions and presumably free of Psorosis, for the presence of Tristeza by means of examination of bark sections immediately below the bud-union, and indexing bud material from these trees on to West Indian lime which indicates the presence or absence of Tristeza by certain distinctive chlorotic reactions in the young lime leaves.

Only buds from selected trees will be used for propagating future nursery plant materials and private nurserymen, producing plants for distribution to the public, will be required to use bud material from only certified trees as soon as it is possible to complete this programme of certification.

There is no cure for Tristeza or Psorosis infected trees.

Psorosis infected trees should be dug out when they decline to the stage of being uneconomic. This stage is usually reached anywhere between 10 and 20 years after the appearance of the disease.

Tristeza infected trees should be dug out immediately they are found.

(ix) Reaping of Citrus

The reaping of citrus is as important as the growing of the crop. Too much care and attention cannot, therefore, be given to it. By careless reaping a grower can destroy the fruits of several years of labour. What all growers must realise is that damage to fruits renders them unfit for export and may make them unfit for processing as well, since damaged fruits soon decay. Citrus fruits should be handled with even greater care than that with which eggs are handled. The practice of shaking fruits from the trees or picking them with a stick is bad. Fruits shaken from the trees fall to the ground and most likely get bruised. In the process of picking fruits with a stick the chances of pricking or bruising them with the stick are great and, again, however careful the picker, most of the fruits will fall heavily to the ground and be damaged.

The proper equipment for reaping fruits consists of a picking bag, a pair of clippers, a step-ladder and a box. The picking bag is so made that the picker can carry it in such a way that when he clips the fruit from the tree he can pass it easily into the bag, and when the bag is full he can step down from the ladder and empty the fruits into the box by merely opening the bottom of the bag. Gathering fruits in this way ensures the least possibility of damage to them.

Once the fruits have been picked they should be kept off the bare ground. If there are not enough boxes to receive them then soft trash should be spread on the ground and the heap of fruits should at no time be higher than 18 inches.

The fruits should always be protected from sun and rain. A simple and inexpensive shed of four posts with crutches and four rods connecting them across on which are laid palm leaves or banana leaves is adequate. This shed should, of course, be maintained in good condition in order that it might serve its purpose effectively.

On no account must citrus fruits be carried in hampers or baskets as doing this causes the fruits to rub against one another and against the sides of the baskets or hampers and thus get bruised. A box with rigid sides having smooth surfaces is the proper container in which to transport citrus.

Careful reaping of fruits entails:

(1) clipping of fruits from trees instead of pulling;
(2) conveying them from the trees to the boxes in picking bags;
(3) protecting them from the sun and rain, and doing everything possible to prevent any kind of damage to the fruits.

CHAPTER 22

Coffee

In 1900 the amount of coffee exported was 5,360 tons. The figure fell to 5,200 tons in 1925. In 1951 it stood at 1,118 tons, the principal markets being Canada and Britain.

The steady demand and attractive prices now ruling abroad favour an increase of the acreage now under cultivation, coupled with proper attention to existing groves and to methods of curing.

The International World Bank Mission recommend an increase of 20,000 acres and a final output of 30 million pounds, advantage being taken to couple the new plantings with the soil conservation programme.

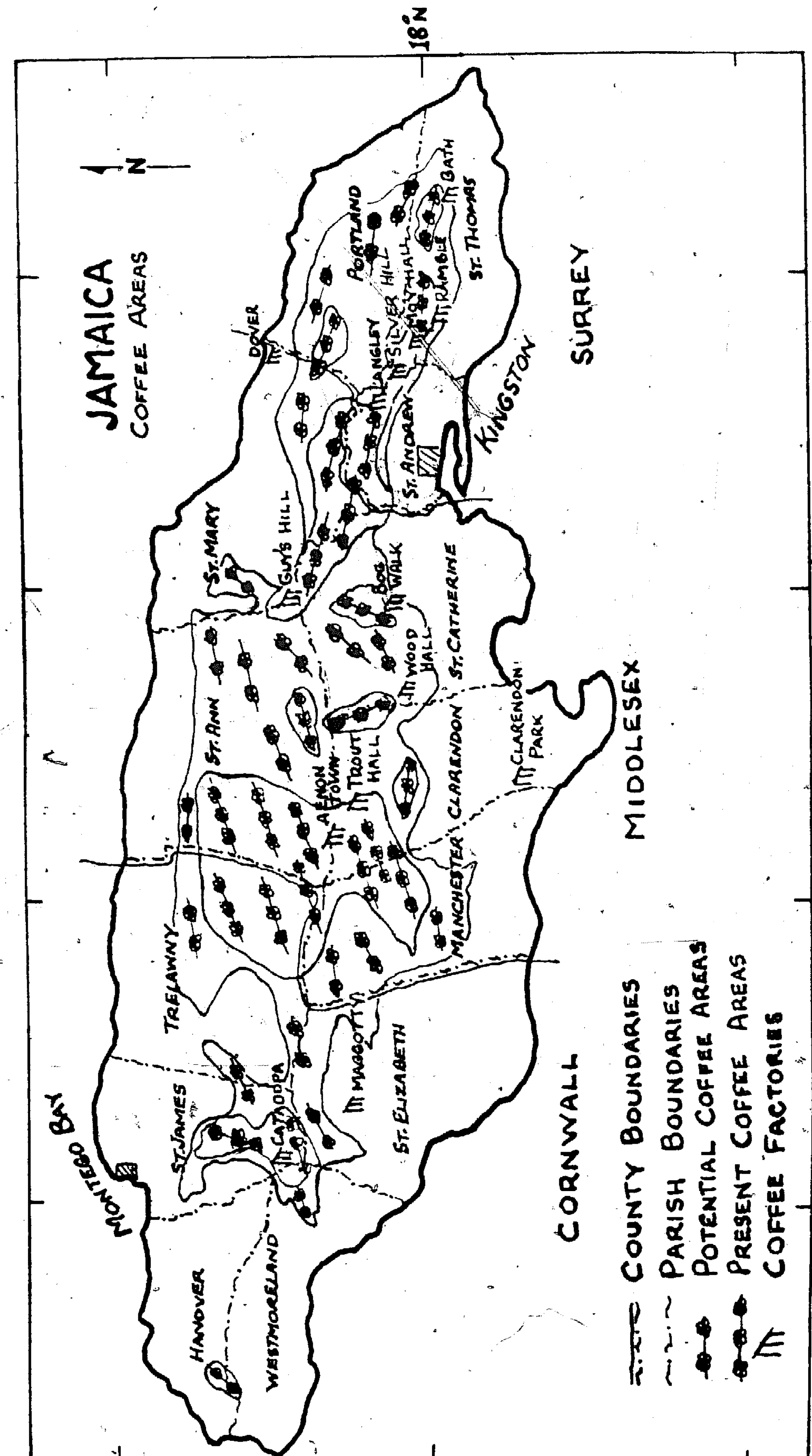
While the danger of over-production following on high market prices must not be lost sight of, the moderate target recommended by the World Bank Mission, coupled with the advantages of Imperial preference and an already established reputation for good quality should make the development of the industry worth while.

A Coffee Growers' Association under the protection of the Jamaica Agricultural Society has been formed, and the registration of coffee growers throughout the Island is now taking place.

(i) The Nursery

The aim of coffee nursery work is to produce the largest quantity of seedlings for the expenditure involved, so that plants with malformed roots and weaklings can be discarded, and only desirable plants transplanted to the field. This selection gives the best chance of full establishment, and it is a proved fact that a healthy seedling gives the best promise of vigour in the mature tree.

Seed Preparation. Cherry coffee picked for seed should be fully ripe. In whatever way pulping is carried out, that is, by use of a pulping machine or by hand, care must be taken not to damage the beans. After removing the pulp, the slimy coffee beans should be placed in a container of water and thoroughly stirred. This will allow the 'lights' to rise to the surface of the water so that they can be easily removed. When only the heavy beans are left, these should be placed on drying trays or



matting in a shady place where they can dry slowly. Care should be taken to ensure that the direct rays of the sun do not contact the coffee, as drying might be too rapid and the viability destroyed.

Before drying and while the beans are still sticky, it is good practice to mix the seed with finely ground charcoal powder. The charcoal mixes with the mucilage and forms a coating which helps to prevent the parchment from splitting and to ensure regular drying. The more regular the drying the more regular the germination will be.

It should be noted that many farmers prefer to ferment the beans and remove all the mucilage on the parchment before drying. The chemical analysis of the mucilage shows it to possess fertilizing qualities, so that in Jamaica it has been found advantageous to leave the mucilage on the beans, as it is believed to be more closely allied to Nature's way.

When the seed has been sufficiently dried, that is, completely surface-dried but still soft when bitten, it should be stored in a cool dry store until required for planting. It is best to leave the seed in trays, so that it can be turned occasionally.

Selecting the Site. Considerable care must be exercised.

(*a*) A site with a gentle slope across which the beds can be laid out is most suitable.

(*b*) The soil should, if possible, be a loam or at least a friable type which will guarantee good drainage, internal and surface, and easy lifting of the seedlings when ready for transplanting. In a heavy soil it is very difficult to lift the seedlings without tearing off many of the finer hair roots.

(*c*) A permanent water supply must be easily available, for although it is essential that the soil should be friable and easy-draining, it is necessary, depending on climatic conditions, to water freely. After sowing, the beds should be kept moist, but not sodden, at all times until germination; if wilting occurs, the cotyledons may fail to break the parchment.

Preparing the Site

(*a*) Plough the area selected in March or April as a weed control measure.

(*b*) Disc or hoe late April and put in a leguminous cover crop in May.

(*c*) Turn under the cover crop at the height of the blooming stage.

(*d*) Disc or fork in November, preparatory to making the beds.

Proper preparation of the site will not only increase fertility and result in soil of desirable tilth, but considerably reduce the time and labour required to make satisfactory beds, besides helping to control weeds and insect pests.

Preparing the Beds. The beds should be so laid out that:

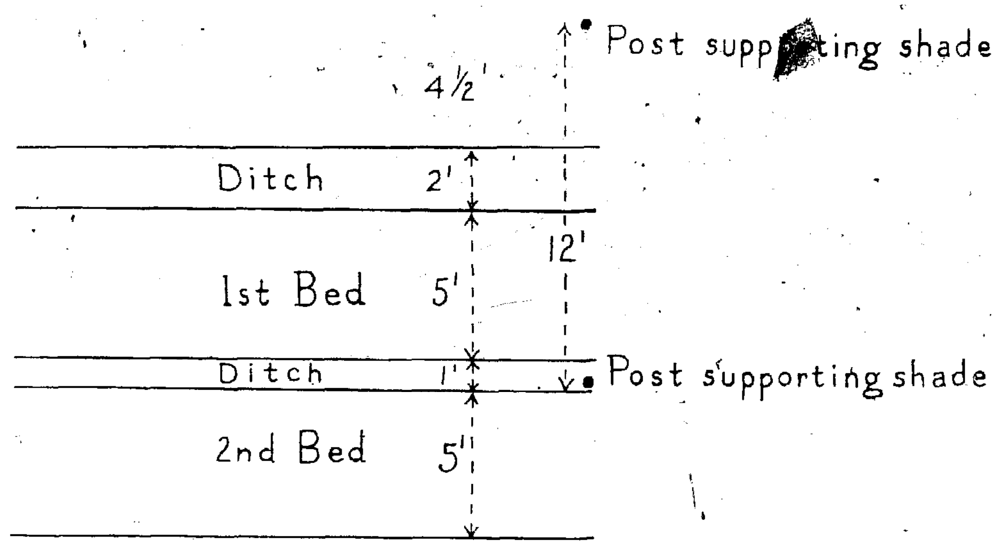
(*a*) The greatest possible area is utilized for seedling production.
(*b*) Care and maintenance is simplified.
(*c*) The stock of plants can be calculated easily.

In practice the following size has been found most convenient: five feet broad by thirty-seven feet four inches long. Five feet broad allows 9 rows of seedlings 6 in. apart with 6 in. to spare on both sides of the bed. Thirty-seven feet four inches long allows 110 plants per row, spaced 4 in. apart. The capacity of the bed is, therefore, 990 seedlings.

Lining. If the nursery is on a large scale, it will be necessary to provide artificial shade. Lining for the beds, and the support for the shade should be done at the same time; absolute accuracy will result in lower cost of production. The posts supporting the shade should be spaced twelve feet apart. Allowing five feet for each bed and a path one foot wide between the beds, each post will fall in the centre of the path. The post supporting the shade should be tall enough to allow six feet clear under the shade.

Making the Beds

(*a*) Starting at the highest point dig a ditch two feet wide and six inches deep across the slope, and four feet six inches from the outermost post supporting the shade, throwing the earth on the lower side, to make the first bed.



(*b*) Level and shape the first bed, using a rake to produce a good seed bed, at the same time pulling the excess earth over to the second bed.

(*c*) Dig a ditch one foot wide to form the path between the first and second bed, proceeding as before; and continuing down the slope until the desired number of beds are made in the block.

(*d*) The block should be surrounded on all sides by a ditch similar to the head ditch, and all paths should slope to the ditches for drainage in rainy weather. The ditches running opposite to the beds should be graded to provide free drainage.

In an endeavour to reduce costs, some planters do not fork or clean up the pathways. This is false economy, as the grass and weeds left in these pathways spread into the beds, so that added attention is necessary in the early stages of development of the seedlings. It pays to clean the whole site thoroughly.

In wet areas the beds should be raised above the level of the surrounding land, but this may involve the propping of the sides, otherwise the edges break away and the outside rows of seedlings suffer.

In a dry area it is better that the beds should be at the same level as the pathways. As the pathways become trodden, the level becomes lower than the beds with little risk to the outside rows.

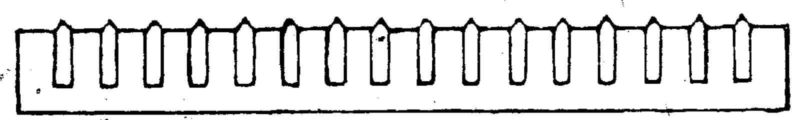
As it is impossible to prevent the pathways between the beds from becoming slightly lower than the surrounding land, precautions must be taken to prevent these paths becoming drains in wet weather. To prevent any scouring, small barriers should be placed at intervals across the pathways.

Shade. The most effective and easily controlled shade is a layer of split bamboos or palm leaves laid on cross-pieces supported by hardwood posts. The split bamboo, although more expensive, is more convenient as hardening-off of the seedlings can be accomplished progressively by removing every alternate slat, or as required.

(*a*) Nail round stick laths, not less than two inches in diameter, from post to post, to form a support for the split bamboo.
(*b*) Erect bamboo posts in the paths not served by the hardwood posts. Across the top of the bamboo posts stretch barbed wire to provide additional support for the laths.
(*c*) Experience has shown that coffee seedlings will not grow satisfactorily under Bastard Cedar, or Hog-Plum.

Sowing. The making of the beds, and the shade, should be completed before any sowing is done. The whole area should be tidied up and enclosed. The outer beds should be protected from the sun by a lattice, using split bamboo. The outer edge should be well-harrowed and kept clean and free of lumps of soil to control crickets. As stated previously, the beds have nine rows spaced six inches apart, and the coffee seeds are spaced four inches apart in the rows. Before planting, the surface soil on the beds should be raked into a fine texture.

The easiest method of planting regularly by hand is to place nine pegs at each end of the beds six inches apart. Cords are attached to each of the corresponding pegs, thus marking out the nine rows. Several beds can be lined in one operation. The actual planting points are then marked along the rows with a comb as shown in the following diagram:



No great pressure is required on the comb to leave indentations approximately ½ in. deep. Into these the seed is placed with the flat side down. Care must be exercised to ensure that the seeds are not planted too deep, as this gives uneven germination and often produces a badly-twisted seedling. When the row has been completed a slight sprinkling of soil should be placed on top, just sufficient to bury the seed ½ in. below the surface.

By keeping the soil slightly damp, seed should normally germinate in six to eight weeks.

The best time to sow coffee seed in Jamaica is in December or very early January. By the time the seed has germinated, in approximately six to eight weeks, the seasonal growth urge will just be increasing in 'tempo', so that with quick growth and development the seedlings pass through the dangerous stage when, with the stems still green and succulent, they are easily attacked by insect pests.

Mulching. Under certain conditions it is excellent practice to cover the beds with a thin layer of short-cut grass, such as is produced by a chaff-cutting machine or cow waste. If the mulch is too long, trouble may arise in removing it when the seeds germinate, or if left on the soil surface the long strands may hinder the seeds from rising into the air as the stem develops.

In dry areas, mulching is definitely recommended, and should always be applied as dry material.

In certain areas where the soil is infested with centipedes, or as they are referred to in Jamaica 'Forty-legs', the mulch harbours these pests and great damage may be caused to the seedlings. In such cases it is better to avoid mulch and apply copious water.

During the period of maximum growth, i.e. April to August, it is essential for satisfactory development that the seedlings should receive adequate water supplies.

Pests and Diseases

1. *Insect Pests*

(*a*) As previously stated, a bed five feet wide and thirty-seven feet four inches long will have 990 seedlings, assuring 100% germination. One cricket, taking up residence in a bed, can, and

will, cut down every seedling in about four nights if allowed to operate unhindered.

(*b*) As previously mentioned, centipedes can also do considerable damage if the environment favour their multiplication.

Under nursery conditions, where biological control does not function effectively, green scale will sometimes develop in such number as to require eradication.

2. *Control*

(*a*) *Crickets.* If the hole can be located, careful digging will reveal the cricket. For widespread damage use poison bait.

(*b*) *Centipedes.* Avoid using mulch if the centipede is likely to be a pest.

(*c*) *Green Scale.* Spray with Shell white oil 1–40, 70 pounds pressure.

Weeding. If the ground has been well prepared and thoroughly cleaned before planting, very little weeding will be required. If it is necessary, however, great care must be exercised not to disturb the seed, or if germination has taken place not to damage the young plants. As soon as the first pair of leaves has opened out, the rows should be obvious and weeding can be carried out if carefully done. When the seedlings have developed into any size, the soil will become so shaded that few weeds will persist.

Lifting and Packing. When seedlings have to be lifted from the nursery for despatch to other areas, the following precautions should be taken.

Before the seedlings are lifted the leaves should all be severely cut back so that moisture loss from the leaf surface is reduced to a minimum, thus preventing the seedlings from drying out quickly. This cutting back is better done while the seedlings are still in the soil, for as soon as the roots have been removed from the soil the plants must be quickly bundled in wet trash or rolled up in wet sacking. It is most important to see that the roots are not allowed to dry out, as this will greatly reduce the chances of the plant surviving, and all the good work previously carried out in the nursery will be wasted.

As the seedlings are lifted, all poor plants should be destroyed, and not left in the nursery to give them longer time to pick up strength. These poor plants must be rejected, as this is the first chance the planter has to begin to select good types for transplanting to the field. At times this culling may amount to as much as 50% of the total number planted, but there is no use issuing a poor seedling as it will have a poor chance of survival, and even if it does survive, the ultimate tree will be of poor quality.

is obtained, preventing the development of fungal pests in damp areas, or the development of focal points for insect infestation in drier areas.

Either of the two existing systems of coffee-pruning in Jamaica, i.e. Short-top and Long-top, is good if strictly adhered to. In view of the fact that each system has its advocates, it is desirable to show the merits and demerits of each.

Short-top, or Single Stem

Among the *advantages* are:

(*a*) Easily reaped.
(*b*) Damage by wind negligible.
(*c*) Less damage by hurricanes.
(*d*) Shade requirements more easily met.

Disadvantages

(*a*) Skill and attention required for proper training, i.e. capping, etc.
(*b*) Skill required for pruning.
(*c*) Extra time and labour required for pruning and handling.
(*d*) Breakages due to careless picking, i.e. the tendency of pickers to pull the branches around, instead of walking round the tree.
(*e*) Loss of primaries, by hurricane, or falling branches trained over a period of years, reduces the crop potential permanently.

Long-top, or Multiple Stem

Advantages

(*a*) Less time and labour required for pruning.
(*b*) Handling after pruning eliminated.
(*c*) Skilled labour unnecessary.
(*d*) Easier regulation of crop to prevent overbearing.
(*e*) More regular annual bearing per unit acreage.
(*f*) Average yield equal to, or higher than, single stem.
(*g*) Reaping just as fast, if the head is bent down with a hook and cord.
(*h*) A damaged or broken head can be easily replaced.

Disadvantages

(*a*) Breakages due to wind and careless picking.
(*b*) Damage by hurricane.
(*c*) Damage to cut surfaces by termites and fungi.
(*d*) Shade requirements more exacting.
(*e*) Reaping slower and more difficult.

Short-top System. There is no arbitrary height at which the main stem should be 'capped'. On an average 4 feet 6 inches is most common, but if the position of the bush is in any way exposed, 3 feet 6 inches to 4 feet is almost ideal.

If the seedling has grown satisfactorily it should have attained the

required height in approximately three years. Some growers prefer to nip out the centre bud in order to stop further growth, but it is considered better to wait until the cut can be made on fairly woody tissue, that is, the stem of the growing shoot should be cut at the correct height when it is turning from green to brown, due to the formation of woody tissues.

There are several methods of 'capping'. The commonest method is to cut the stem immediately above the top pair of primary branches (see Fig. 3). By using this method there is a risk of the main stem splitting if the top primary branches bear a heavy crop or if the picker is unduly heavy-handed.

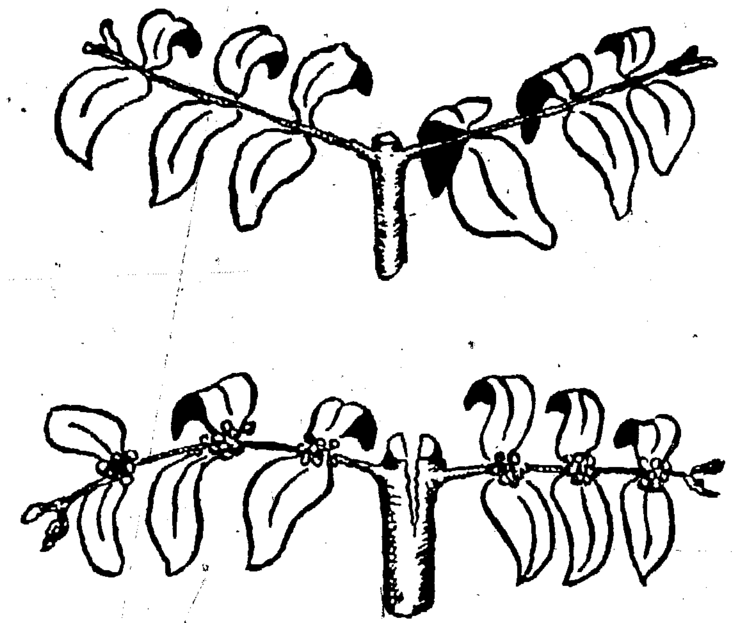


Fig. 3

There are two successful methods of overcoming the danger. The main stem may be 'capped' together with both the primary branches immediately above the pair of primary branches that must be retained (see Fig. 4).

Fig. 4

The second method is to 'cap' the main stem and one of the primary branches, making the cut at an angle of 45°. In the young tissues the wound soon heals over, and the main stem develops into a natural bend.

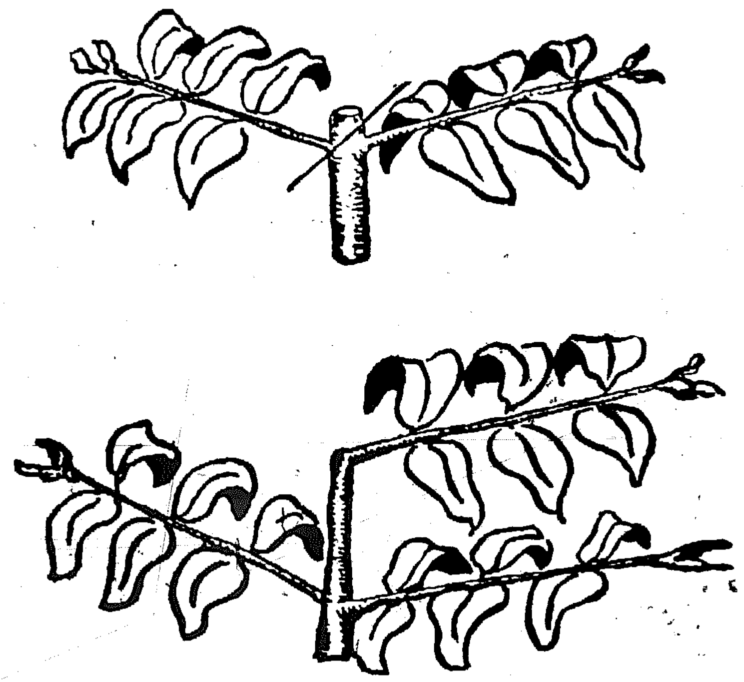


Fig. 5

When the tree has been 'capped' at the required height, the general plan of shaping the tree must be considered.

In order that all the lower primary branches may be given a chance to

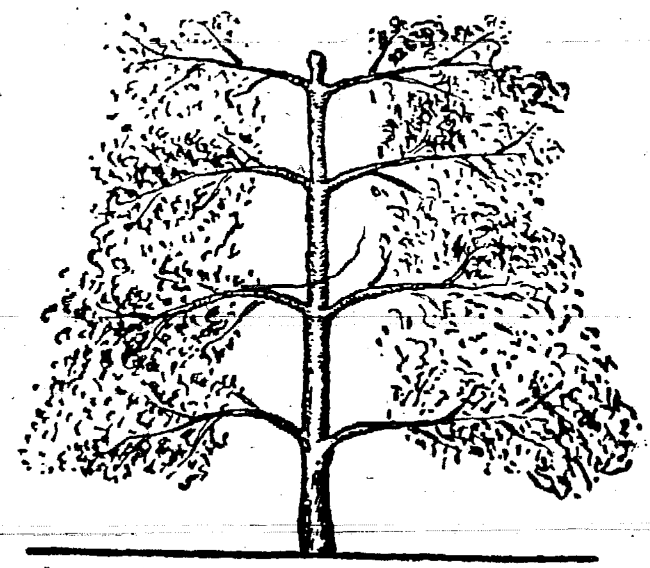


Fig. 6

bear crop, it is necessary to allow both light and air to penetrate into the centre of the tree so that a chimney, as it is called, must be left free of suckers and leafage right down the centre of the tree. On a fully-grown tree this chimney should be 12 inches across.

One of the great advantages of the Short-top system is that once the main skeleton of the tree has been formed, no stumping or heavy cutting is required. Pruning is, however, necessary on secondary and tertiary branches, so that new wood of the best quality for bearing is always being produced. The simplest and most effective method is to develop what is known as a herring bone system of secondaries on each primary.

The system of pruning is simple if the following points are carried out. Do not allow opposite secondaries to remain on the trees, otherwise there is a definite risk of overbearing. If the tree bears too heavy a crop it will become debilitated, and is then much more liable to become the victim of pests and disease.

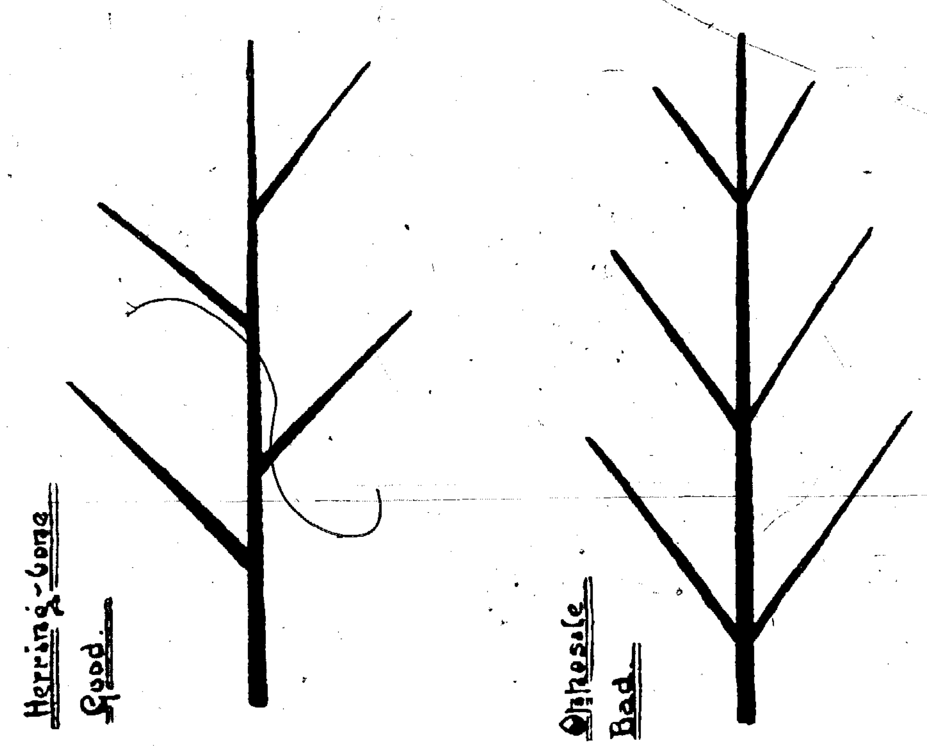


Fig. 7

Do not allow a secondary branch to grow back into the tree, either from the top or lower side of the primary. Always try to keep the branch growth radiating out from the centre.

It is important to remember that pruning is absolutely necessary if the grower wishes to produce high quality coffee.

Shown graphically, the complete cycle for training a short-top tree is as follows:

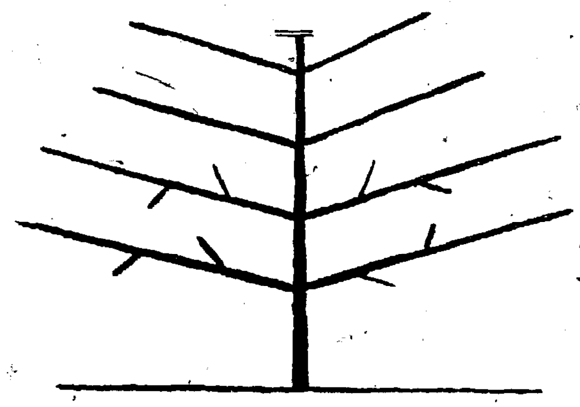


Fig. 8

First, when main stem reaches required height, 'cap' main stem.

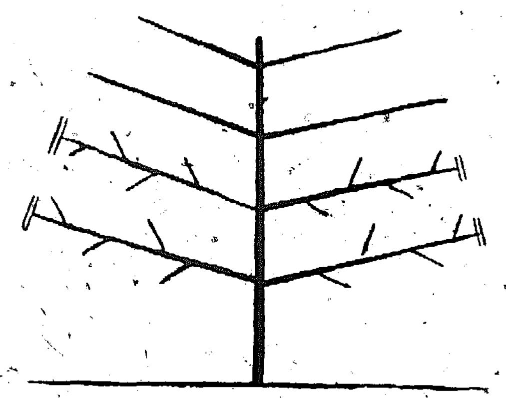


Fig. 9

Second, when the lower primaries reach a length of approximately 3 feet 6 inches, nip out centre bud and develop secondary growth.

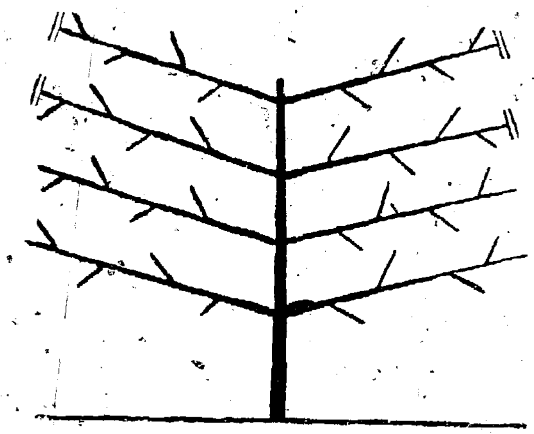


Fig. 10

Third, when the upper primaries reach required length, nip out centre bud and develop secondary growth.

All the pruning now required is to keep the chimney open by removing suckers and branches growing back into the tree, and to select correctly-spaced bearing wood.

If attention is given, during the first few years of development, to the forming of a good skeleton to the tree, much trouble will be avoided in the future, and the short-top system can be carried on almost by rule of thumb.

'When is the best time to prune?' is a question that is often asked. The first point to remember is never to attempt to cut or prune a tree that is in any way debilitated, either on account of bad health, or as a result of having borne too heavy a crop the previous year.

Leafage means health, so do not reduce still further what little remains on a sick tree. When the tree is full of leafage, pruning may be safely carried out.

The second point is that if good growth has been made without any signs of blossoming, then pruning can safely be carried out, but if the flower buds are just forming, it is better to delay pruning until the flowering has set. The reason for this is that if leafage is reduced while the flower buds are as yet in an early stage of development, many of these flower buds will change over and produce leafage instead of flowers so that a smaller crop is borne. Once the flowering has safely set, the grower can proceed to select correct bearing wood and, if need be, limit the belief that it is wrong and harmful to the tree to cut off branches that have already flowered based purely and simply on the grower's dislike to prune off crop. The grower imagines that he is losing crop when in reality, in removing badly-placed wood, he is giving a better chance to the good wood to bear more, better quality cherries.

The one exception to the above rule is sucker growth. The long green shoots which grow from the main stem should be removed as early as possible in their development, as they consume more than their fair share of the available moisture.

Long-top System. As stated earlier in this chapter, there is little to choose between the short-top and long-top systems as regards crop-bearing, if pruning is well done. In spite of the local disadvantages of Long-top, the adopted policy is to carry on the existing Long-top but gradually bring it back into a regulated system from which the best quality beans can be obtained.

This change-over must be gradual in order to avoid losing crop. For approximately two years the coffee bushes will continue to have a non-descript appearance, but gradually as the old heads are removed and the new ones develop, quite a degree of regularity can be attained.

In order that the grower will understand the goal he is aiming at, a description of the ideal system of controlling long-top will be given first.

After this explanation has been completed, some hints will be given in dealing with the present derelict state in which most of the existing long-top now is.

The whole point in adopting the long-top system is that new wood, which is the best for bearing, is continually being developed as the old wood (which has borne) is being removed. This process develops into a continuous cycle (Fig. 11).

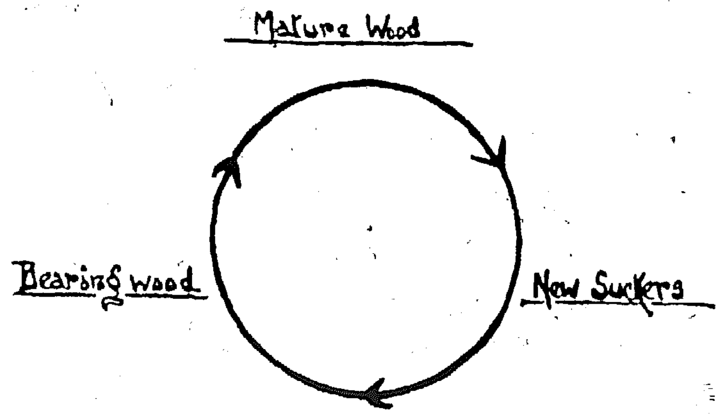


Fig. 11

Shown graphically the ideal system is as follows:

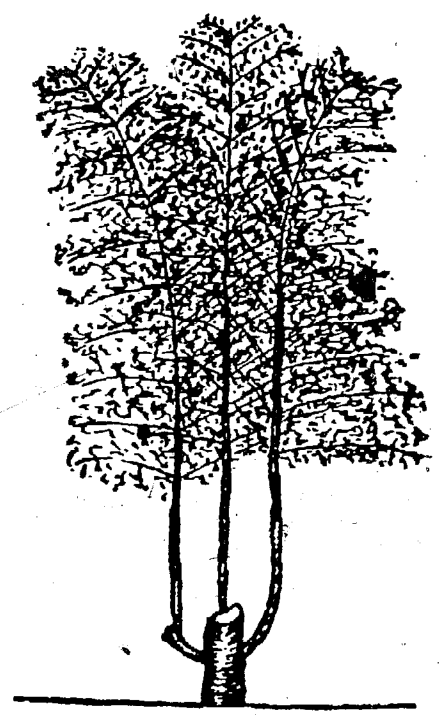


Fig. 12

First, prune off all the primary branches on the old tops up to a height of 4 feet. By allowing light and air to enter the centre of the bush, sucker growth is encouraged.

Fig. 13

Second, when a cluster of new suckers has developed, either on the old stump or low down on the existing long-tops, three only should be selected and all others removed. Under this system too careful pruning of the old heads is just a waste of time, as the old tops will shortly be removed. The main point to remember is that the new suckers must receive first consideration. Any old wood or primaries that hinder the development of these new suckers must be sacrificed. It is advisable to keep a space of approximately 18 inches between the top of the new suckers and the lower remaining primaries on the old tops.

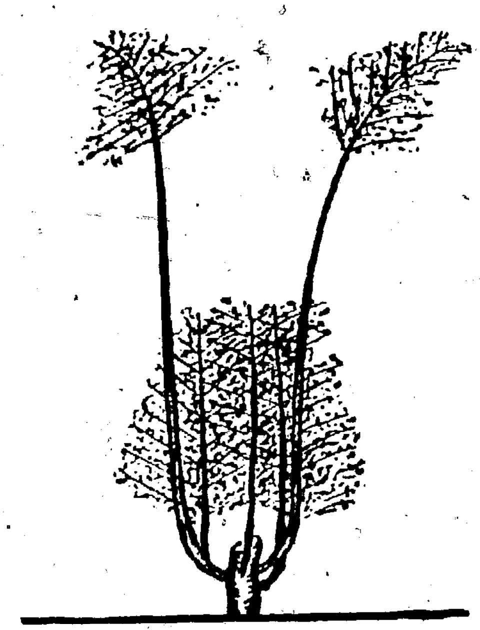


Fig. 14

Third, the three new suckers are now in full bearing, so that the worst of the old tops can be removed without any loss of crop. If need be two old tops can be removed, depending on what amount of crop the new suckers are carrying.

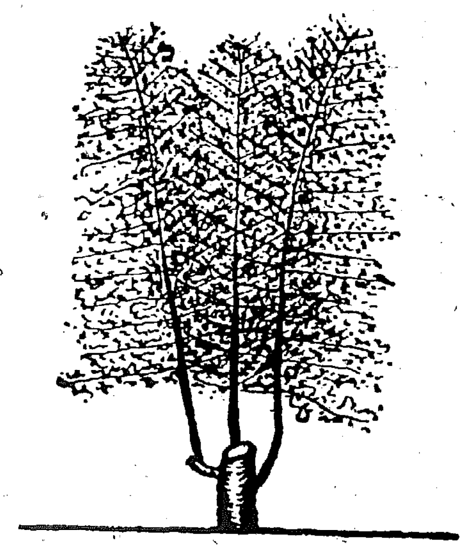


Fig. 15

Fourth, old top completely removed and bush reconstituted with three new fully-formed tops.

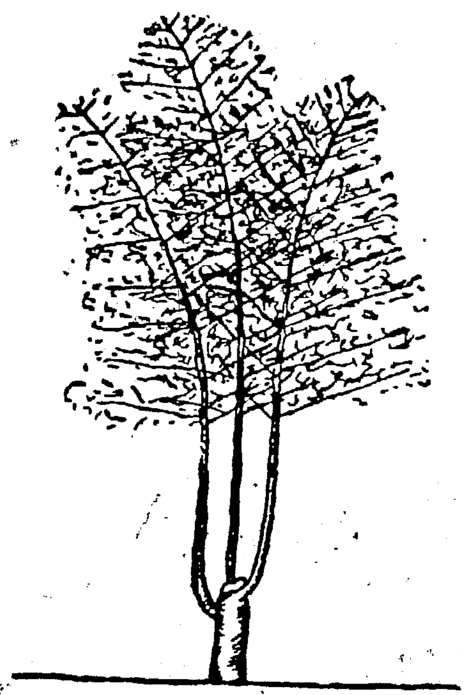


Fig. 16

Fifth, as soon as the lower primaries have borne a crop and are developing a long straggly growth they should be pruned off close to the

main stem. When these lower primaries have been removed to a height of 4 feet, new suckers can again be drawn out as in Fig. 13.

The procedure to adopt in reshaping the existing Long-top coffee depends entirely on the present condition of the tree. It may not be necessary to commence from stage one as illustrated in Fig. 12. If the tree has suitable new suckers it may be possible to adapt it to any stage in the perfect cycle.

If the old tops are heavily overgrown, carrying a mass of suckers in all stages of development, do not cut too harshly. Thin out obviously useless wood and allow light and air to enter into the centre of the bush. When suckers appear at a distance of 12 to 24 inches from ground level, select three and carry out the process as explained.

Mistakes are bound to occur, but with each succeeding cycle, as more knowledge is acquired, the system will be found to be fairly simple.

Where cutting or stumping is required, the following methods are necessary in order to guard as far as possible against rot, which is very prevalent in Jamaica.

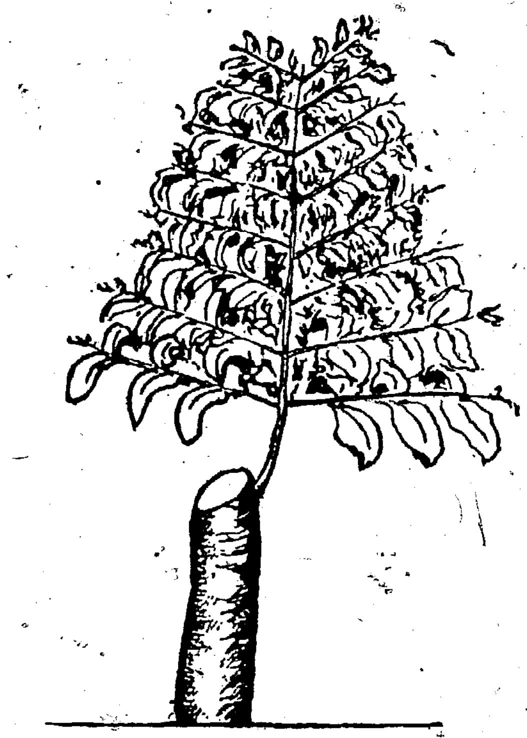


Fig. 17

1. When stumping an old head, the cut should be made at an angle of 45 degrees sloping away from the new sucker. This allows rain to drain off, and is a partial safeguard against rot. If at all possible the wound should be dressed with paint or tar, but even this is not an assurance against fungoid attack.

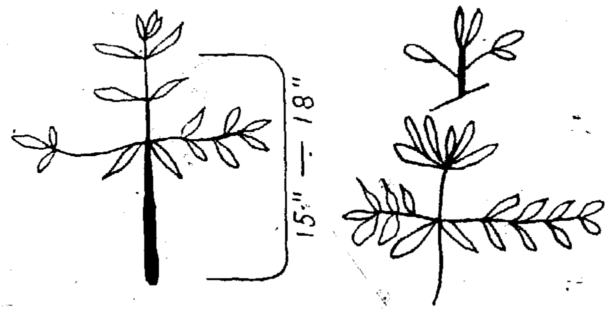
2. In the removal of primary or secondary branches, cut as smoothly and as closely to the main stem as possible. This will allow the wound, if small, to heal over.

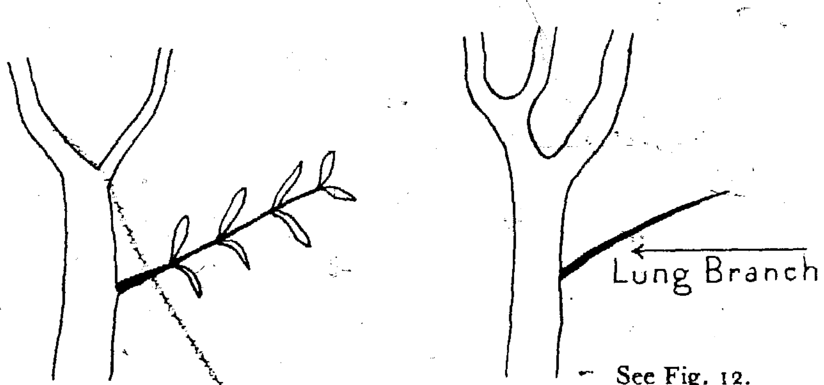
The Long-top or Multiple Stem System from the Nursery Stage

The site at which the first capping is done will be decided according to local practice at planting out. For example, in some districts where fall planting is done, the plants will be ten months old, and will not be as much advanced as eighteen months old plants, planted in the areas favouring spring planting. Whichever the practice, 'cap' first at about fifteen to eighteen inches high. Capping should not be done on brown wood, but on wood turning green to brown, and preferably on green wood.

When the first pair of suckers is established, all primaries below and at the fork should be cut off, except one, the 'lung branch' or 'breather'. In due course, one of the suckers is capped; this will in turn give rise to two suckers, thus three suckers will be obtained, resulting in a tree with three heads. Wherever possible, the 'lung branch', or breather, should be left on the side of the tree corresponding to the 'un-capped' sucker, to provide a balance.

By this method an extensive clean-growing stem is obtained from which to gain the suckers which will be required for the new cycle about five years later.





See Fig. 12.

An additional method that has been successful in some countries is that of bending over the young stem. This method is known in Latin America as 'Agobiada'. The stem is bent over at an angle of 45° by means of a peg. Suckers arise from the stem, and three suitable ones are selected. As soon as these reach a height where they are easily seen, the mother stem is cut at an angle of 45°, close to the last sucker.

(iv) Soil and Nutrition*

Mulching (Experiment at the Bukalass. Experimental Station, Uganda). The mulched plot gave a much greater increase in yield over the clean-weeded plots, and the permanent cover crop plots yielded nearly the same as the clean-weeded plots.

Tons per Acre—Fresh Cherry

Treatment	*1938–39 Crop*	*Total for 5 Seasons*
Clean weeding	2·79	19·35
Mulch (elephant grass)	4·95	23·52
Permanent cover crop	2·74	13·20
Weed cover	1·78	9·41

Importance of Potash. Potash is a dominant factor in the mineral constituents of the coffee bean. This is prominently brought out in the ash analysis (third column), where there is more potash than anything else.

Potash is needed at all times. *Phosphoric Acid* is needed chiefly at the beginning of the fruiting season. *Nitrogen* is needed at all times. *Nitrogen* should perhaps be applied in split application, as it is subject to leaching.

A green legume crop, supplied with a mixture of potash and phosphate and a little nitrate, will produce a good bulk of organic manure, but when turned under, unless a dressing of a readily available nitrogenous fertilizer be given simultaneously, there will be such competition for the available nitrogen in the soil by the microbes responsible for rotting that the coffee will suffer severely. There will be yellowing of the leaves followed by die-back.

The coffee crop annually removes large amounts of *potash* from the soil, and it is wise to restore applications of the constituent yearly.

Fertilizer should not be applied in a band at the drip of the tree, but should be applied broadcast over the surface of the soil.

Of the artificial manures only the purely nitrogenous may be applied as top dressing. Both the phosphate and potash fertilizers are retained by the soil almost where applied. They move down very slowly indeed. These manures should be turned under upon application. Probably the best time would be before the rains in between crops.

*By courtesy U.S. Dept. of Agriculture, Office of Foreign Agricultural Relations.

Nitrogenous fertilizers, if the most lasting effect is to be obtained, should not be applied until near the end of the rain. It should be taken as a general rule that quick-acting nitrogenous fertilizers should only be applied towards the end of the rains. Slowly available nitrogenous forms of nitrogen are not lost by leaching as much, and are generally better for crops like coffee.

Nitrogen Deficiency. The first symptom is a reduction in the size of the leaf. The texture of the leaves on the inside of the tree, those unable to fully perform photosynthesis, is rather harsh and the leaf is thin. This texture feel is not definite and is very easily confused with the feel caused by other deficiencies. The next symptom is chlorosis, in which the main lateral veins of the leaf first become yellow, the chlorosis then extends to the blade of the leaf, but generally the veins are markedly more yellow than the interstitial tissue. The leaf has a distinctly leathery feel. As chlorosis progresses the more mature leaves drop prematurely until the twig is completely defoliated, after which it dies back from the tip. On fruiting twigs it will be found that collapse and 'break down' of the beans occur even in the young cherries.

Potash deficiencies manifest themselves in a whole series of symptoms. The first is a papery feel of the inner leaves. The leaves may be thin, when they have a feel reminiscent of a sheet of 'crinkly' note paper, or when you think they feel like a sheet of good cartridge paper. It is interesting to note that in a group of trees infested with mealy bug contiguous to uninfested or very slightly infested trees, the inner leaves of the infested trees are papery and thin, while those of the uninfected trees are normal.

The next stage in the series of symptoms is the development of a puffy leaf. The leaf tissue between the main lateral veins rises into a ridge and the papery feel is more accentuated. With progressing potash deficiency the drip tip of the leaf becomes pinched at its base and tends to rise at right angles to the general plane of the leaf.

This is followed by the abortion of the tip giving a leaf with a rounded point. A later stage appears to be the death of tissue along the edge of the leaf and a chlorotic condition.

Phosphorus Deficiency. The only symptom which can be correlated is a harsh feel to the surface of the leaf. This condition is neither easy to describe nor to detect.

Lime Deficiency. When the soil has an ample supply of lime, the leaves are found to be distinctly stiffer than those on trees growing on a soil deficient in lime.

Manures that should be used include all classes of animal manures, decayed pulps and their composts, coffee husks and mill waste, rubbish of all kinds, including cane pulp or bagasse and vegetable waste, green manures, all dead vegetable or animal substances in decomposition, the

froth from cane mills, sediment carried by the water, mud, rubbish, dry leaves, etc. These fertilizers have no rival in coffee culture and can be used at any time of the year. They may be reinforced with chemical fertilizers. If used alone they should be employed in sufficient quantities. Animal manures should not be applied in the fresh state.

Before resorting to chemical fertilizers the coffee grower should be able to obtain a part of what he needs from his own property. Among these is coffee pulp. Coffee pulp is one of the richest of materials in fertilizer value. Pulp forms more or less 70% of the weight of the coffee cherry.

Composition of Fresh Pulp

Components	*Percentage*
Water	60
Organic matter	38·12
Mineral	1·29
Nitrogen	·59

Composition of the Ashes of Coffee Pulp

Components	*Percentage*
Phosphoric Acid	10·33
Potassium	52·99
Calcium	3·80
Magnesium	7·60
Sulphuric Acid	3·27
Chlorine	·82
Sodium, Silica, Iron Oxide, Carbonic Acid	21·19

Coffee pulp used as fertilizer returns about ½ part of the phosphoric acid, ½ the potash and a little more than ¼ of the nitrogen that the tree needs to mature the cherries.

Preparation of the Coffee Pulp. Fermenting pits of concrete are recommended. The pulp should be carried to the pit daily, after draining the excess water, and spread over the base of the pit in a light uniform layer, upon which a cover of good quality earth to the depth of one inch should be spread. On the earth is spread lime dust sufficient to whiten the surface. To accelerate the fermentation of the pulp that dries, a uniform application of water to the surface should be given every two or three days.

Successive layers are added to the end of the season. The last soil layer should be thicker, and more lime should be used. The pulp should remain in the pit for at least six months, watering it occasionally. One or two weeks before being used it should be turned, mixing the soil, pulp and lime thoroughly.

The decomposed pulp should be applied at the rate of two baskets or kerosene tins to an individual terrace made 4 feet wide on the upper side of the tree. When a terrace does not exist, it is suggested that a small trench be made about 2 feet from the trunk and filled with the cured pulp, and later cover them with the earth previously removed.

The most appropriate time to apply the pulp is in May and June when rains are abundant. If not possible then, apply in November, December and January before the blossoming season.

The parchment husk is poor in nutrient and slow in decomposition. It should be piled for a year or eighteen months. If burned in the mill, the ashes should be preserved as they are very rich in potash. It is not, however, recommended to burn either pulp or parchment, as that destroys the humates of calcium and potassium that are the black earth that the tree thrives on.

Experiment in Fertilizing. Hawaii produces annually approximately 10,000,000 pounds of green coffee on 5,000 acres. One of the dominant factors in this high production per acre has been the intensive use of commercial fertilizers.

The Fukuda experiment in the Kona district was initiated in 1930. This was a 5 × 5 Latin square with 9 trees per plot and 9 ft. between trees. Elevation was 1,500 ft. There was no shade. Semi-annual fertilizer treatments at the rate of 80 pounds of each element, whether used alone or in combination (the annual rate 160 lbs.). Nitrogen was half ammonia sulphate and half sodium nitrate.

No significant differences were obtained until the third harvest, but from then on very significant increases were noted in the plots receiving potash. In the eighth harvest the yields were:

Check 3,800 lbs. N. 2,200; N.P. 3,700; NK. 22,300; and N.P.N. 25,200.

A second experiment in Takaskiba, at an elevation of 2,200 ft., was started in 1934. It consisted of 3 randemized blocks of 5 treatments in 9 tree plots. The treatment and the fertilizers were the same as in Fukuda plots.

Beginning in 1935 the plots receiving potash in conjunction with nitrogen gave significantly higher yields than those without either N or K.

Annual Yields of Coffee from the differently fertilized plots at the Takaskiba farm

Treatment	1935–36 *Cwt. 1 acre*	1936–37 *Cwt. 1 acre*	1937–38 *Cwt. 1 acre*
(½N) PK	126	248	85
NPK	132	242	84
NK	139	249	77
FK	103	168	50
NP	97	130	16
Standard error	6	18	15

In both experiments potash used in conjunction with nitrogen gave increased yields over nitrogen used alone or with phosphate. Forty pounds of N with K produced as good yields as 80 pounds of N. No responses were obtained from the use of phosphatic fertilizers.

Localized applications around the trunks of coffee trees of N fertilizer containing ½ ammonium sulphate and ½ sodium nitrate resulted in a marked increase of soil acidity after seven years.

CHAPTER 23

Coconuts

(i) The Economic Importance

Before World War II coconuts commanded an important place in the exports of the Island, but during the post-war days the development of local production of edible fats and oils, which received an impetus in the early war years, has resulted in a wholesale transfer of production from exports to local factory production. In addition between one-third and one-half of production continues to be consumed locally in the unprocessed state.

An important economic aspect is the susceptibility of the coconut tree to hurricane damage, and for that reason coconut insurance has become a feature of the industry. Another important economic feature of the crop is that, due to its long-term nature, it is never usually planted as a pure stand. The crop has been regarded as an estate crop, and 90 per cent production comes from farms of 200 acres and over.

(ii) Selection and Propagation of Planting Material

In selecting nuts for establishing a grove the entire method of approach should be aimed at careful selection of good seednuts. Both yield and constitution of the parent tree, as well as location, should be taken into consideration. Nuts should be taken from robust, high-yielding trees which are grouped together, thus ensuring that cross-fertilization will be among these trees, all of which have the desired characteristics.

The dry unhusked nuts are laid on their sides in nursery beds and partly covered with earth. Germination takes place in about three months, and at the end of another three months, when the shoots should be about 9 inches tall, the seedlings with nuts attached are ready for planting out. At this stage there is less setback than when the seedlings are allowed to grow taller and produce roots which are unavoidably destroyed when these tall plants are transferred to the field. This method of approach is regarded as important in order to reduce losses in the field, as well as retarding the rate of growth of the seedlings. The start given to a seedling in the nursery decides whether the adult tree will eventually produce nuts of a high

quality or not. To make certain that only good seedlings are planted in the field, a selection of seedlings is made in the nursery. Therefore, there has been a double selection, since the seed nuts were selected to commence with and the seedlings themselves have been finally selected.

(iii) Preparing the Land

Selecting the Land. The coconut favours deep alluvial or loamy soil which allows free drainage. For this reason the best results are obtained especially near the seacoast, but the coconut also thrives to a considerable distance inland, provided climatic and soil conditions are suitable. Rocky soil, and heavy soil with poor drainage are unsuitable. It is therefore inadvisable to plant on heavy clay soils on level land which cannot be well drained.

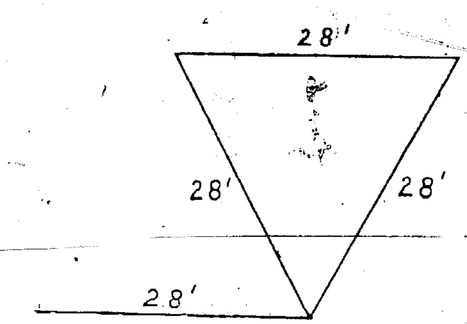
Red earth land and other acid types are also unsuitable. Alkaline soil, provided it is well-drained, is suitable for coconuts, even though the soil may be shallow. These top soils are usually dark-brown, grey or yellow-brown.

Preparing the Holes. The holes should be not less than 3 ft. wide × 3 ft. deep. They should be weathered for six or eight weeks previous to being planted. After planting they should only be partially filled with surface soil, the remainder being filled in course of time through cultivation and weathering. If available, some well-rotted manure should be placed in the bottom of the holes, mixed with a little surface earth, at the time of planting.

Spacing. Many plantations space 30 ft. × 30 ft., but 26 ft. × 25 ft. (70 to the acre) is common. Spacing, however, must be ruled by soil and locality, high quality land allowing for closer spacing. On level areas that need good drainage the trees can be established in rows parallel with the trenches. Spacings used might be:

Distance between rows	*Distance along rows*	*No. to the acre*
30 ft.	25 ft.	58
30 ft.	24 ft.	60
30 ft.	22 ft.	66
30 ft.	20 ft.	72

On level areas, free draining and not needing trenches, the best form of spacing would be triangular rather than square. By the triangular method the palms are set at fixed distances at the corners of equilateral triangles as shown in the diagram.



Spacing may be between 30 x 30 x 30 ft. giving 55 trees to the acre and 26 x 26 x 26 ft. giving 72 trees.

On hillsides it is most desirable to institute proper soil conservation measures, in order to permit cultivation to be carried out without loss of top soil, to allow thorough and uniform drainage, to prevent the roots of the coconut trees from becoming exposed. Planting in such cases should be on the contour, with the trees placed in the middle or just below the middle point in each bed. To make this possible exactly uniform spacing cannot be achieved, owing to variations in slope, and lining will have to be staggered from bed to bed. For each desired planting distance a range of spacings will have to be allowed, and it is suggested that the following be used:

Desired average spacing	*Min. distance between trees*	*Max. distance between trees*
30 ft.	26 ft.	34 ft.
28 ft.	24 ft.	32 ft.
26 ft.	22 ft.	30 ft.

(iv) Planting

As a rule it is more satisfactory and economical to propagate seedlings in a nursery as described above, rather than to plant out seed nuts direct in prepared holes in the field. The seedlings should, however, be set out in the field as soon as possible after they germinate and develop a heavy root system in order to reduce the shock from transplanting to a minimum.

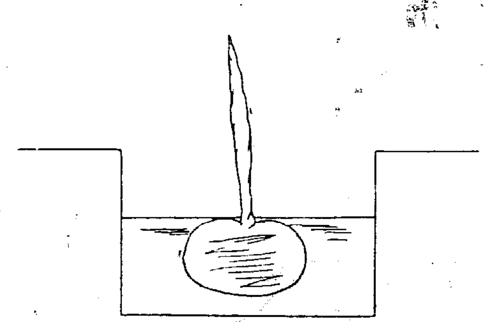


Fig. 1

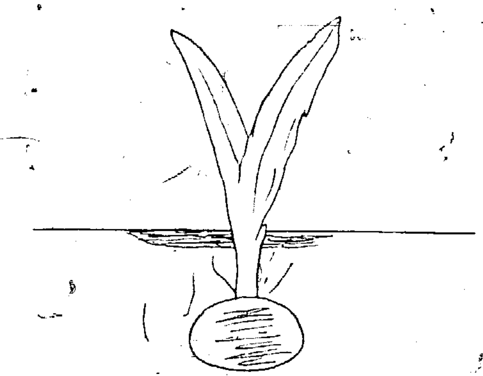


Fig 2

In setting out the young plants, they should be put into the prepared holes and covered with the top of the husk showing just flush with the earth with which they have been covered. As mentioned before, the hole, after planting, should only be half filled (Fig. 1), leaving the remainder to

fill in by cultivation and weathering (Fig. 2). This not only protects the plant, but allows it to develop a robust root system.

The Coconut's growing Bud. The most crucial period in the life of a coconut tree is the first two or three years before the trunk begins to form. During this period the successive leaves produced are larger and larger until leaves as big as those of a full-grown tree emerge. It is only after this that a trunk begins to appear. Now, why should the production of a trunk growth and foliage development proceed hand in hand? The answer is, that the coconut does not possess the power of thickening its trunk once it is formed. The 'bole' or 'bulb' at the base of the old coconut tree is not secondary thickening; it results merely from an attempt to produce new roots from the base of the tree. During the early period, while larger and larger leaves are appearing, the one and only vegetative or growing bud a coconut ever has remains at or very near to ground level and steadily swells. This swelling continues until leaves of full size are produced, and the bud then starts growing upwards. The final girth reached by the bud while at the base of the tree is the final girth of the tree, and the amount of plant food passing up and down the trunk will always be limited by that girth.

A tree with a slender trunk will never be a heavy bearer, and other things being equal a tree with a trunk of large girth will bear well. All this is being determined while the leaves are still emerging from the ground. Those leaves are manufacturing plant food, which is being used up in root development and in expanding the girth of the growing bud. If any of those leaves are destroyed or damaged, or if the roots cannot obtain all the soil nutrients or water that the plant requires owing either to drought, water logging or competition with weeds, etc., the girth development of the bud, and therefore of the final tree, will be adversely affected.

(v) Maintenance

Cultivation. Sufficient has been said to indicate why it is so important to cultivate coconuts thoroughly in the early years. If such cultivation can be maintained throughout the life of the plant, then yields obtained will be much better than if the plants have to compete with grass and bush, and cattle are allowed to roam through the field damaging the banks of the trench and or puddling the soil, thus causing poor soil aeration.

The question arises as to the crops which might be planted through young coconuts. Suggestions have been made that cane might be one of these crops, but it cannot be recommended for several reasons, the chief of which being that it is a gross feeder and would compete with the young trees. The same disadvantages occur with the use of fodder grasses grown for cutting. The ideal crops undoubtedly are legumes such as cow peas, soya beans and peanuts. While cow peas might be grown on most coconut soils, the soya beans would probably be limited to alluvial areas and the peanuts to relatively dry sandy soils. Pigeon or Congo peas could also be grown, provided the plants are kept well away from the young coconuts. For grain crops, corn is not generally suited to coconut soils, but dwarf Guinea corn (not tall Guinea corn) could be grown if the rows were kept some distance from the trees. Hill rice, too, might be tried, particularly on the heavier alkaline soil types.

Bananas as an Inter-crop. Bananas and coconuts are very good crops for growing together, since the primary requirement of both crops for optimum production is a deep fertile free-draining soil. When it is intended to practise such inter-cropping, it is usually advantageous to use a wider spacing for the coconut trees so as to allow a minimum of interference with the banana plants by shade of the coconut trees. Of course, this method provides for the time when trees get older, since during the early stage of coconut growth the bananas will suffer no such effect. But with a long-term crop such as coconut, the field layout must be properly planned to avoid obvious errors at a later stage. The two main advantages of inter-cropping with bananas are:

(1) Beneficial effects of cultural treatment of the bananas on the growth and production of the coconuts.
(2) Cash returns received from the sale of banana fruit until the coconuts come into bearing.

It has been a noticeable feature of all coconut trees grown in admixture with bananas that they grow more vigorously and produce more coconuts than otherwise where cultural practices are less intensive.

Fertilizers. In general the application of fertilizers should be according to requirements of the particular soil, as well as the yield of the plantation. Potash plays a dominant role in coconut manuring and is of predominant importance in the case of young palms, even more than for bearing palms. From information available for local conditions it is recommended that 1 lb. N.P.K. should be applied to each tree per year for the first three years. This is increased to 2 lb. per tree per annum for the fourth and fifth years, and thereafter 4 lb. per tree per annum for the economic bearing life of the tree.

In the early stages, until the stem is formed, manures should be applied close to the palm, up to a distance of 1 foot during the second year. As the palms grow older the area around which manures are applied should be gradually extended. The success of manuring depends mostly on systematic application, and good results should not be expected by haphazard application. Apart from this, no remunerative results could be expected by treating ill-grown, tapered and dud palms, which should be removed and replaced with healthy seedlings in well-prepared holes.

On the unit value, artificial manure is economical, but where organic manures are available at a moderate price, these should not be overlooked, neither should the burying of husks which answers manifold purposes.

Mulching. Young palms are particularly susceptible to drought conditions, and there is no better method of protecting young plants against drought than by mulching with coconut husks around the palm up to a distance of 4 to 6 feet. If coir dust is used for mulching seedlings an area around the base up to 6 inches should be left unmulched.

Harvesting. Nuts should be picked regularly once every two months, and not more than two bunches should be cut down. These nuts should be placed in heaps in the field and allowed to mature for two or three weeks before husking. All fallen nuts should be sent for immediate curing, otherwise they will germinate in the heaps and produce inferior copra. Nut storage is unnecessary when nuts are harvested ripe and brown. Nuts which are harvested correctly produce a greater weight of thick copra which is also whiter and harder. If nuts are picked under-ripe or over-ripe, then the copra is thin and rubbery or thin and dark. Husked nuts should be covered, otherwise the exposed nuts on top of the heap will be cracked open by the heat of the sun and will rot.

CHAPTER 24

Cocoa

(i) World History

At the time the Spaniards discovered the Western Hemisphere, cocoa seeds or 'beans' were used as currency and crushed to make a peppered drink in Central America and the West Indies. The Spaniards introduced the drink (without pepper) to Europe, but cocoa was not used much until after 1830 when bar chocolate began to be manufactured. Consumption increased further after 1880 with the production of milk bar chocolate. By 1900 world production amounted to 100,000 tons and has now increased to 850,000 tons. In 1953, the London Cocoa Conference passed a resolution encouraging expansion to a million tons by 1963. In 1955, the F.A.O. Conference assessed cocoa as a crop with one of the safest futures. At the moment British West Africa and Brazil produce the major portion of the crop.

(ii) Jamaican History

After the English conquest, existing plantings of cocoa were extended until 1727, when all except sheltered plantings were destroyed by a 'blast' (supposedly a hurricane). Afterwards, until 1850, a severe excise duty was imposed which prevented the crop being grown except for local use.

In 1870 the price of sugar fell with the introduction of beet sugar. This led to a heavy replacement of cane by various crops including cocoa and a mixture of bananas and cocoa. In 1874 cocoa production was only 20 tons per annum. Production increased between 1905 and 1925 to between 2,500 and 3,500 tons.

Between 1870 and 1930 the price remained at between 6d. and 8d. per lb. The price fell in 1930 and remained at about 4d. per lb. until 1947; since then it has remained above 1s. 5d. per lb.

By 1930 plantations were suffering from the effects of age and exposure to the sun, both of which caused a decline in cocoa yields. Discouraged by the fall in price and diminishing yields, many of the farmers dug out their trees and replanted their fields with bananas. Those who retained their trees followed the common practice of permitting a basal growth to replace the main trunk of each tree.

Recently, under the Farm Development Scheme, farmers have been provided with a maximum of £39 5s. od. per acre in subsidies over a five-year period for planting the crop. Under the Scheme 50,000 acres of new plantings will be established by 1967.

(iii) Plant Description

In its wild state the cocoa tree grows under the shade of taller trees. Cocoa plants, sown from seed, at first produce 'choupons'—straight stems with leaves growing in a spiral around the stem. All choupons end their growth with the production of several branches, collectively known as 'Jorquette' arising at one focal point. Individually these branches are known as 'fan' branches because their leaves are arranged in two lines. Fan branches normally give rise to further fan branches, but occasionally a choupon grows from them. The trunk of the tree is extended by the growth of choupons below each jorquette.

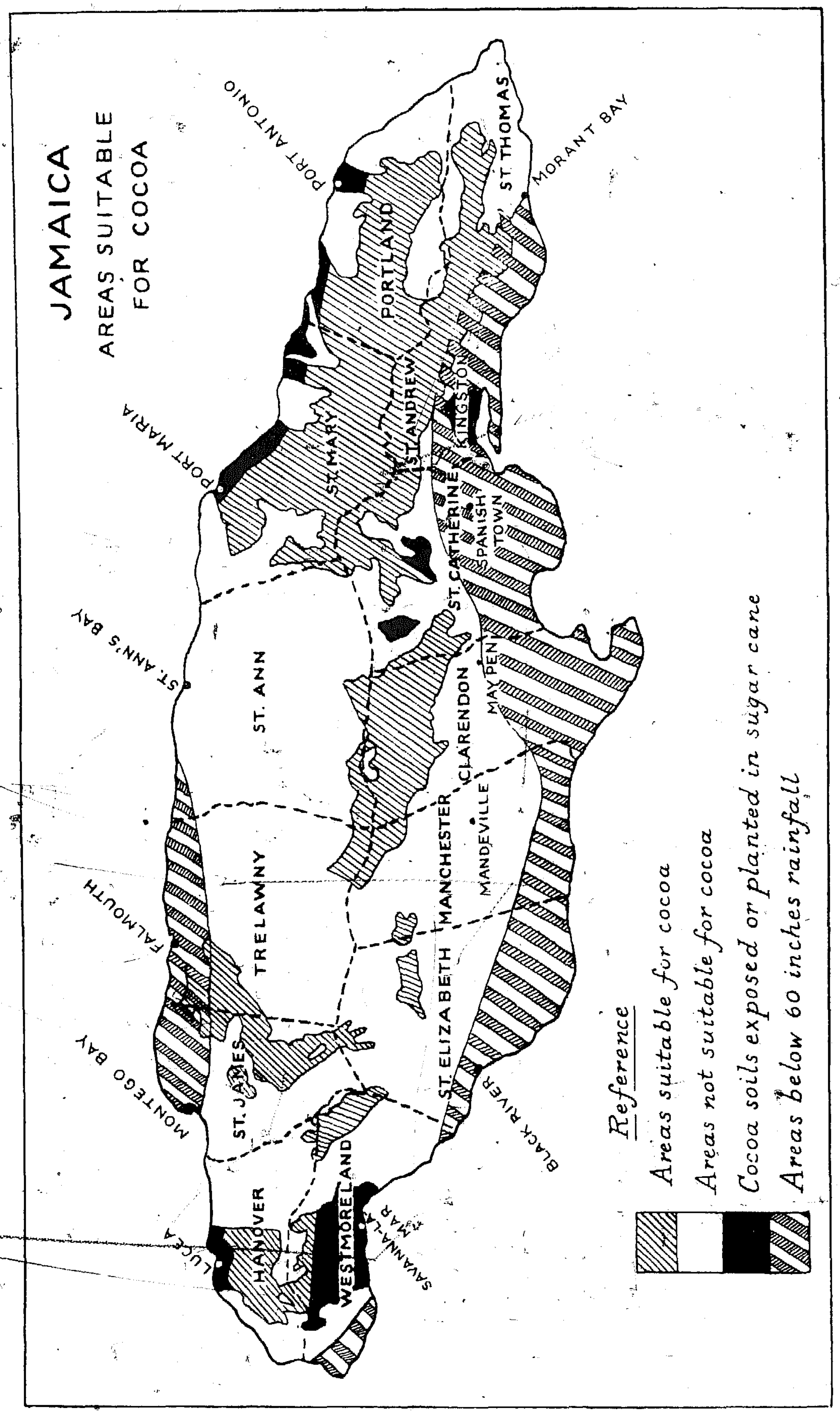
Seedlings usually begin flowering when they are about four years old. Rooted cuttings and buddings when 2½ years old. Flowers arise from the trunk and from branches which are more than a year old. Flowers consist of five sepals, five petals, five stamens alternating with five staminodes. There is an ovary of five carpels with a single style. Flowers are plentiful but only about five per cent usually set fruit. Pollination is effected by small insects including Midges and Thrips. Small fruit are known as 'Cherelles'; these increase in size and become 'pods'. Pods take about five months to ripen and contain twenty to forty-five seeds or 'beans'. The number of pods required to yield one pound of dried beans is known as the pod 'index'. Pod indices vary between five and fifteen, the average for Jamaican seedling cocoa is about twelve.

(iv) Varieties

There are numerous varieties of cocoa. These are divided into two types: the Criollo and the Forastero. These types have crossed freely and are difficult to differentiate except by their beans and the shape of their pods.

The Criollo varieties possess large plump beans with white interiors. Interiors will, however, be a light red when the flowers receive fertilization from Forastero pollen. The interior of Forastero beans is a deep reddish-purple and the beans are flat-sided and usually smaller than Criollo beans.

Criollo pods are usually high-shouldered, long pointed and warty with a thin pod wall. Forastero pods, with a large proportion of Criollo genes, may also be high-shouldered or bottle-shouldered, long or short pointed and slightly warty. This group occurs commonly in Trinidad from which



it gets the name 'Trinitario'. The purer Forastero varieties usually have smooth, melon or calabash shaped pods with thick pod walls.

Criollo pods are usually green while Forastero pods vary from green or red or have a combination of both colours.

Criollo plants are less hardy than Forastero plants.

All of the varieties obtainable from the Ministry of Agriculture are Trinitario-Forastero in type. Several varieties are distributed:

(*a*) Rooted Cuttings of the ICS (Imperial College Selections) (Trinidad) types 1, I.C.S. 6, I.C.S. 8, I.C.S. 60, I.C.S. 95 and I.C.S. 98. I.C.S. 60 so closely resembles Criollo in type that it is termed a near-Criollo. Its pollen is self-sterile—it will effect pollination only in other varieties but not in itself and must therefore be planted between plants of other varieties. The Trinidad varieties (as mature trees) have very low pod indices of from $5\frac{1}{2}$ to $7\frac{1}{2}$. (Number of pods per lb. of dry cocoa.) Their mother trees in Trinidad yielded an average of over 50 pods annually.

(*b*) Hybrid seedlings. These are varieties obtained by crossing varieties imported from the Amazon Valley with varieties selected in Trinidad (the ICS varieties mainly). These Hybrid Seedlings will in future make up the largest proportion of cocoa plants distributed.

(v) Propagation

Cocoa should not be propagated by sowing ordinary seed. If seed is sown the plants that grow will produce extremely variable yields, for cocoa does not come true from seed.

To be assured of high yields it is necessary to establish plants either:

(*a*) from special seed produced by crossing selected trees from the Amazon Valley with other Amazon trees or with selected varieties such as the I.C.S. varieties. Resulting plants are known as Hybrid Seedlings and exhibit hybrid vigour and high yielding ability, or

(*b*) by vegetative propagation of selected high yielding trees. By this means plants are grown from parts of the original tree. Such plants are known as 'clones'. Vegetative propagation may be carried out by rooting cuttings in special propagators, budding or Topper layering. With budded plants it is advisable to mould and root the scions as devised in the Topper technique.

(vi) Climate and Soil Requirements

Cocoa requires a relatively heavy rainfall of over 65 inches per annum. Very heavy rainfall of over 120 inches per annum will encourage growth, but the incidence of black pod disease is usually very high and, unless controlled, will reduce yields.

High-yielding Tree

Poor-yielding Tree

The two chief soil requirements in Jamaica are depth and freedom from free or absorbable lime.

The soil should be at least two feet deep.

Free or absorbable lime interferes with the absorption of iron, which is especially required for the production of chlorophyll—the green colouring

matter of the leaves. Leaves show a yellowness or chlorosis and the plants yield poorly and are short-lived.

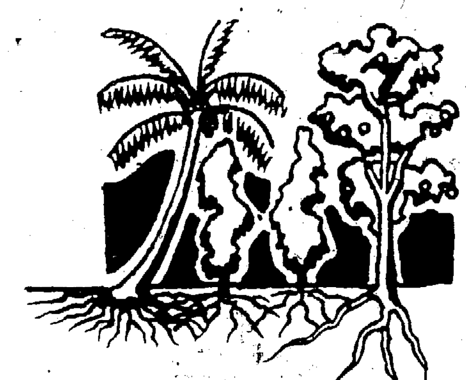
(vii) Shade and Windbreak Trees

Shade is the third most important requirement for cocoa next to climate and soils.

In Jamaica unshaded cocoa suffers severely from die-back brought about by the burning of the sun and by damage from thrips, an insect, which is attracted to unshaded cocoa.

Besides preventing die-back, suitable shade trees also assist in drainage, aeration and manuring, and protect the cocoa trees from wind, and so maintaining a high humidity in the grove.

Suitable shade trees are deeply rooted. These deep roots assist in lowering the water-table during excessive rain; they also obtain plant food more deeply than the cocoa and certain portions of this plant food is put within reach of the cocoa when the shade trees' leaves decay on the ground. The organic matter in these leaves also improves the aeration of the soil. Most of the suitable shade trees belong to the same family as beans and peas and, like them, are able to assimilate nitrogen from the air. This nitrogen is eventually added to the soil where it serves the cocoa.



Coconut **Breadfruit**

Suitable shade trees do not, however, yield saleable crops and some farmers are prepared to use such unsuitable shade trees as coconuts and breadfruit for the sake of their saleable crops, in spite of the fact that these trees reduce the yields of the cocoa trees. Both coconuts and breadfruit provide too dense a shade over a restricted area and the roots of the coconut compete with those of the cocoa. Coconuts also encourage the presence of rats which feed on the cocoa pods.

The most suitable shade tree is the Red Pod Wild Tamarind (*Pithecolobium arboreum*). It is a legume and one of the few shade trees on which the Fiddler Beetle does not feed or lay its eggs. It also produces a well used lumber. Farmers are well advised to use this tree as shade. Where, however, the farm is too small to grow cocoa in the best possible manner, farmers may use fruit, food forest and other lumber trees as permanent shade. In deep valleys which only receive four hours or less sunshine on clear days, it is not necessary to plant permanent shade trees.

In addition to permanent shade trees it is necessary to provide temporary and semi-permanent shade plants to shade the cocoa until the permanent shade trees are six or seven years old and large enough to shade the cocoa.

The most suitable temporary shade are bananas or plantains (provided these are treated with Dieldrin against Borers). Pigeon or gungo peas and castor oil may also be used. As a guarantee in case the temporary shade plants are blown down, defoliated by leaf spot or die out at an early age, semi-permanent shade should also be planted in addition to temporary shade. The Inga (Locust or Cocoa Oak) should be used as this semi-permanent shade. Plants may be obtained through the Instructors and planted at 12 by 12 feet. They should be cut back and kept to the height of a banana plant and eventually destroyed when the permanent shade trees are 6 to 7 years old and large enough to shade the cocoa.

Low crops, such as cocoes, tanniers and dasheens, will also assist growth by increasing the humidity around the cocoa.

Finally, windbreaks should be planted on those sides of the field which face prevailing winds. The same thrips which attack cocoa also attack mangoes and these should not therefore be used as a windbreak.

(viii) Planting

Before cocoa can be planted it is necessary to

1. Set up erosion controls.
2. Decide on planting distances.
3. Obtain good shade from temporary shade plants.
4. Prepare planting sites well in advance.
5. Wait until sufficient rains are assured.

The usual erosion controls are:

(*a*) the selection and protection of the required number of run-off drains, and

(*b*) grass barriers. Drains with a 1 in a 100 fall are added below the grass barriers where the soil is not free draining.

Twelve feet by twelve feet is the planting distance recommended for cocoa.

Shade plants are usually set between cocoa plants at spacing to comply with those to be adopted for the cocoa. Bananas are set at the same distances, and pigeon peas and castor oil at half the distance of the cocoa.

The permanent shade trees should be planted at thirty-six feet by

thirty-six feet apart. Where breadfruit is used as a permanent shade tree it should be planted seventy-two feet by seventy-two feet apart with a small leafed permanent shade tree half way between breadfruit plants.

Planting sites are best prepared well in advance to allow the soil to settle. Where bananas are the temporary shade the planting site may be made at the foot of the bananas, providing their ratoon crops are 'moved away' from cocoa. Open a one and half foot deep and one and a half foot wide hole. Fork in about three inches of well-rotted manure or leaf mould and fill in with top-soil to encourage rapid downward growth of roots. Spread the bottom soil around the site.

The actual time of planting should depend on the assurance of rains. Do not plant except when you expect consistent rains for at least a month afterwards.

Plants are distributed to farmers in plastic pots which are easily torn open. When this is done the plant is ~~carefully removed and placed in a~~ suitably sized hole on the planting site, well above (6 inches) the level of the surrounding land to allow the root-crown to be exposed in later life. Plant firmly and tie firmly to a four foot long stake driven in near the plant. Staking counters wind damage and encourages upward growth. The stake will also mark the young cocoa plants when the field is being weeded.

(ix) Cultivation

The cultivation required is chiefly weeding. Unless plants are kept cleanly weeded they will not make uninterrupted good growth.

Young plants may be circle forked in advance of their roots, but this should cease when roots meet. It is best also to mulch young plants before a drought.

Attention must also be paid to tying plants to their stakes for the first two years.

(x) Pruning

Pruning may be carried out with a cutlass used on low branches or with a pruning hook for high branches. This hook is also used for harvesting.

Pruning will be required to

(1) Develop trees with good shapes
(2) Remove dying branches
(3) Remove diseased pods.

Pruning to develop trees with good shapes ensures that branches will be encouraged to develop where they will be

(*a*) strongly joined to the tree
(*b*) bear the best crops by being in the best position to obtain light and nutrients

(c) sufficiently high to allow a certain amount of ventilation and to allow easy access for field operations.

Removal of branches which do not fulfil these requirements will also encourage yields from other branches.

The essential differences in growth between seedlings and rooted cuttings also necessitate differences in type of pruning.

In the case of seedlings, pruning should be employed to encourage growth of the type described for seedlings under section 3—'Plant Description'. All choupon growths should be removed. None should be allowed to grow except, of course, the original one which grows from the seed. This will stop the trunk growing at the first jorquette. Usually five fan branches arise from the first jorquette. These should be thinned to three fan branches, upon which the whole structure of the tree is 'built'. Well spaced secondary, tertiary and subservient branches are allowed to develop on the three jorquette fan branches.

Rooted cuttings and buddings grown from fan buds are more difficult than seedlings to train to a proper shape for their early natural tendency is to grow as much sideways as upwards. Staking during the first two years will lead to the formation of an erect main stem. Two to three years after planting, when the plants are about shoulder height, a start should be made to remove all branches that arise below knee-height. Prune lightly and often to prevent the plants receiving a severe setback. These low branches should be fully removed by the time the trees are eight feet in height. Selective pruning should begin early among the high branches on the main stem. The earlier that the weaker, badly positioned branches are removed, the better will it be for the tree.

In the case of both seedling and rooted cutting plants an annual pruning should be carried out in June each year to cut off the ends of branches when trees begin growing into each other. Otherwise branches will rub together and destroy each other, flowers and young pods. This particular pruning operation is known as 'depuntering'.

Whenever a branch of greater diameter than about three-quarters of an inch is cut off, the cut should be treated with paint or tar to prevent die-back.

Finally, the pruning of dead and dying branches and diseased pods is required in the interests of field sanitation. Especial emphasis must be laid on the removal of diseased pods, for, unless this is given efficient attention, disease will spread to healthy pods and also become established in the cushions from which the diseased pods grow. After collection, diseased pods must be buried a foot under the ground.

Besides pruning cocoa trees, it will also be necessary to prune their shade trees to prevent them becoming too tall and easily damaged in hurricanes.

(xi) General Fertilizer Recommendations for Cacao

During the first years of the plant's life a fertilizer mixture of the formula 10–10–10 should be applied to each plant on most soils in the island. This mixture may be obtained by mixing together:

3 parts sulphate of ammonia
3 parts 18% superphosphate
1 part muriate of potash.

The fertilizer should be applied at the following rates depending on the age of the young plants—

1-year old plants—⅛ lb. in March and September of each year.
2-year old plants—¼ lb. in March and September of each year.
3-year old plants—⅜ lb. in March and September of each year.
4-year old plants—1 lb. in March and September of each year.

Five-year old plants and bearing trees should be treated with a 10–5–15 fertilizer mixture at the rate of 1½ lbs. per tree in March and September each year.

A 10–5–15 fertilizer mixture may be obtained by mixing together

2 parts sulphate of ammonia
1 part 18% superphosphate
1 part muriate of potash.

(xii) Diseases and Pests

Jamaica is extremely fortunate to be free from two very serious cocoa diseases. These are the Swollen Shoot Disease of West Africa and the Witches' Broom Disease, which attacks cocoa in Central and South America and in some of the West Indian Islands. Both diseases decrease yields considerably and cause the death of affected trees.


Pod Attacked by Black Pod Disease

The only serious diseases affecting cocoa in Jamaica are the Black Pod Disease caused by *Phytophthora palmivora*, a fungus, and Cherelle Wilt which is a physiological complaint. Cherelle Wilt causes the shedding of young pods, while the Black Pod Disease causes a gradual rotting of the outside of the older pods. Black Pod Disease seldom attacks pods until they are half grown. This disease does not affect the beans, but, unless the pods are mature, the beans are prevented from reaching maturity.

Black Pod may be controlled by spraying with Bordeaux Mixture.

Cherelle Wilt cannot yet be controlled, but as it is connected with the supply of moisture and nutrients, it will affect plants less when they are grown under highly fertile, well drained conditions.

The only pests of consequence are the Fiddler, May and June Beetles, rats and woodpeckers.

Fiddlers. There are two sizes of Fiddlers—the large: *Prepodes vittatus* and the small: *Pachnaeus litus*. The legless grubs of the Fiddlers bring about the death or debility of cocoa and citrus by eating the bark around the roots of the trees.

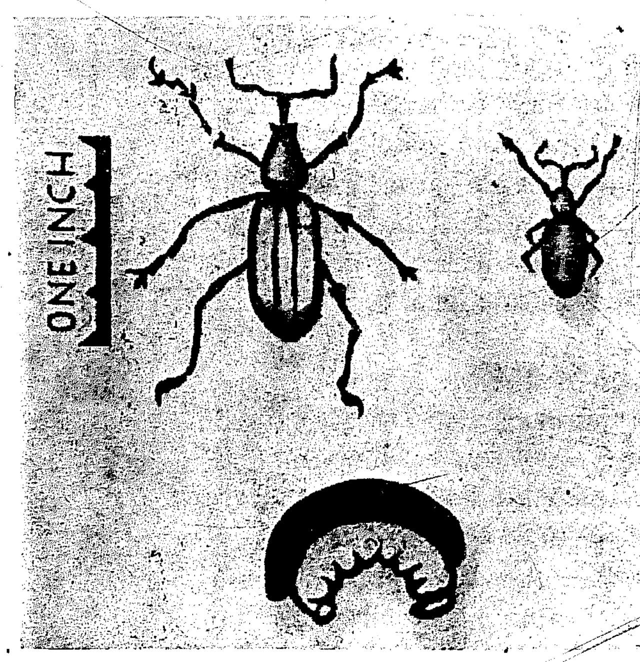
Dieldrin powder applied at the rate 2 lbs. per acre in 112 gals. of water under the canopy of cocoa plants, every two years will control this pest.

Young trees may be saved during rainy weather by early

(1) removal of the grubs,
(2) placing coir waste around the stem below ground level to encourage the development of new roots and
(3) cutting back the trees and halving remaining leaves.

The first sign of attack is a copious blossoming in the absence of flushing.

May and June Beetles. The grubs of the May Beetle (*Ligyrus tumolosus*) and June Beetle (*Lachnosterne jamaicensis*) can cause similar damage to cocoa plants, not as commonly as Fiddler Beetle.



Large and small Fiddler Beetles and Grub (note Grub has no legs)

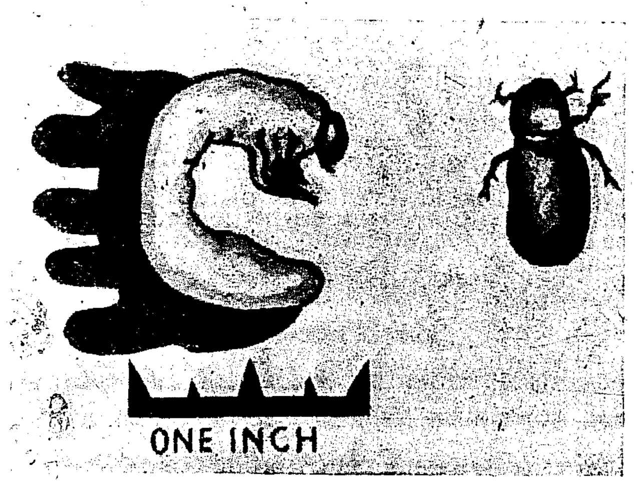
At present these beetles cannot be controlled except at an excessive cost, but experiments are being carried out to discover a cheap method of control.

The first sign of attack by a grub is the drooping of leaves and excessive flowering in absence of flushing. Young plants may be prevented from

Stem of Cocoa Plant killed by Fiddler Beetle Grub

dying, when the weather is damp, if farmers do the following things:

(*a*) Find and kill the grubs.
(*b*) Cut back the cocoa plant to half its size.

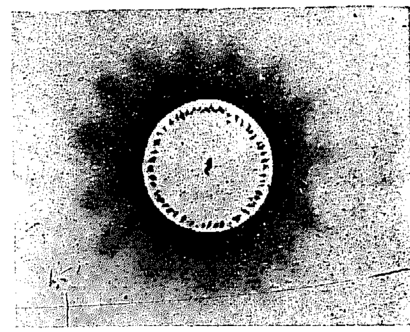


June Beetle and Grub (Note Grub has legs)

(*c*) Cut in half the leaves left on the plants.
(*d*) Place rotten leaves or coir waste around the area damaged by the grubs. This will help new roots to grow quickly.

Rats and Woodpeckers bore holes in pods and eat their beans. Rats may be controlled by using suitable poison baits placed in bamboo joints tied to cocoa trees. Woodpeckers can only be scared by shooting. Fortunately, they are only common near afforested areas.

Leaf eating slugs and caterpillars and sap-sucking aphids and thrips are among the minor pests. Damage is not usually severe enough to necessitate controlling these pests. Thrips may, however, damage unshaded cocoa severely and cause its die-back, unless care is taken to restore the shade.



Thrips on a sixpenny piece, showing small size of Thrips

(xiii) Harvesting

Cocoa is harvested during two periods in the year, The main harvest occurs usually between September and November and the lesser harvest usually between March and May.

As pods become mature they increase in size and their colour changes. Green coloured pods or parts of pods gradually turn yellow. Red coloured pods or parts of pods gradually turn orange.

Pods may be harvested as soon as these change in colour become definite. They require to be cut from the trees otherwise cushions will be damaged and yields will be lowered. The pruning hook mentioned under pruning, may be obtained for harvesting the pods high up in the tree.

(xiv) Processing

Processing consists of fermenting and drying the beans.

Fermentation

(1) removes the mucilage covering the beans,

(2) changes the astringent taste of the beans to only a slightly bitter taste,

(3) results in the interior colour of the beans changing to a rich brown and the beans becoming plump with the formation of air-spaces within them. The shells of well fermented beans are also easily removed.

At present, Jamaica is the only country producing unfermented cocoa. Very soon it will be impossible to sell such a low-class product and the

Cocoa Industry Board is now engaged in building Central Fermentaries all over the island. One is already in operation at Richmond.

Proper fermentation can only be achieved when the beans are subjected to a temperature of about 50° F. It is necessary to put about a thousand pounds of beans, together, in a box before this temperature will develop. These beans must also receive aeration by shovelling them, with a wooden shovel, from one box to another box on the second, third and fifth days, except in the case of Criollo cocoa which is put to dry on the fourth day, for its fermentation only takes three days. Forastero cocoa requires six days for fermentation and drying begins on the seventh day.

Boxes may be made of several types of wood, including cedar, and should be at least 3 feet × 4 feet × 2½ feet with quarter-inch wide interstices in the bottom for drainage. Iron nails will be eaten away by the cocoa drainings and cannot therefore be used for constructing boxes. Boxes must also be made so that they can be taken to pieces for cleaning.

Boxes should not be provided with lids. During fermentation the beans are covered with a plastic sheet or at least four layers of banana leaves to prevent loss of heat.

Usually, at the beginning of the crop, supplies of beans are insufficient to fill a box and beans may be held over in a box under banana leaves and added to the top of the succeeding day's beans. Three days' supplies of beans may be fermented together in this way.

During drying, beans are exposed to the sun in layers of about six inches thick, preferably on wooden floors, or on mats on concrete floors. The debris in the beans are removed on the first day and the beans are turned several times each day, with a wooden rake. They are raked into heaps or ridges for the night. Floors are scraped each morning to remove deposits of mucilage. Drying is usually complete after seven days of unclouded weather.

(xv) Yields

Annual Average yields of seedling cocoa vary from 250 lbs. of dried beans per acre (¾ lb. per tree) in Trinidad, to 600 lbs. per acre (1¼ lbs. per tree), with the lower quality types of Forastero cocoa in the Gold Coast.

In Trinidad, over 600 lbs. per acre is obtained annually from rooted cuttings of their Trinitario-Forastero selections.

CHAPTER 25

Havana Tobacco

(i) Seedbeds (Nurseries)

The nursery should be laid out on an open area free from shade. The soil must be fertile and well drained. The seedbeds should be raised to a minimum height of nine inches above ground level. The soil should be thoroughly cultivated making sure that the soil is prepared to a fine tilth which will enable the plants to develop a good root system.

A seedbed 60 feet long by 3 feet wide should be sown with 1 gram of pure viable clean seeds per bed and from which approximately 1,000 seedlings can be obtained.

How to make the seedbed. The seeds should be protected from rain and sun during the early stages of growth and this may be done by placing bamboo hoops at 3 foot intervals across the beds and over these hoops thin calico or cheese cloth is stretched. The hoops should not be more than 1½ feet high at the centre and the covering should be securely fastened on each hoop so that wind and rain will not remove the cloth.

Before the seeds are sown the beds should be levelled off and at the same time removing bits of twigs, roots, stones, and lumps of soil. The amount of fertilizer that is placed in a bed depends entirely on the fertility of the soil. The usual practice is to add 1½ lbs. of **potash** and a similar amount of **superphosphate** to 90 square feet bed surface.

Adding **ammonium sulphate** or **nitrate of soda** to the beds should be avoided as either of these elements produce soft, thin plants that are unable to survive when transplanted.

The fertilizer should be sprinkled evenly on the surface of the beds and thoroughly worked to a depth of 2 inches into the bed. This may be done by the use of a rake or by hand. The surface of the bed should again be levelled off then thoroughly watered thereby setting the surface so that when the seeds are sown subsequent watering will not bury the seeds and so prevent them from germinating.

Sowing. To sow 90 square feet of seedbed, place 1 gram of seed in a watering pan in which there are 2 gallons of water. The contents of the pan are watered into the bed. Watering is done lengthwise and across the

bed. To ensure even distribution of seed continuous stirring of the contents of the watering pan must be done throughout the operation.

Precaution against grass and weeds. To eliminate weeding by hand which is time consuming and costly the beds may be treated with steam, methyl bromide or calcium cyanamide.

Precaution against eel worm. As a precaution against eel worm the beds may be treated with Derris dust.

Precaution against ants. The first precautionary measure to adopt is to destroy all ants' nests in the vicinity of the nursery by applying dieldrin, agrocide or chlorodine. As a very effective repellant add 1 dessertspoon of Caladine in the water when the seeds are being sown.

After seeds are sown the addition of any chemical to the beds may injure the seeds.

Care of seedlings. The beds should be watered 3 times daily for the first 10 days and after that period it may be necessary to water twice daily. If seeding is too thick the beds should be thinned out to a spacing of approximately 1½ inches apart. All weeds must be removed thereby reducing competition and eliminating the possibility of disease. When the leaves attain the size of a six-penny piece, the covers may be removed for 4 hours in the morning and approximately 18 days after sowing the covers may be kept off the beds the entire day. Exposure to sunlight for lengthy periods gives the suckers a chance to be hardened off before setting them out in the field. The beds should not be left uncovered during rain or at nights.

From 40 to 45 days after sowing, the seedlings should be 6–8 inches from root to heart and should by then attain the size of an ordinary pencil. During wet weather watering should be withheld and, as a precautionary measure against *Phytophthora* (damping off) and other fungus diseases, it is advisable to water the beds with Cheshunt Mixture every 4th day.

To kill aphids, fleas, beetles, cutworms, grasshoppers and horn worms, spray with Endrin or dust with 5% D.D.T.

(ii) Cultivation and Planting

Alluvial soils are considered most ideal for the growing of Havana tobacco (cigar type). Good tobacco can be successfully grown on light upland soils that are freely drained. A slightly alkaline soil is, however, most favoured.

All roots and stumps should be removed before ploughing starts. It is necessary for land preparation to commence at least 2 months before planting is scheduled to commence. To effectively bring about these conditions it is desirable that a minimum of 4 ploughings to a minimum depth of 6 inches with a similar amount of harrowing should be done. After the last harrowing and before planting starts the land should be levelled.

If old tobacco stalks and bush have to be burnt the ash and remaining humus should be scattered as any appreciable accumulation of this in an area will undoubtedly cause rough coarse leaves. All shade trees should be removed if possible from and around the field.

Gravel or very sandy soil will only produce a good yield if irrigation is possible in the absence of a high rainfall during the growing period.

Even on sandy loam soils it may be necessary to put drains to collect and remove water caused by excessive rains. These drains may be advantageously placed about 2 chains apart in an east-west direction if possible. The seedlings should be planted parallel to these drains in a direction which gives the rows the full benefit of the sunlight throughout the day. The rows are placed 3 feet apart and the plants are spaced 15 inches along the rows. The holes should be dug 4–5 inches deep and digging of the holes should proceed slightly ahead of planting. The holes should be thoroughly watered. The wet earth is placed around the sucker and firmly pressed at the same time taking care to see that the stems are not damaged. Planting may continue throughout the day.

Before the suckers are taken from the seedbed the beds should be thoroughly watered at least 4 hours before. This enables the suckers to be drawn without damaging the roots. Storage of the seedlings should be done in a cool place and should be placed root downwards on wet sacks.

Fertilizing. The amount and type of fertilizer that is used will depend on the soil requirement. The application of fertilizer should only be made on the recommendation of a qualified soil chemist.

Fertilizer of the wrong type and amount per acre may cause large, rough and coarse leaves that cannot be sold. On the other hand money might be thrown away by applying an element that is already in abundance in the particular soil and the excess is really not required by the plant.

Fertilizer may be applied by mechanical applicators 3–4 inches below the row in which the tobacco is to be planted or it may be applied by hand in a circle around each plant. Fertilizer is usually applied about 10 days after planting.

Inter-row cultivation. Due to the soil type and/or intensity of rainfall during a particular period there is no hard and fast rule that can be laid down regarding method and type of cultural methods that must be used. The general practice is to start cultivating the rows with a mule-drawn cultivator about 10 days after planting. Followed by this operation workers are sent in the field with hoes who loosen the soil 7–8 inches around each plant.

The first operation by hand is usually done at 10–12 days and the second and final at 21–30 days after planting.

A field is usually cultivated by animal-drawn implements 4–5 times

at intervals of 2–3 weeks during the growing period and this operation may continue until 3 weeks before flowering commences. At the end of these operations each row is moulded to a height of 4–5 inches.

From the middle of the 3 foot space between rows, hoe up the ground and distribute around the plants, taking care to keep the mould as broad as possible. A small drain is so formed which runs into the east-west drains, so that a heavy rain shower will be quickly drained off. The reason why the moulds should be as broad as possible is to keep the earth round the plants moist. If a sharp ridge is made the earth will dry out very quickly, and the roots will not form properly, so the plant will not grow. Second moulding takes place about 20 days after planting, and the drain formed by the first moulding should be deepened out and the earth thrown out and distributed all round the plants and over the bank evenly. This second mould or bank should be about 1 foot high. The first mould should be 6 inches high.

Supplying. The diseased or dead plants should be detected at 7–10 days after planting. These should be supplied as soon as the first hand-moulding takes place, as suckers supplied after that period are unable to compete with the older plants.

Topping. Topping of a plant requires some experience. Should a plant be topped too low, rough, coarse, unmarketable leaves will develop and if topped too high the full growth of the leaves will not be attained. Topping should be done when a plant has about 15 leaves and by then the flower bud which is clearly visible should be removed; 2–3 tiny leaves being removed along with it.

Selecting plants for seed. Only healthy plants should be chosen from which seeds are to be selected for future plantings. These plants should have a large number of broad long leaves with veins and mid-ribs that are not too large. The texture should not be too coarse or rough. Leaves that are long and narrow with conspicuously large veins and mid-rib should not be selected. Ratoon trees are usually low in vitality and diseased and therefore these plants should not be selected for producing seeds.

In order to prevent cross-pollination by wind and insects it is necessary to cover the un-opened flower with a large paper or cloth bag.

Suckering. As soon as the plants have been topped or even before topping takes place, small side shoots will appear at the base of each leaf where it joins the main stalk. These should be removed as soon after they appear as if allowed to grow they will considerably reduce the yield per acre.

Harvesting. The leaves begin to ripen about 45 days after planting, and when the bottom leaves begin to crinkle and show a golden tinge accompanied with a light green colour, it is time to harvest. The lower leaves ripen first, and in some countries these are picked off the plant as they ripen and are strung up on bamboo rails in the barn to dry. The usual method is to wait until the top leaves are almost fully ripe, the lowest leaves being well over-ripe, then the whole plant is cut down. These are then placed on the ground to quail, but care must be taken that they are not scorched by the sun. As soon as the leaves are pliable and have lost their brittleness they should be taken into the shade. If the weather is dry, and it is fairly certain that no rain will fall in the night, it is better to cut the tobacco plants in the afternoon and leave them outside all night to quail, then after the dew has dried off the leaves the next morning they can be taken to the barn and hung up. The cut plants must never be bundled up together in heaps as they will start fermenting and the leaves will be spoilt. Care should be taken that no leaves are broken by rough handling. When the plants are being cut, it is best to bend them over a little with the left hand and cut as close to the ground as possible without damaging the ratoon suckers at the base. When the cut plants have been taken to the barn, they should be held upside down and the stem again cut down to the first good leaf. The very over-ripe and usually severely broken leaves, which have for so long been touching the ground, are of not much value and should be cut off. These leaves are called 'fonque' leaves.

The cut plants are now rid of all fonque leaves and should be tied up in pairs and slung up on bamboos, one plant on either side of the bamboo. Palm thatch (stripped) can be used for the tying. Each plant is tied around the stem under the last leaf nearest the base. This ensures that it will not slip out of the string when hung up. The pairs of plants should be spaced on the bamboos at 6-inch intervals, if the plants are of large size, and a little nearer if of small size. The bamboos (rails) should be spaced at 6-inch intervals also, so that the leaves of the plants do not firmly come in contact with each other. If the plants are large the spacing should be wider.

Another method of harvesting is to prime the leaves, starting at the bottom of the plant as soon as they are matured. Usually 3 to 4 leaves may be primed every 5 days. The leaves after priming are strung 3 to a bundle, 60–70 bundles to an 8 foot rail and the rails spaced 8–12 inches apart on the tier poles. When the leaves are properly dried they are removed from the rails and headed into small bundles.

Ratoons. The one or two suckers which have been left to grow out from the base of the cut plant, must be looked after exactly like the 'principal' plant, i.e., they must be topped and suckered at the proper time, and a light moulding should be given them to ensure that they grow into strong healthy plants. The filler type leaf will be obtained from the ratoons. Some planters go on cutting and allowing more and more new ratoons to grow up until the leaf produced is small and worthless. If the

first ratoons are properly handled they can be made to produce very good leaves, and will add greatly to the lbs. per acre. From the right type of 'principal' plant 50% of the leaves should be wide enough for binder leaf, the other half of the leaves will probably be too narrow, broken or discoloured, and so will be classified as fillers. From an average crop in a good year one should be able to produce 50% binder and 50% filler leaf. Binder leaves should not be less than 14 inches in length and at least 6½ inches in breadth when dry. Filler leaves of less than 7 inches in length are uneconomical to produce.

(iii) Tobacco Curing

Curing. After the plants have been cut and hung up in pairs on the rails to dry, it takes 35 to 50 days before the leaves and their stems are perfectly dry. The time for drying differs greatly as this process depends on the weather. If the weather is cold and damp, it is best to keep charcoal fires burning between the several rooms in the barn. A damp, clammy atmosphere in a barn will cause the tobacco to sweat, so every precaution must be taken to prevent this from taking place, as once 'sweating' starts it is difficult to prevent it from going through the whole barn and so spoiling the tobacco. If the days are sunny it is best to hang the affected rails out in the sun for a few hours to check the sweating. During sunny days the barn should be opened.

When the tobacco leaves and stems are dried stripping of the leaves can commence. The early morning is the most ideal time to start removing the pairs of plants from the rails. When the necessary quantity has been taken down, start making a 'stick press', that is, the bundles of plants with their dried leaves still hanging to them are placed in a staple or stick press with their heads or tops towards the centre and the stalk end outwards. To avoid excessive heat developing which spoils the leaves stripping should commence within 48 hours after the press was packed down. As soon as the leaves are stripped they should immediately be graded for length and then tied into heads of 40–45 leaves. It is desirable to retain a fair amount of moisture in the leaves to aid in the curing process. When the desired amount of heads is ready, they should be stapled together in a pile (pylon) —5 feet by 9 feet and 5 feet high. The size of the pylon will depend on the quantity of tobacco available. When the pile is about 3 feet high a hollow bamboo, large enough to allow a thermometer to pass easily down its centre, should be placed on the layer of tobacco in the pylon with one end of the bamboo in the middle of the pylon and the other end projecting 6 inches from the side of the pylon. A straight bamboo of about 1½ inches diameter should be used and the partitions between the hollow joints should be removed. To do this a small opening about 3 inches long and ¾ inch wide must be made at one side of the bamboo. These openings are also necessary to allow the heat from the tobacco to reach the thermometer which must be pushed down the bamboo to the centre of the pylon. It is best to tie the thermometer to a strip of bamboo, which can easily be pulled up or pushed down the hollow bamboo. The bulb end of the thermometer must be nearest the centre of the pylon. Continue to pack the tobacco on top of the bamboo until the required height of 5 feet is reached. Then insert the thermometer and cover the pylon with sacking or matting. The fermentation will start almost the first day and every morning the thermometer must be read and the reading recorded. The heat developed during fermentation should not exceed 130° F. At this stage the pylon must be turned. During this operation care must be taken to place the tobacco that formed the sides, with 3 layers from the top and bottom in the middle of the new heap or pylon since the tobacco from this section has not had the opportunity of being heated. Turning a pylon must be done as quickly as possible so that as little heat as possible is lost. Pylons should be built on plank floors, so it is best to have one compartment in the barn with a wooden floor raised at least 6 inches above the ground, and also the sides should be of boards or wattle plastered with earth. The method of stapling or stacking the heads of tobacco leaves is quite simple. First start a row outside completing the full size of the pylon, then about 3 inches inside this row start another row, the heads always being outwards and the tips of the leaves inwards. When these two outside rows are completed, start stapling across with the heads pointing outwards and go on doing this, making the straight rows about 3 inches apart until the centre of the pylon is reached. Then start at the other side doing the same thing until the whole of the first layer is complete. Start the second and succeeding layers the same way and the cross rows as well, so that the pylon is composed of many layers of tobacco, built up to 5 feet high.

Barns or Tobacco Houses. These should be built of hard wood posts with wattled side and thatched roofs. All interior wood not coming in contact with the ground may be of softer woods, though the crosspieces, on which the bars or rails are to rest, must be strong, as the weight of the green plants is fairly heavy.

It has always been said that one room per acre is sufficient, but with more modern methods of cultivation and consequently better sized plants it is safer to have two rooms to the acre, and so have plenty of room to space the rails properly and dry the tobacco more quickly. The size of a barn for 1 acre should be then 33 feet by 27 feet by 24 feet high at ridge pole, and 9 ft. high to plate (i.e. outside posts). The length of 33 feet is made up as follows:

3 feet, 12 feet, 3 feet, 12 feet, 3 feet. The 3 feet spaces are walk ways to enable one to move freely between the rooms when moving the rails. The 12 feet spaces are the rooms, where the tobacco is to hang. In breadth the

rooms are 27 feet with a centre walk way of 3 feet. On every row of posts across the breadth of the barn crosspieces must be put up at 3 feet intervals, on which the bamboo rails are to hang. The ends of the barns may be thatched to within 6 ft. of the ground, that is as far as the wattling, and two or three shutters should be made in this side thatching, which can easily be opened or closed as required. For each room 125 to 130 bamboo rails are required, so for 1 acre 300 bamboo rails are more than enough. The extra rails are always handy in case of breakages, also if the crop is extra large. With large sized plants it is best to space them at one foot intervals on the rails, in this case 125 rails per room are necessary and these will hold 6,000 plants. One corner must be set aside to make the room for a watchman, also the 'press', where the tobacco will be stored for fermentation, as explained previously.

(iv) Tobacco Disease and Pests

Diseases. In Jamaica, fortunately, tobacco diseases are not very numerous. The commonest are mosaic disease and eelworm. Tobacco wilt or stem-rot, which in some other countries affects the whole area, is rather rare. Black-root-rot, another form of tobacco-wilt, is also rare. Fungus diseases such as *Phytophthora* and *Pythium* are also to be found, but usually in the nurseries. Rust spots on the leaves are to be seen here and there in the fields. Fungus spots are common in the barns during damp misty weather and are to be seen on the drying leaves. This spot is sometimes known as 'water spot', also another spot disease known as 'frog eye' is to be found on the drying leaves in barns where the ventilation is bad and the conditions are moist.

Mosaic. This disease is carried by a virus and is the most prevalent disease in Jamaica; it is to be found everywhere on all tobacco plants throughout the island. Often the 'principal' crop is not very badly affected, but usually the 'ratoon' crop is full of mosaic-diseased plants. The leaves of a mosaic-diseased plant are mottled in colour, and are marked rather like marble. They are usually fairly thick in texture, coarse and uneven in colour and do not burn well; also the size and shape of the leaf is affected and an altogether undesirable type of leaf is obtained. Many wild plants growing in the tobacco fields and surrounding them are hosts and insects can transmit the disease to the tobacco from the host plant. Mosaic disease is highly infectious and can be distributed throughout a tobacco field by the labourers touching the plants in the course of their duties. The best method of stopping the disease from spreading is to remove all early affected plants and burn them. Seed should not be taken from mosaic-diseased plants, seedbeds should be regularly and carefully inspected and mosaic-diseased suckers immediately pulled out and destroyed.

Nematodes (Eelworms). This disease usually occurs in areas where there is no rotation programme. The plants are attacked at the roots on which galls are formed, and this shows up above ground as the affected plants are stunted and unhealthy looking, with small yellowish leaves. In the seedbeds also young suckers will be found stunted and discoloured, and will not grow when these parasites have attacked them. Thorough and clean cultivation during the dry months, giving sufficient aeration and sunlight assist in retarding the development of eelworms already in the soil. Infected areas should be treated with Derris dust.

Phythophthora or 'damping off' is usually found in the seedbeds. It is a fungus disease caused by too much moisture and insufficient sun. As a preventive seedbeds should be watered with Cheshunt Mixture once every four days, and in rainy, cloudy weather, watering should be done as little as possible. Shades should be kept over the young seedlings during heavy rain, and taken off during fine weather. If a bed is found infected, it should be destroyed. Timely thinning out of the seedlings also helps prevent fungus disease, as air can reach the soil around the roots of the remaining plants.

Pythium. This fungus disease is usually found in the seedbeds and is most conspicuous when the suckers are almost ready to be planted out. The affected suckers collapse and on examining the area where the stem comes in contact with the ground, will be seen a slimy rotten area. In the fields this disease is usually found in sections that are very wet. Spraying the seedbeds with Bordeaux or Cheshunt Mixture is a preventive but in the fields nothing practical can be done except replace the affected plants by using older suckers from the nurseries.

Frog Eye and Angular Leaf Spot. These diseases are most prevalent when the rainfall is excessive and not much can be done to prevent them, except in the barn. The barns or tobacco houses should be kept as dry as possible and good deep drains dug around them, also the earth floor should be dug up from time to time to keep the soil dry. Air must be made to circulate in a barn that is full of green tobacco to prevent excessive humidity. In damp weather charcoal fires must be kept burning between the rooms and all doors and windows kept closed. In fine weather all doors and openings must be kept wide open to allow as much dry air as possible to go through the hanging tobacco, and the rails should be shifted from time to time and re-spaced to prevent any leaves from sticking together.

Pests. Firstly, there are ants to contend with in the nurseries, and very formidable they can be, as they take away the seed which are about to germinate, and can clear a bed of all seed in one night. Methods of dealing with these pests are dealt with in Chap. 47. Crickets and cut-worms are found both in the nurseries and plantation, and may be destroyed by spreading out bait round the plants—Paris Green mixed with meal and molasses is one of the best baits. There are many caterpillar pests which

feed on the tobacco leaf and so damage it, such as the cut-worm (prodenia) plusia, heliothis (bud worm) and the horn worm. These can be destroyed by spraying the plants with a 1–1½% lead arsenate solution or dusting with a lead arsenate mixture. The flea beetle, also grasshoppers, may be destroyed by spraying with the same solution. There is also the Nezara Viridula, commonly called the 'stink bug' which must be caught by hand, and the green hoppers of the Capsidae family which are almost impossible to eradicate and which can damage the leaves considerably if they appear in great numbers. Tobacco lice do not seem to appear in Jamaica, which is very fortunate, as much havoc can be caused by them. Although spraying with a solution of lead arsenate is mentioned above, it is not recommended in the plantation but only for seedbeds, as in dry weather the solution sticks to the leaves so much that it will not come off even when the leaf is dried and cured, and so renders it unmarketable. For field purposes dusting with lead arsenate and fine dust should be resorted to. This dust remains on the back of leaves long enough to kill off all caterpillars, but falls off in time, especially when the leaf is dry.

Lasioderna sericorne or **tobacco weevil,** can do much damage to the cured leaf, especially when kept in store for some time. All stocks of tobacco seed should be kept in well corked and sealed bottles, as weevils breed freely in old seed. Seed should be thoroughly dried before sealing up in bottles. The pylon room, where the stripped leaf is kept, should be cleaned out regularly and if necessary sprayed with Malathion. Fumigating is the best means of ridding stored tobacco of weevil and there are some powerful fumigants on the market which the makers claim will destroy the weevil without affecting the taste or flavour of the tobacco.

Virginia Tobacco

(i) Selection of sites for nursery beds, sowing of seeds, precaution against grass and weeds, treatment of soil for eelworm and ants, and care of seedlings, are similar to the methods outlined under Havana tobacco.

(ii) This type of tobacco differs somewhat in its soil requirements from the cigar type in that it favours a sandy soil that is freely drained. Heavy soils usually produce thick, coarse leaves that will not cure satisfactorily. Apart from this demanding requirement the conditions relating to cultivation, planting, fertilizing, inter-row cultivation, supplying, topping, suckering, selection of plant for seeds are similar in practices adopted in Havana production.

The spacing for Virginia tobacco should be 48 inches between the rows and 20 inches along the rows.

(iii) Harvest only ripe tobacco—To prime evenly ripe tobacco requires workers with some experience. One to three leaves usually ripen together on each stalk and may be primed at the same time. The degree of ripeness when priming takes place influences the price, aroma, colour, texture and chemical composition of the cured leaf. Priming immature leaves increases the curing difficulty and lowers the grade and value of the leaves.

The leaves should not be crowded on the sticks neither should the sticks be crowded in the barn.

The number of leaves per bundle should not exceed three. Do not place more than 28–30 bundles on a rail. The rails should be spaced from 8–10 inches apart on the tier poles. The size of the leaves will undoubtedly influence the spacing in the barn.

General Curing Recommendations

1. As soon as the barn is filled the fires should be started. At the beginning of the cure the temperature should be about 10° (F.) above the outside temperature. Raise the temperature 1°–2° (F.) per hour to 103°–105° (F.) over a period of 30 hours. At the completion of this period the leaves should be quite yellow with a light greenish cast. The temperature must be so regulated as to prevent the leaves from drying out before yellowing is completed.

2. Avoid rapid increase in temperature. In most areas best results are secured by keeping the ridge ventilators slightly opened at the start of the cure. When the temperature has reached about 100° (F.) the opening in the ridge ventilators may be slightly increased.

3. **Colour fixing and leaf drying stages.** Colour fixing usually takes place at 110°–120° (F.). At the beginning of this phase the leaves should start to dry and curl. The temperature at this stage should be increased 1°–2° (F.) per hour. Depending on the weather conditions it takes about 10–15 hours to fix the colour.

Leaf drying usually takes place at 125°–150° (F.). At this stage the temperature may be advanced 2°–3° (F.) per hour, and takes about 30 hours. The amount of moisture that leaves the leaves at this stage is excessive and to remove this abundance of moisture it is necessary to have the ridge and bottom ventilators wide open.

4. **Stem drying period.** Stem drying usually takes place at 140°–160° (F.) and this temperature should be maintained for about 30–35 hours. Advance the temperature 3°–5° (F.) per hour, maintaining a temperature of 160° (F.) until the stems are properly dried. Never increase the temperature above 160° (F.) as the barns may burn. When the temperature has reached about 135°–140° the top ridge ventilators may then be closed.

When the cure is over, the doors, top and bottom ventilators should be opened and so remain until the leaves have absorbed enough moisture to become pliable when they should be taken down and packed in a heap

and so remain for about three weeks. This bulking down period conditions the leaves and dissipates any green colour remaining in the leaves after the cure.

Barn Construction

The type of barns used for curing is very simple in construction. The size of the barn recommended for our use is 16 ft. × 16 ft. by 24 ft. (to the eave) inside measurement. This barn area is adequate for 3 acres of tobacco. The sides may be made of wood, logs, zinc or aluminium. The tops are usually covered with zinc. The tops and sides should be thoroughly insulated to prevent loss of heat.

Properly constructed and efficient ridge and bottom ventilators must be provided.

It is essential that the inside of the barn should be in multiples of 4 feet as this is the distance between the tier poles. The first set of tier poles should be placed about 6 feet above the ground and each succeeding set about 2 feet higher.

Each barn has a heating unit, which has to be imported.

Conclusion

To be successful in the growing of tobacco it is very necessary to thoroughly cultivate the soil. Produce first-class seedlings and never plant out doubtful or weedy-looking suckers; catch caterpillars by hand or dust with D.D.T. or spray with Endrin to prevent them from damaging the leaves.

Adequate barn space is essential, and to prevent 'sweating' and development of other fungus diseases, provision should be made for adequate ventilation in the barn.

CHAPTER 26

Pimento or Allspice

Pimento, also known as **Allspice,** is the dried unripe berry of the tree *Pimenta officinalis*, Lindl., which occurs in the West Indies and Central America, being most common in Jamaica. Pimento is an anglicized word from the Spanish, 'Pimienta'; its alternative name, 'Allspice', is derived from the fact that the spice is said to combine the flavours of clove, cinnamon and nutmeg.

(i) History

The earliest reference to pimento being exported to London is possibly in 1601 when a drug from the dry berries of certain trees of the myrtle family, possibly allspice, was given to Clusius by Garret, a druggist of London, and described and figured by the former in his *Liber Exticorum*.

The next reference to pimento is found in Sir Hans Sloane's *Natural History of Jamaica* in which it is recorded that the tree grows on the hilly parts of this Island but chiefly on the north side thereof. He records that dry berries were sold at the beginning of the season at 1s. 6d. per lb. and later in the season at 1s. per lb. He also records that the tree usually flowers in the months of June, July and August, but that in several places flowering occurs sooner or later than this, that the twigs, leaves and berries stripped from the trees are dried for many days on cloth in the sun and that the ripe berries, because of the wet and plenteous pulp which they contain, are unfit for curing.

By about 1755, according to Patrick Browne, the export of pimento had reached to 438,000 lbs. valued at £21,925. He describes how pimento was by that time cultivated with great care in many parts of the Island, that it was being planted in regular groves or 'walks' and that the trees begin to bear in three years after they are first planted, but do not produce a substantial yield until they are about seven years old.

The occurrence of barren and fruitful pimento trees has been recognized for a long time. The botanist Grisenbach considered the 'male' pimento to be a form in which the female organs were not fully developed. An earlier botanist, Macfadyen, stated that the flowers of fruiting pimento trees are always found to be hermaphrodite and that the flowers of the

barren trees differ from those of the bearing trees only in that they are somewhat smaller and that the stamens are more fully developed and more numerous, whereas the parts of the pistil are smaller.

In the most recent Flora of Jamaica, that of Fawcett and Rendle, the subject of 'male' and 'female' pimento trees is not mentioned. It is only in very recent years that attempts have been made to find out why some pimento trees are barren and to find means of overcoming this barrenness.

Trade in the export of dried pimento berries to Europe developed rapidly and by the early years of the eighteenth century pimento was an important export crop in Jamaica. Towards the end of the nineteenth century the annual quantity exported exceeded 10,000,000 lbs. in some years and the value of the crop exceeded £80,000.

However, in recent years production has declined to between three to five million pounds annually and prices have correspondingly increased. The price paid to the producers for the dried berries is now 4s. per lb. Several theories are advanced as to the causes for the decrease in production. One is that since the production of pimento leaf-oil commenced (the first still for which was set up in Manchester in 1922–3); the continual stripping of the leaves from the trees has caused a large number of the trees to die. The export of pimento from Jamaica last exceeded ten million pounds in 1925.

More recently a rust appeared on the leaves of the pimento and caused extensive damage in 1934 and subsequent years, since which time much of the pimento formerly existing in areas above 1,000 to 1,500 feet elevation has died out. In the late thirties, during a period of very low pimento prices, many large properties containing pimento were purchased by Government and cut up for land settlement and on some of these land settlements the pimento trees ceased to receive any form of care or attention. However, with the Second World War pimento prices picked up and have since then been maintained at a high level so that pimento is once more a valuable export crop to Jamaica.

Within recent years considerable new planting of pimento has actually been carried out. Between the years 1956 to 1958 the nurseries operated by the Ministry of Agriculture and Lands distributed over 60,000 plants and have not been able to satisfy the demand, which appears likely to exceed 50,000 plants annually for the next few years.

(ii) Distribution

Pimento is indigenous to the West Indies and to certain areas in Central America. It mainly occurs in Jamaica and to a less extent in Cuba. Standley who has made many botanical collections for the Chicago Field Museum of Natural History considers it also to be a native of South Mexico and probably of British Honduras, and that it was introduced into

Costa Rica and Honduras. The tree also possibly occurs in Haiti and Puerto Rico, and has been introduced into some of the other West Indian Islands, notably Grenada where a five-acre plantation is treated as an orchard.

The closely allied Bay Tree, *Pimenta racemosa* (Mill.), J. W. Moore, from which Bay Rum is prepared, occurs in the dry zone flora throughout the Windward and Leeward Islands of the West Indies.

(iii) Botany

Pimento, *Pimenta officinalis*, Lindl., is a member of the myrtle family (*Myrtaceae*) and is closely related to the Bay Tree, *P. racemosa* (Mill.), J. W. Moore, and to the Clove *Eugenia aromatica*, Baill. The tree grows to a great age. It is evergreen and normally attains a height of from 20 to 30 feet. Some trees will exceed 40 feet. The trunk is slender, rarely exceeding a diameter of 2 feet, and is much branched towards the top. It has a silvery brown bark which is normally shed twice a year. The leaves which are dark green and leathery are set opposite and are aromatic, containing a large percentage of essential oil. The berries which ripen to a dark purple are about one-quarter of an inch in diameter, but are harvested green for the essential oil which they contain. All parts of the tree are fragrant and it is exceptional in that herbarium specimens long retain their fragrance.

It is also commonly held that barren trees can be brought into bearing by breaking or cutting them back drastically for a few years, but there is no factual evidence to support this view. Indeed, a number of barren trees which were cut back three years ago for top-working still continue to behave as barren trees.

Several attempts have been made to explain this barrenness, but its true cause has not been established.

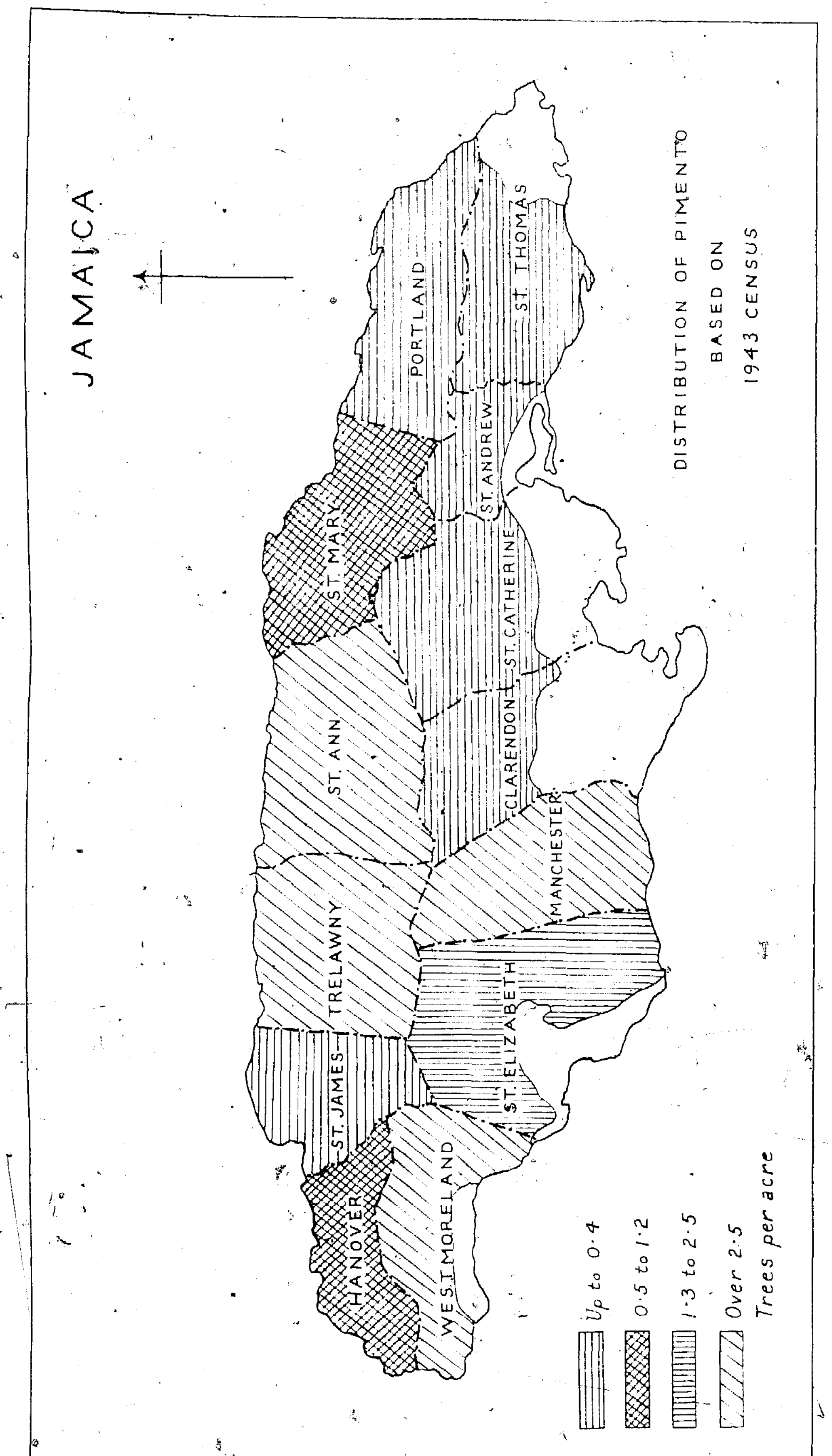
It is not possible to distinguish the barren from the fruiting trees in the young stage. It is only after flowering that the barren trees can be distinguished from the fertile ones.

The problem of barrenness is of great economic importance not only for the owner of a pimento grove in which such trees occur, but also for the nurseryman, since in the absence of a practicable method of vegetative propagation it is necessary to rely entirely on raising young plants from seed and there is up to now no means of determining what proportion of the seedlings will turn out to be barren trees.

Pimento is more or less self-sterile in that the ovum of a flower is not pollinated by pollen from the same flower.

(iv) Climate

The habitat of pimento in Jamaica is mainly the wet limestone forests, particularly the Bauxite plateaux. In these areas the rainfall is normally



PIMENTO PICKING HOOK

over 60 inches per annum and there are generally only a few months with less than 4 inches of rain. However, along the north coast of Trelawny and St. Ann parishes there is an area which supports much pimento in which the rainfall barely reaches 40 inches per annum and there may be as many as six 'drought' months with less than 4 inches of rain. On the other extreme, pimento thrives along the coastal areas of Portland where the rainfall is well over 100 inches per annum. In Jamaica the easterly Trade Winds blow almost constantly and climatic conditions are consequently tempered, with the result that the mean monthly temperatures rarely exceed 80° F., although maximum temperatures may reach 95° F. and minimum readings occasionally fall below 55° F.

(v) Soils

Pimento in Jamaica thrives mainly on the 'Terra Rossa' or Red Limestone soils and on the 'Rendzina' or Black Marl soils. The tree requires good drainage which is normally found in the coarse and porous red limestone soils. On the black marl soils pimento tends to be concentrated on the shallower and rocky phases where the underlying limestone allows for adequate drainage. Pimento is also found on clays overlying the Richmond Shale, mainly on slopes where outcrops of thin limestone occur and where drainage is favourable. Some pimento also occurs on the freely draining shale soils of lower St. Andrew parish.

(vi) Propagation

The Pimento tree seeds readily and young plants spring up along fences and in thickets, etc., where for the first few years of their life they can obtain protection from livestock, from the sun and from drying winds. The fruit is readily eaten by birds and this, coupled with the fact that the seedlings are mainly found underneath fences and clumps of trees, gave rise to the idea that the seed would only germinate after having passed through the intestines of a bird.

Growing pimento from seed is quite simple if attention is paid to certain details. Only fresh ripe fruit must be selected for seed. Green berries, such as are picked for drying on the barbecue, are useless for propagation. If possible selection should be made of fruit from well formed bunches and from trees which are known to fruit regularly and have other desirable characters. The seed should be extracted from the fresh ripe fruit by removing the fleshy covering, called the pericarp, by squeezing the seed out with the fingers or by washing it in water. The freshly washed seed should be dried in the shade and not exposed to the sun, otherwise its powers of germination will be reduced. If the fruit has to be kept a few days before sowing, it is better to leave it in the pulp and run the risk of slight fermentation rather than to try and keep the expressed seed and run the risk of drying out.

The freshly dried seed should be sown as soon as possible otherwise it loses its viability. Sowing should be done under shade in freshly prepared beds, or in boxes or pots of freshly prepared soil. A specially prepared sandy soil to which plenty of well decayed organic matter has been added can be used or a bed 4 feet wide can be excavated to a depth of 4 inches and filled with a mixture of coir waste and sand, or with coir waste alone. The beds or boxes should be well watered before sowing, preferably the day before, and the seed should be thinly broadcast and lightly covered with coir waste or fine soil. When sowing in pots three seeds should be sown to each pot. Covering the beds with damp sacking or paper will hasten germination, but the sacking, etc., must be removed as soon as the first sign of germination occurs.

Watering must be carried out carefully using a fine-rosed watering can or a hose fitted with an adjustable nozzle which is set to give a fine mist-like spray. The frequency of watering will depend upon the weather; in very dry hot weather it may be necessary to water twice daily whereas in dull damp weather the watering may be reduced to once a day or omitted entirely, depending upon the condition of the soil.

The plants should be raised under overhead lattice shade permitting about one-half of full sunlight. The same amount of shade will be sufficient for hardening-off potted plants.

After nine or ten days from sowing, the first seedlings will begin to appear as small insignificant-looking dull purplish sprouts about a quarter of an inch long which could be mistaken for the fruiting body of a fungus. They can be easily identified as pimento seedlings on account of the strong characteristic smell emitted when they are lifted and squeezed. Germination will usually continue over several months and each sprout will soon produce a pair of small opposite leaves. At the two- and four-leaf stage the plants may be carefully lifted from the bed or box by prizing them out of the soil with a sharp, pointed stick, care being taken not to damage the very fine roots or to allow them to dry out. The seedlings should be potted into large bamboo joints, or 6 by 6 inch bamboo baskets, or into plastic pots. If this is carefully done under humid shady conditions it should be possible to get a nearly 100% take. If the plants are left to become older in the seedbeds (6 to 8 leaves) they are more difficult to transplant successfully and losses are likely to be heavier. They should be potted into large containers in order to encourage early rapid growth so that from seed sown in August the seedlings may be ready for planting out the following May. If smaller pots are used the plants will not be sufficiently advanced for spring planting and will have to be kept in the nursery until the autumn rains have set in.

For potting, a well drained friable mixture should be used containing two parts of rich garden soil, one part of coarse washed river sand and one

part of well rotted compost. Backward plants may be encouraged by watering with a dilute solution of sulphate of ammonia (1 tablespoon to 2 gallons of water), not more frequently than once in three weeks.

Pimento seedlings appear to be more susceptible to leaf rust (*Puccinia psidii*) than mature trees and a sharp look-out should be kept for the appearance of bright orange pustules on the young leaves. If these symptoms appear the seedlings should be immediately sprayed with Bordeaux Mixture (3 : 3 : 100) and this treatment should be repeated every second or third week until the condition clears up. In raising large numbers of very small seedlings one has also to be prepared for the condition known as 'Damping-off', a soil-borne fungus disease which causes the rapid collapse of young seedlings. This can be prevented by watering the beds with 'Cheshunt Mixture' before sowing and at intervals of 2 or 3 weeks thereafter.

The seedlings should be ready for planting out in the field when they are from 10 to 15 inches high and are growing vigorously.

(vii) Planting

In planning a pimento orchard a decision must be reached as to what the main source of income is to be, whether from the sale of berries to the spice trade or from the sale of leaves for the production of pimento leaf-oil. It is most inadvisable to attempt to reap both leaves for oil and berries for spice from the same tree as this will eventually lead to the destruction of the trees.

If the berries are to be the final product then spacing between the trees should be as much as 25 to 30 feet apart depending of course upon the strength of the land. Closer planting than this is likely to produce a tall-stemmed timber tree rather than a tree furnished with foliage from the ground upwards. If the aim is to produce leaves for the production of leaf-oil then a much closer spacing is advised.

Until it is possible to produce plants which are guaranteed to produce fruiting trees it is recommended that in planting for berry production three plants should be set to each stand. These can be planted in a triangle about 12 to 18 inches apart and when bearing starts the most promising one can be retained and the other two cut out. The pimento tree like other plants will respond to good initial treatment. Holes prepared 2 or 3 months beforehand and of a size such as is recommended for coffee (i.e. 2 by 2 by 2 feet), with the 3 plants set in a triangle should give the plants the proper initial send-off. The plants with their containers should be well soaked the night before planting. Care should be taken in removing the plants from their containers to disturb the soil as little as possible. The seedlings should be planted firmly and to the same depth as they stood in the pots. The plants should then be watered in and mulched and if the situation is at all exposed they should be shaded by erecting a temporary cone of leafy branches over them.

The problem to be faced after setting out the plants is how to maintain them until they can fend for themselves. The better the treatment in the next few years the sooner can the plants be allowed to take care of themselves. Maintaining the land in good heart until such time as the trees commence bearing (in five or six years) is expensive and it is advisable to find some additional temporary use of the land to off-set this expense.

Where the land is amenable to it, planting through an intercrop is probably the best practice. The choice of intercrop will depend on the soil, location and the preference of the individual farmer. Bananas, annatto, Congo peas may be used, and other crops can readily be suggested.

(viii) Pests and Diseases

The pimento tree is susceptible to a number of diseases and pests.

The most important disease, and one which has at times inflicted great loss, is the **Pimento Leaf Rust** (*Puccinia psidii*, Wint.). This disease attacks the expanding foliage, the inflorescences and succulent young stems. Defoliation is caused and the resultant new foliage in turn becomes diseased. The incidence of the disease is influenced primarily by—

(i) relative abundance of susceptible new growth;
(ii) the occurrence of long periods of wet weather; and
(iii) temperature.

Temperature has, as forecasted by MacLachan, determined the pattern of pimento production in recent years. *Puccinia psidii*, because of the lower temperatures prevailing in such areas, is much more prevalent at the higher altitudes above 1,000 feet. MacLachan records that in the 4 years before the advent of this disease in Jamaica more than 40% of the crop came from areas below an altitude of 1,000 feet and that the percentage had increased to more than 60% after the disease appeared.

Hitherto there has been no practicable means of preventing or controlling the disease and growers have been advised to restrict new plantings to areas at less than 1,000 feet elevation and to avoid situations where it is known that fogs and late dews are frequent. More recently the possibility of controlling the disease on existing trees by use of modern fogging machinery, applying some of the newly introduced fungicides, has been under investigation.

A **die-back** resembling 'Fireblight' and an outright dying of young and mature trees occurs from time to time. At present the incidence of this malady appears to be on the increase. Various fungi have been isolated from affected material but no decision as to the causal pathogen has yet been made.

Pimento is sometimes attacked by insect pests. Perhaps the most serious of these are the **Termites** or 'Duck Ants' which gain entrance through broken surfaces caused by storm damage or by bad harvesting. Control is fairly easy by applying a small quantity of white arsenic on the point of a penknife inserted into the termite runway or nest. Various pith and wood borers sometimes multiply rapidly and cause local concern, for example the **Pimento Borer** (*Cyrtomerus pilicornis*, Fab.) which in 1896 caused wholesale infestation and death of numerous young and old trees in parts of St. Ann.

(ix) Harvesting

The berries mature from three to four months after flowering. Reaping generally occurs from July to September, but it has been recorded as late as December and even on occasions in February.

The berries are ready to reap when they are fully developed but still green. Several methods of reaping are practised but the commonest is probably still that of putting out the work to contract, each picker being contracted to be paid according to the number of 'zincs' (the kerosene tin of 4-gallon capacity) of berries reaped. The practice has been for the reaper to use his family, his children being sent up the tree to break off the twigs and small branches bearing the berries and to throw them down to the ground where the man and his wife sitting in the shade of the tree proceed to rub off the berries. As pimento wood is very brittle this practice can lead to serious damage to the tree in that excessively large branches and a great deal too much leaf is often broken off. It is still no uncommon thing to see a recently harvested tree in which 80 to 90% of the foliage has been destroyed. The damage can be so severe that the trees may take three or four years to recover sufficiently to produce another crop.

A great deal of nonsense is talked about the benefits likely to accrue from breaking pimento. Breaking is a practice greatly to be deprecated in that besides setting back the cropping of the tree, the jagged wounds which are produced form 'loci' for the entrance of rot organisms and possibly cause 'die-back', which is a periodic feature to be found in most pimento 'walks'.

As an alternative, clipping off the small twigs which bear the berries with secateurs and tree-pruners is strongly recommended and this is already being carried out quite satisfactorily by a number of growers. If this is carefully done defoliation is greatly reduced, and the clean cuts made by the secateurs reduce the chance of disease spores gaining entrance.

There is every inducement, with the present high prices obtaining, for new pimento groves to be planted in an orderly fashion and to be treated as orchards. This will mean regular spacing and adequate pruning and training to produce a low spreading tree so that reaping and pest and disease control can be made easy.

After gathering and picking the clean berries they are carried to the barbecue, a flat concrete floor, where they are spread out in the sun to dry. They are raked over two or three times a day and heaped and covered at night against rain. After from 7 to 10 days of sunning the berries are dry and ready for bagging. At this stage they should be dark brown or nearly black and should rattle when a handful is shaken near the ear.

Before they leave the estate the berries are further cleaned by winnowing to remove dirt, grit and pieces of leaves and twigs. They receive a final winnowing before storage at the Government Pimento Clearing House.

CHAPTER 27

Annatto

The dye-producing Annatto plant is a native of the West Indies. It is particularly hardy, thriving on any soil where there is not an excess of moisture, and can be planted to advantage on poor lands as it produces and sheds leaves in great abundance, so that if the trees are spaced sufficiently near to each other, the fallen leaves provide a ready means of enriching the top soil.

(i) Economic Importance

There are at the moment no processing factories in the Island where the dye can be extracted from the seed. The dried seeds are exported, the quantity shipped in 1958 being 651,748 lbs. valued at £48,720.

In addition to its use in the textile dyeing industry, annatto is largely used for colouring butter, cheese and smoked fish.

(ii) Propagation

The annatto is propagated entirely from seed, the seed being taken from freshly gathered ripe pods. If dry seeds are sown, the loss from failure to germinate will be appreciable. As the tap root of the seedling is long, the soil of the nursery beds should be dug deep.

(iii) Preparing the Land and Sowing

For the nursery a sheltered, moist situation is advisable, as although the mature tree is exceptionally hardy, the immature seedlings are very tender, susceptible to damage from sun, heavy rains and rough winds. The bed should be well and deeply forked, manured and harrowed or refined.

If the seed is not to be broadcast, small trenches about an inch deep and nine inches apart should be made, and marking pegs put in at each end.

Sowing. The seed should be sown in the rainy seasons, if the labour of watering the seedlings in their infancy is to be avoided. If the shallow trench method is followed, the seeds are dropped in about four inches apart, and lightly covered over. Some farmers, however, prefer to broadcast and leave the seed to germinate where they fall. This method, they claim, yields a higher percentage of seedlings.

(iv) Planting

The distances at which annatto trees should be planted vary according to the soil and the lie of the land. Between 10 ft. × 10 ft. and 15 ft. × 15 ft. is recommended. The land having been lined out and pegged, the mounds are prepared. These should be about 2 ft. across by 2 ft. deep.

Time of Planting. The seedlings should be taken from the nursery at about four months old and planted out in the wet season. If planted in the dry season they will die. Great care should be taken when lifting the plants at the nursery to preserve the fine roots intact, if possible with a little of the nursery earth still attached. On no account should the sun strike the rootlets. After planting, the leaves of the seedling should be cut in half with a suitable pair of scissors.

(v) Maintenance

Weeding. After the seedlings have been established in the field, they must be kept free of weeds. Light mulching will help, and the planting of catch crops after the plants have attained a reasonable height. Little more than this attention will be needed, as the annatto has very few insect or fungus enemies, and under favourable conditions will begin to bear pods in the second year. With proper cultivation and pruning, two crops a year can be reaped.

(vi) Reaping and Curing

Reaping. The pods occur in clusters and maturity is evidenced when a few of the pods in the cluster split open, disclosing the ripe seed adhering to the inside of the pods. The cluster should then be cut with suitable clippers, care being taken to cut immediately above the first node, below the cluster. This practice permits of a second crop in the same year from that branch.

Curing. After being gathered, the pods should be dried in the sun every day, and kept away from rain and night dews. By the tenth day, the seeds will be properly dry. If not dried sufficiently, the dye matter attached to the seeds will be soft and tend to rub off from the seeds.

Threshing. When ready for threshing, the dried pods should be placed in the sun until they are warm and crisp. They are then placed in a bag and beaten with a stick until the seeds have all fallen off. They may then be recovered and bagged by being passed through a ¼-inch mesh sieve. If any fine particles come through, a second sieving with a finer mesh will be required.

(vii) Varieties

There are two principal varieties—one with long or pointed heart pods and the other more rounded. There is little to choose between the two, although some planters seem to prefer the long or pointed. Two others, 'Parrot' and 'Sensee', occur, but not plentifully. These are of a poor quality and dry on the trees without opening the pods.

CHAPTER 28

Ginger

Ginger is a herbaceous perennial, with leafy shoots growing to a height of about 2 ft. The commercial ginger is the underground tuberous stem (*rhizome*), like a thickened root, palmate in shape. It grows freely in most tropical countries—India, Malaya, China, Fiji, Natal, West Africa, the West Indies and Central America. It is nowhere found in the wild state. Commercial ginger, which is hard, fibrous, pungent and not juicy, should not be confused with Canton ginger, the preserved or green ginger usually sold in syrup in fancy jars. This latter (not grown in Jamaica) is a Chinese variety, thicker, succulent, free of fibre, very mildly pungent.

Economic Importance. Ginger is one of the earliest of Oriental spices known to Europe. It was known to Greeks and Romans and was well known in England before the Conquest. It is recorded as being sold commonly in England in the fourteenth century at 1*s.* 7*d.* per lb. (about £3 today). It was exported from San Domingo in 1585, and in 1547 22,000 cwt. was exported from Jamaica to Spain (Renny, *History of Jamaica*), since when Jamaica has been a continuous source. In 1958, 1,981,118 lb. valued at £286,463, was exported. In 1896, 1,960,609 lb. was exported.

Due, among other reasons, to heavy production from West African sources, the demand for Jamaica ginger has now fallen off, with a corresponding drop in market prices.

Propagation. The plant requires an equable, warm and moist climate, a shaded situation, and a rich, well-drained, well-tilled humus or loamy soil, and an elevation of between 1,500 and 3,000 ft. It is propagated by division of the tubers or rhizomes into small portions, each with an eyed tip, which are planted in rows about 12 × 12 ins. apart. Manuring is essential, and also protection from drought. This protection is often secured in the ginger-growing districts in Jamaica by running 'banks' of white yam through the ginger fields, the vines with their heavy broad leaves forming a kind of living mulch.

Preparing the land. As before mentioned, the land should be in a shaded situation, rich and well-drained, and loamy. It should be well-

tilled and manured. It is essential that the earth should be well-pulverized and deeply dug.

Stiff coarse clays are quite unsuitable, as are also sandy or gravelly soil. A deep loamy soil overlying white or yellow limestone is best. The plant grows luxuriantly in such soil.

Formerly in the ginger districts of upper Manchester and Clarendon the practice was to cut down woodland, repeat cultivation until the soil was worn out, then move on to fresh woodland. This wasteful method could only have one ending, and in 1895 the Jamaica Agricultural Society under the presidency of the Governor, Sir Henry Blake, commenced experiments in manuring the fields, analysis of the exhausted land showing deficiency of lime, phosphoric acid, sodium, and organic matter.

The standard fertilizers, stable manure and guano were tried, but without success. Ultimately a mixture of marl with a compost of about 10% of soluble phosphates, ammonia and potash salts gave a yield on previously worn-out ground of 2,500 lbs. per acre, with roots of extraordinary size and quality.

Planting. Segments of the 'hand' are broken off at the joint, each segment containing an eye or bud, and from these buds the plant grows. The segments should be from 1 to 2 ins. long.

The plants are usually put in between March and April, depending on some rain to give the plants a start. Sometimes the plants are kept on the ground in a shaded spot and covered lightly with trash, and kept moist, till they begin to sprout.

Beds. In planting, the ridge and furrow system is usually followed, as with potatoes. The earth is thrown up in ridges 1 ft. or so wide and running to the desired length. The plants are set in the ridge, the furrows acting as drains to keep water from the ridges. The plants are set about 1 ft. apart, and a few inches beneath the surface.

Maintenance. The ginger appears above ground in about ten or fifteen days after planting, but in adverse circumstances, longer. During the period of growth little is required beyond weeding.

Reaping. The ginger is ready for lifting when the green leafy stems turn yellow and begin to wither. Then it is carefully dug up with a fork, care being taken not to bruise or break the hands. They are then heaped up, the roots broken off and adhering soil shaken off. This must be done promptly, for if the ginger dries with the roots on it, it will not become white. The rhizomes are then thrown into a pan of water and are ready for peeling and drying. One acre yields from 1,000 to 1,500 lbs. of dried ginger, and in exceptional cases 2,000 lbs.

Peeling. The removal of the thin skin from the rhizomes is a special job requiring expert and experienced hands using a special type of knife, as the best market prices go to full, bold, unbroken hands.

Curing. After peeling, the hands are thrown into clear water and washed. The cleaner the washing the whiter the finished product. The hands are peeled during the day and allowed to remain in water overnight. Next day, after washing, the hands are placed in the sun to dry. A clean well-kept barbecue, or sheets of corrugated galvanized metal should be used in preference, and the hands turned over at mid-day and taken indoors in the evening. Protection from rain is also necessary, as the hands are apt to get mildewed or mouldy if unduly exposed to damp or wet. In six to eight days drying will be complete. In the process of drying nearly 70% weight is lost, dry market ginger containing 7 to 12% of moisture.

Varieties. There are in Jamaica two varieties of ginger, the yellow or 'turmeric' and the blue. The growing plants cannot be distinguished from each other, and it is possible that the 'blue' is only a degenerate form of the 'yellow'. The root of the blue is hard and fibrous, and yields a smaller proportion of powder and is less pungent and of less commercial value. Much less of the blue variety is, however, grown, the yellow being far more predominant.

CHAPTER 29

Black Pepper

The **Black Pepper** plant is a climbing vine native to the forests of the south-west coast of India and is grown for its berries which are dried and ground to produce the pepper of commerce.

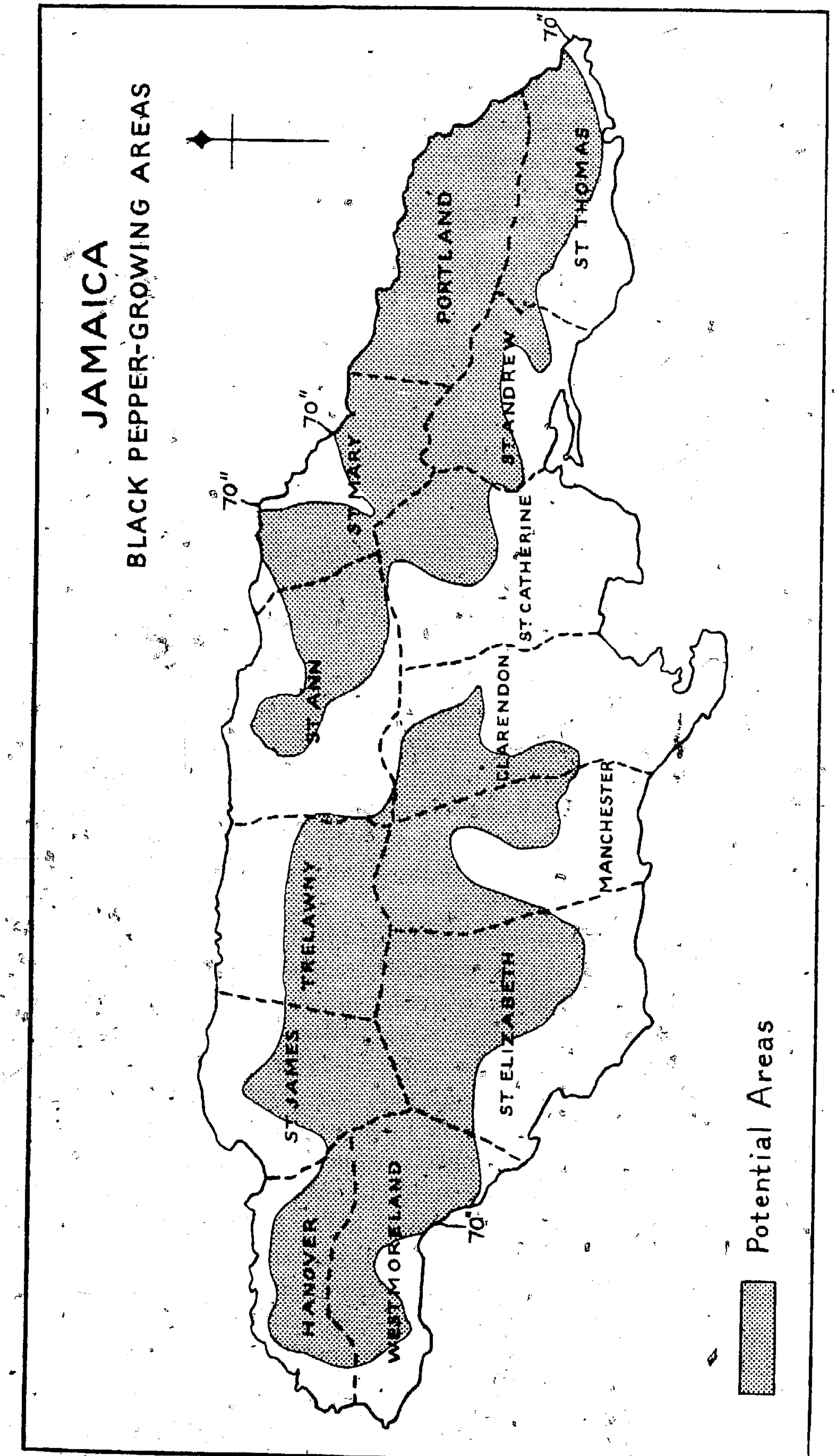
The history of pepper growing has been one of stimulation of planting due to high prices, followed by over-production, falling prices and neglect of plantations.

Due to the destruction of the vast plantations in Indonesia caused by the 1939–45 war, the world supply has been greatly reduced. Total world production in 1939 was 181,815,000 lbs. and in 1949 it was only 53,336,000 lbs.

In most countries where black pepper is grown it is a peasant crop, but it is nevertheless the basis of a vast trade in spice from Asia to Europe and North America. It is reasonable to argue that as production in the East is declining and as the world's largest market is in the United States of America, production should be encouraged in the Western Hemisphere. Freight charges to the American market would thereby be greatly reduced and in times of political disturbance the greatest market would have some assurance of supplies.

Black pepper can be a useful crop for small cultivators as it can be treated as an inter-crop among coffee and cacao, using the shade trees as support for the vines. The climate suitable for cacao is also suited to black pepper. In addition, black pepper is not averse to limestone soils and it could therefore form an alternative crop to cacao on such soils.

The present market price of black pepper does not however make it an attractive crop for the small man in Jamaica because we would have to compete with countries in which black pepper is already well established and which have the know-how and relatively cheap labour. But fortunately for Jamaica there is likely to be before long an outlet for green pepper berries, leaves and stalks to a local company which, besides growing black pepper on its own estate, expects to be in a position to purchase material from other producers in order to extract the valuable oils, etc., locally. In view of this prospect it would probably be most advisable that, initially at any rate, development should take place in the eastern area of the Island within reasonable distance of the site of this factory.



(i) Botany

The pepper plant may attain a length of 30 feet or more. The young stems are swollen at the joints and become woody on ageing. From the joints numerous rootlets are produced enabling the plant to attach itself to a tree or other kind of support. The leaves are oval or ovate in shape and end in a sharp point. They are dark green and shiny above, pale green underneath, and of a rather leathery texture. They are borne on short stalks or petioles, are without stipules and are arranged alternately about the stems. The flowers are very minute and are borne in catkins, produced at the nodes opposite the upper leaves. In the case of the wild pepper plant the flowers are usually unisexual, the plants being either monoecious or dioecious. For cultivated pepper gardens the hermaphrodite forms are preferred.

The fruit is berry-like and sessile. At first as it ripens it becomes yellow, afterwards turning bright red. At the same time the catkins lengthen. Each fruit contains a single seed, enclosed in a pericarp in a pulpy layer. Pepper vines flower during the wet season and mature their fruit in about six months after flowering.

Vines raised from cuttings produce for the first two or three years purely vegetative runners. In the third and fourth years they begin to produce flower spikes which are sympodial (i.e., the extension in growth is made from a side bud). For a few years more, monopodial vegetative growth (i.e., growth arising from the terminal bud) continues vigorously along with the production of fruiting branches. There is a marked reduction in the production of vegetative runners as the vine ages. It is not uncommon for the vines to bear for 30 years or more.

Vegetative runners bear aerial roots which adhere well to the 'standard' or support. Leaf petioles on vegetative runners are two or three times longer than those on the leaves of the fruiting branches, with a proportionate reduction in the size of the leaf-blade.

Lack of purple pigmentation distinguishes a fruiting bud from a vegetative one.

Flower structure varies with sexuality. Hermaphrodite flowers consist of a pistil having a star-shaped stigma, the stimatic rays from three to five in number, and two stalked stamens one on each side of the ovary. The stimatic rays are felted with long hairy growths and the tips are somewhat swollen and bulbose. The pollen grains are generally seen enmeshed between the hairs.

Dehiscence does not scatter the pollen grains. The agency for scattering pollen grains is the heavy falling of rain drops. Pollination is apparently not done by insects.

(ii) Climate

Pepper, being a native to Malabar on the south-west coast of India, thrives in a hot humid climate. It has, however, been successfully grown as far north and as far south as the 20° latitudes. Its cultivation is normally confined to an altitude range from sea-level to a few hundred feet elevation, the upper limit of cultivation being about 2,500 feet. It demands a wet climate, and less than 100 inches rain per year is generally considered to be insufficient. The rainfall should be evenly distributed, although pepper appears to be able to tolerate a dry season of some duration. As would be expected it is a shade-loving plant; too much shade, however, is said to reduce its flowering and fruiting. A temperature range of between 65° F. and 95° F. suits its requirements.

The sketch map shows those areas of Jamaica in which the mean annual rainfall is seventy inches or more. It can be seen that there are two well defined areas, one in the East and one in the West. As far as climate goes these areas are suitable for the growing of black pepper.

As black pepper will thrive from sea-level up to about two thousand feet altitude there should be no difficulty in finding suitable sites, provided that dry sandy soils, wet heavy clays and badly drained areas are avoided. Exposed areas can be protected by growing wind-breaks and shade trees.

(iii) Soils

Although in its natural habitat the plant thrives on red lateritic virgin soils, it can be grown on a wide range of soils, but heavy clays and poor sands are generally to be avoided. Free drainage and plenty of organic matter are necessary. It has not been possible to find any records of the range of pH values of suitable pepper soils, but the plant is known to respond to dressings of lime.

(iv) Propagation

Most authorities prefer to propagate pepper from cuttings rather than from seed. There are several ways of preparing the cuttings. In some areas, (e.g., Mysore in India) cuttings four to five feet long are used, gathered from runners which spring from the base of the plant. In Bombay Presidency such runners are layered, being lightly covered with compost or leaf-mould. The plants are severed when rooted at the nodes. A more common method is to take five-to-six-node cuttings from the basal runners and to set them with three nodes underground. In Assam and Ceylon it is more common to take terminal cuttings from the upper parts of one-and-a-half to two-year-old vines. These may be from 18 to 24 inches long and are set out straight in the field in their permanent sites. Although it is recommended in Ceylon that cuttings should not be taken

from branches, yet in Sarawak prunings of seven nodes, specially prepared, are taken from any part of the vine apparently with equal success as long as they have a terminal bud.

When planting material is in short supply, single-node cuttings have been successfully used. These are sometimes called leaf cuttings and consist of leaf, petiole and bud attached to about two inches of stem. In Trinidad a simple method using the same propagators as are used for striking cacao cuttings has been worked out. This method uses Beta-indole-butyric acid, two mg. per ml. of 50% alcohol, employing a quick dip method. It is stated that 75% of the cuttings are rooted in 21 days. After seven days' hardening the plants are potted and are ready to be planted in their permanent positions three months later.

In Jamaica the Ministry of Agriculture and Lands is using two methods of propagation:

(a) leaf cuttings; and
(b) seven-node cuttings.

This latter method is practised in Sarawak. It entails selecting terminal shoots, whether main or subsidiary, with ten leaves, nipping out the growing point, leaving the top three leaves and removing the next four leaves below these three. From ten days to a fortnight later the cutting with seven nodes is removed from the vine and set with the defoliated portion underground.

The seven-node cuttings are rooted in pots of light sandy soil with plenty of leaf-mould, either in I.C.T.A. propagators or in frames completely covered with plastic sheeting. It is necessary to take precautions against direct sunlight reaching the leaves and to maintain a high level of moisture both in the soil and in the surrounding air. No success has been obtained in Jamaica by setting the cuttings straight into the field where they are intended to grow.

Single and two-node cuttings can be successfully rooted in containers set in pots under polythene sheeting with the minimum of watering, provided the plastic sheet rests on the leaves and is tucked firmly around the block of cuttings to maintain maximum humidity. This is best done in a glasshouse, but good results have been obtained in a shade house.

(v) Shade

In those pepper-growing countries where shade is considered necessary it is a common practice to clear the jungle by cutting out undergrowth and lianes during the dry season and burning the dead material just before the advent of the rains. The trees that are left are used as supports for the pepper vines. In open cultivated land, however, it is necessary to supply the shade by planting live supports.

In clearing any new area for black pepper it is desirable to retain sufficient trees at twenty to thirty feet apart to give shade and to lop back intervening trees to about a height of seven feet to provide support for the vines. These should be spaced about seven feet apart. In some places it may be necessary to plant standards, either live stakes or hardwood posts. If planting is done through a plot of coffee or cacao, standards for support of the vines will already be present in the form of the existing shade trees. If it is intended to plant up ruinate land then additional temporary shade, such as Congo peas, *Tephrosia*, and plantain, should be established before attempting to plant the pepper.

Whether or not shade is essential for black pepper is a vexed question. In Indonesia black pepper is generally grown on artificial supports without shade, but in India and Ceylon the general concensus of opinion is that some shade is necessary. Local climatic conditions no doubt play a leading part in deciding whether to use shade or not. It was found in India that young pepper requires much shade, but that as the vines develop too much shade reduces flowering and fruiting. The necessity of preventing the roots from drying out in the open fields has led the Chinese to practise heavy mulching with cut grass.

Experience in Jamaica suggests that shade is necessary in the early years of a plantation, but when the pepper begins to bear the shade can be more or less removed and reliance placed on the shade cast by the pepper vines on their supports, in conjunction with mulching to keep the soil cool.

(vi) Supports

The cultivation of pepper in Jamaica will require the provision of supports, either natural (live) or artificial.

For good live supports, plants should be selected which:

(1) are quick growing
(2) have permanent rough bark
(3) will stand up to heavy pruning
(4) have deeply penetrating roots so as not to compete unduly with the pepper
(5) are (preferably) leguminous species.

In Madras it was found that the best plants for live support were, in order of priority:

(1) *Erythrina indica* (Indian Coral Tree)
(2) *Garuga pinnata* (an Indian gum tree)
(3) *Spondias mangifera* (Hog Plum)
(4) *Mangifera indica* (Mango)
(5) *Strychnos nux-vomica* (Nux-vomica)
(6) *Caria arborea* (an Indian gum tree).

Numerous references from India also report the use of some of the following trees, *Cola acuminata* (Cola), *Terminalia* spp. (including Jordan Almond), *Pterocarpus marsupium* (Gammalu), *Grevillea robusta* (Silky Oak), etc. In Malaya, in addition to *Erythrina* spp., *Ceiba pentandra* (Silk Cotton), Jackfruit and *Morinda tinctoria* (Indian Mulberry) are also used as supports.

In the West Indies the following trees have been tried:

(1) *Crescentia cujete* (Calabash)
(2) *Gliricidia sepium* (Quickstick)
(3) *Erythrina* spp. (Coral Bean, Immortelle, etc.)
(4) *Jatropa curcas* (Physic Nut).

The best growth was obtained when using calabash; the mechanical advantage of using *Gliricidia* (in that it is easily established) was masked by the physiological effect of dense shade which needed constant lopping.

In Puerto Rico *Casuarina* spp. (She-Oak, Willow) appears to be a promising shade tree for both vanilla and black pepper.

In Jamaica the Ministry of Agriculture and Lands has confined itself to the use of *Gliricidia sepium* (Quickstick) and *Inga vera* (Cocoa Wood) for support and shade, but there would appear to be no reason why some of the species mentioned above, if obtainable in sufficient quantities, would not serve the purpose equally well.

Artificial supports are in common use in Malaya and Indonesia. They are generally of selected hardwood and are expected to last the life of the plantation (15 years). Alternatively, where sound hardwood poles are not easily available, concrete posts have been used.

(vii) Planting

Planting is usually done at the beginning of the rains. In Jamaica the choice of spring or autumn rains will depend upon which rains are the most dependable in the particular area. In many pepper growing countries it is sufficient to set several cuttings together in their permanent quarters. The bottom two or three nodes are set in the ground and dry trash is placed above. In Malabar as many as ten to twelve cuttings are set in a prepared hole on the north side of a tree and the hole is filled in with fine friable soil. In Sarawak, where jungle is cleared by fire, stakes are set out 6 feet apart and heaps made of ash and burnt soil are built around each stake and a cutting set in each mound, or heaps may be made against the trees on which it is desired to train the pepper vines. In Ceylon and Malaya rooting of the cuttings in nurseries is generally recommended. The plants rooted in pots are taken from the nursery and planted at the base of the trees or supports and tied in firmly. In Jamaica it has been found inadvisable to set unrooted cuttings in the field and all planting is carried out with rooted cuttings raised in nurseries.

It is a good practice to prepare planting holes, eighteen inches each way and eighteen inches deep. The soil should be mixed with a basket of crushed limestone and with a similar quantity of leaf-mould before filling in the planting hole. Wood ashes, which can be obtained by burning any material which has been removed in the process of clearing the land, may be added at the same time.

Only well established, vigorous potted plants should be used and these should be set out during a rainy period. The pot in which the cutting is raised should be carefully cut away from the ball of earth which it contains, disturbing the roots of the plant as little as possible. Pepper should be planted firmly and the plant should be set in the ground at the same level as it was in the pot. After planting it should be watered, mulched and shaded.

(viii) Cultivation

On the Malabar coast it is the practice to give a thorough forking at the beginning of the monsoon. At the end of the north-east monsoon a second light digging is given. It is recommended that on sloping land, cover or catch crops should be grown to protect the land and on steeper slopes narrow bench-terraces should be built for each row of plants. In Ceylon it is recommended that the soil should be kept free from weeds and at each time of weeding the earth should be drawn up towards the plants. In Sarawak it is a common practice to apply burnt earth to the vine at the time of planting and thence after every four months.

Cultivation will include keeping weeds away from the vicinity of the plants and a light forking once a year prior to mounding.

(ix) Mounding

It is a common practice to put fine soil round the base of each vine every year. This acts as a top-dressing and keeps the plant vigorous.

Mounding is necessary to keep the plants growing vigorously and soil for this purpose can either be brought into the plantation from elsewhere or scraped up from several feet away and placed over the roots of the plants.

(x) Mulching

Mulching should be carried out at planting and maintained in order to check weed growth and to keep the soil cool and moist. Dried grass, banana trash and shade-tree loppings will serve.

It is very essential to tie-in the young vines to the supports. If this is not done regularly the movement caused by the wind will prevent the aerial roots at each node of the pepper vine from clinging to the support. Tying is best done using raffia and should be applied at the nodes of the vine so that the underside is pressed firmly against the support. After a

time it will be found that the new growths arise close to the support and will cling of their own accord.

Black pepper being shallow-rooted responds to heavy mulching, with banana trash, dried grass, coir waste and other dead vegetable matter. Mulching is particularly important where black pepper is grown with the minimum of shade.

(xi) Manuring

Availability of soil moisture is most important in pepper cultivation and in most countries means are taken to ensure moisture availability by increasing the organic matter in the soil. This is usually done by applications of cow-dung, household refuse, compost, oilcake, fish manure, guano, etc. For instance, in Bombay it is recommended that to each vine should be applied ¼ lb. fish guano, 1 lb. lime and 20 lbs. compost.

(xii) Fertilizer Requirements

Not a great deal of factual information is available as to the fertilizer requirements of pepper. The Taliparamba Experiment Station on the west coast of India has carried out trials over a period of ten years on limed and unlimed soils. As there was only one replication and the yields were extremely conflicting, no strict statistical interpretation could be given. However, all the limed plots gave better yields than the unlimed plots and conclusions were drawn that in the presence of lime pepper responded well to applications of nitrogen plus phosphoric acid, nitrogen plus potash and potash plus phosphoric acid. Nitrogen alone gave the least response. Vines in all treatments also received each year a basket full of cattle manure or compost.

Experience from other countries is most conflicting. Fish manure which contains little or no potash also gives a good response. In Sarawak, prawn waste containing organic matter, phosphates and calcium salts is considered one of the best manures. In many places wood ashes or burnt earth are applied and the good results obtained may be accounted for by the presence of potash, but probably the availability of other salts and the raising of the pH value play a more important part.

As a general guide one cannot go far wrong in giving the vines heavy annual dressings of compost and lime, and following the general fertilizer recommendations for other crops which are grown on the particular soil on which it is intended to grow black pepper.

(xiii) Tying in the Vines

As the vines grow and branch they should be carefully and firmly tied into the supports. The tie should be made around a node so that the node is firmly pressed against the support and is enabled to send out clinger roots. Close attention should be given frequently to this operation as otherwise the continuous movement of the vine (such as might be caused by even light winds) will prevent it from climbing the support.

(xiv) Lowering

Some vines sent up shoots without branches. It is a good practice to remove such runners from the standard. They can be cut right out, layered to produce more plants or coiled round in a circular basin at the foot of the vine leaving about a foot of the runner above ground.

Lowering is also used when establishing young plants to avoid having long vines without branches. When the vine has reached a height of about 30 inches, all but the top three or four leaves are removed and about ten days later the vine is taken down and wound round the base of the standard, all the defoliated portion being covered with fine soil. This will establish a good rooting system and many lateral branches will grow out.

Lowering is an essential operation in order to avoid long, bare vines climbing up the standards. It should be carried out when the young vines are about thirty inches high. The tips of the growing point or points are pinched out and all leaves except the three topmost ones on each growth are removed. Ten days later the vines are untied, lowered and curled round the base of the support. Friable soil is placed over all of the vine except for the parts bearing leaves, which should be tied in against the support.

When the vine starts new growth it will send out roots from each buried node and send up several more shoots. These are tied in and either pruned back or allowed to reach a height of 30 inches and then cut back 12 inches. This alternative growing and cutting back is continued until the top of the support has been reached. The prunings can be used as cuttings.

After cropping for a few years the growth of the vines will become very dense and every second or third year it will be necessary to carry out thinning by drastic cutting back of the laterals to nodes near the main stems.

Annual dressings of compost or other well rotted organic matter should be applied at the time of mounding. Fertilizer treatment should follow that recommended as a general dressing for the particular soil in which the pepper is planted and is best applied in small doses two or three times a year.

(xv) Standards

Where artificial standards are employed it is best to use hardwood posts, nine to ten feet long and these should be peeled of bark and the bottom thirty inches tarred before being set in a hole two feet deep. The hole should be packed in with broken stone and a concrete mixture of 1 : 3 : 6 should be moulded over the stones so as to lead rain water away from the base of the post.

If permanent shade is chosen, either 'Quickstick' or 'Cocoa wood' or a mixture of both is recommended. The shade should be reduced as soon as the pepper plants have become established, about the time of lowering. By the time the vines reach the tops of the supporting standards, all live posts should be kept well trimmed and the trimmings used as mulch. Shade trees at every 21 to 35 feet apart should be left unpruned, except where the shade is dense and needs lightening. Flowering is encouraged by a period of hot dry weather and can be expected to commence with the onset of the spring rains. A second period of flowering is likely to occur when the fall rains start. There is normally a period of eight or nine months between the start of flowering and the commencement of ripening. The pepper is ready to reap when the first berries on a catkin start to change colour. Picking can be done from steps and ladders into baskets and the berries laid out on a barbecue to dry, as is done with pimento. When thoroughly dry they can be bagged and stored in a dry place. There is likely to be a major crop and a small minor crop each year depending to some extent on the rainfall pattern of the particular area.

(xvi) Pruning

Methods of pruning pepper vary a great deal from country to country. In Ceylon it is suggested that if the vine is too bushy at the top it should be thinned out and cut back. Others recommend that after a vine has started to bear, not more than three stems per vine should be allowed to remain and all new runners springing from the base should be cut out. A continuous method of pruning in order to produce branching laterals and planting material at the same time as training the plant is sometimes adopted. Briefly, it consists in starting with a properly prepared plant raised from a seven-node cutting from which the lowest four leaves have been removed as well as the growing tip. This produces a plant with two growing shoots, one stronger than the other. When the stronger shoot has produced ten leaves the tip is pinched out, the three top leaves are left, the next four are removed and the bottom three are left. From ten days to a fortnight later the prepared shoot is cut off below the seventh node and is used as a cutting. In the axils of one or two of the three leaves left after pruning new shoots will spring, which in due course will be treated in the same way. Meanwhile the second of the two original shoots will have developed ten leaves and will be treated and eventually cut off in the same way. There will soon come a time when the second shoot will fail to grow out sufficiently to produce ten leaves and it is then left to develop into a fruiting lateral. In this way the standard will become fully furnished with small fruiting laterals from ground level to the top.

(xvii) Regulation of Shade

The regulation of shade is a complicated problem but it has two objects in view:

(i) maintaining shade during the hot weather to keep the soil cool; and

(ii) letting in sunlight during the cool weather to encourage the production of flowers and fruit.

For instance, on the Malabar coast of India shade is carefully regulated to prevent too much exposure to the direct rays of the sun. But in May, just before the monsoon rains, the branches of the *Erythrina* standards are lopped off to expose the vines to the sun and thereby encourage blossom and berry formation.

(xviii) Harvesting

The berries do not ripen all at once; the flowering season is spread over several months and the berries ripen about nine months later. The usual practice is to gather the berries when one or two in each spike have turned red. The method of harvesting depends upon whether black or white pepper is required.

White Pepper. For the production of white pepper the berries are picked when turning red. They may be steeped in water from seven to ten days in order to decompose the pericarp. When the skins are loosened the berries are stamped by foot in running water and well washed until all skins and stalks are removed. The 'corns' are then spread out to dry on mats.

Black Pepper. For black pepper the berries are picked at a younger stage. They are sometimes heaped for a day or two in order to allow fermentation to take place and are then laid out in the sun to dry, when the flesh blackens and wrinkles over the seed. In Ceylon the berries are steeped in boiling water for ten minutes before being spread out in the sun to dry.

A picker can gather about 60 lbs. green berries in a day, which on drying will give about 20 lbs. dried pepper corn.

(xix) Yields and Economic Life

Pepper vines begin to bear when between three and five years old and produce economic crops for 15 years, and in extremely good gardens for 20 years. As would be expected yields vary considerably from place to place and according to the age of the plant and the treatment it has received. Yields per vine have been quoted as from less than 1 lb. to as much as 12 lbs. dried pepper. A fair average yield would be considered to be from two to three lbs.

(xx) Costs of Production

It has not been possible to obtain very reliable or up-to-date figures as to costs of production. Some pre-war and post-war figures are quoted below, but because of low wages in the East they have little bearing on the estimation of likely costs in Jamaica. In 1929 maintenance costs in India were calculated at from 156 to 170 rupees* per acre.

Figures from Malaya for 1938 indicate that, where hardwood supports have to be provided, the costs should include $500 per acre for 1,000 posts plus $25 to $30 for planting them and that cuttings of *Gliricidia* cost 1·5 cents each and $20 per acre for planting. The Malayan dollar is equivalent to 2s. 4d.

In Assam for 1947 the following costs per acre for producing pepper were estimated and are here converted into Sterling at one rupee being equivalent to 1s. 6d.

Clearing and planting	—200 rupees	—£15 0s. 0d.
Annual maintenance	— 50 rupees	—£18 15s. 0d.
Harvesting	— 50 rupees	— £3 15s. 0d.

More recently K. K. Nambier has described estate plantations in South Kanara and in the Malabar districts of India and has produced some figures of costs of preparation, maintenance and harvesting. He estimates costs for the first year of establishment to be 306 rupees (£23) and the second year 178 rupees (£13 7s.). His estimates for annual maintenance cost thereafter are 140 rupees (£10 10s.) per acre. He anticipates the first crop in the sixth year, for which he allows 20 rupees (£1 10s.) for harvesting. Harvesting costs increase annually up to 80 rupees (£6) in the tenth year. Valuing his crop at Rs. 1. 12 As. per lb. he does not anticipate recovering his outgoings until the thirteenth year. The greatest part of the expense is incurred on labour, the daily rates of which were Rs. 1. 8 As. (2s. 3d.). This is a very conservative estimate, since by the sixth year the pepper should be nearly in full production.

(xxi) Prices

Prices have fluctuated a great deal in recent years. Before 1939, the price varied from between $0.04 to $0.15 per lb. But after the war when price control was lifted it soared to above $1.00 per lb., and after the Korean War it rose to $2.65. The price in February 1956 was $0.70 and recently (June 1959) the market price was quoted at $0.37 per lb.

(xxii) Varieties

There is a great number of different varieties of pepper in the main pepper growing countries. The variety being propagated by the Ministry

* One rupee taken as equivalent to 1s. 6d.

of Agriculture and Lands in Jamaica is known as 'Balamcotta' and was introduced from Trinidad in 1946 and again in 1954. In 1948 five varieties were introduced from the United States Department of Agriculture's Crop Research Division in Maryland. They are:

P.1	212962	Kudarvalli
P.1	212964	Kallivalli
P.1	212965	Balamcotta Kudarvalli (Travancore)
P.1	213293	Karincotta, Karingota (Coorg.)
P.1	213294	Kalbalamcotta

(xxiii) Pathology

In Asia black pepper is subject to attack by a number of insect pests and to one or two serious diseases. A disease commonly called 'rootrot' is caused by a species of *Phytophthora* and possibly by other fungi. This trouble can be prevented to a certain extent by good cultural practices. However, no sure control is known. A 'sudden death' disease has recently assumed serious importance in Sarawak and in other countries in the East and is likely to have very serious repercussions on the pepper trade. It is referred to by Christie as the 'Yellow Disease' and is said to be caused by a burrowing nematode.

A number of weevils 'hollow out' the berries and attacks by scale insects are general, but none of these insects normally cause serious damage. They can be controlled by Derris Dust, D.D.T., or White Oil.

Snails may be troublesome at times attacking and killing newly planted vines. If this type of damage becomes serious it can be controlled by frequent application of bait made of bran and metaldehyde.

(II.) *OTHER FIELD CROPS*

CHAPTER 30

Pineapples

(i) Economic Importance

For many years cultivated chiefly for the home trade in fresh fruit, the area of land devoted to pineapple cultivation was extended, but only to a comparatively small extent, by the advent of one or two processing factories. At the moment, however, only the fringe of this potentially large industry has been touched, one of the deterring factors being a shortage of plants of the varieties most suitable for canning. The importance of the pineapple as an export product may be gauged from the following figures representing importation of the canned pineapple into Great Britain for the year 1950.

	Cwt.	*Value* £
From Malaya and Singapore	67,927	400,038
From South Africa	1,771	10,643
From Australia	25,765	145,948
From Formosa	22,575	114,197

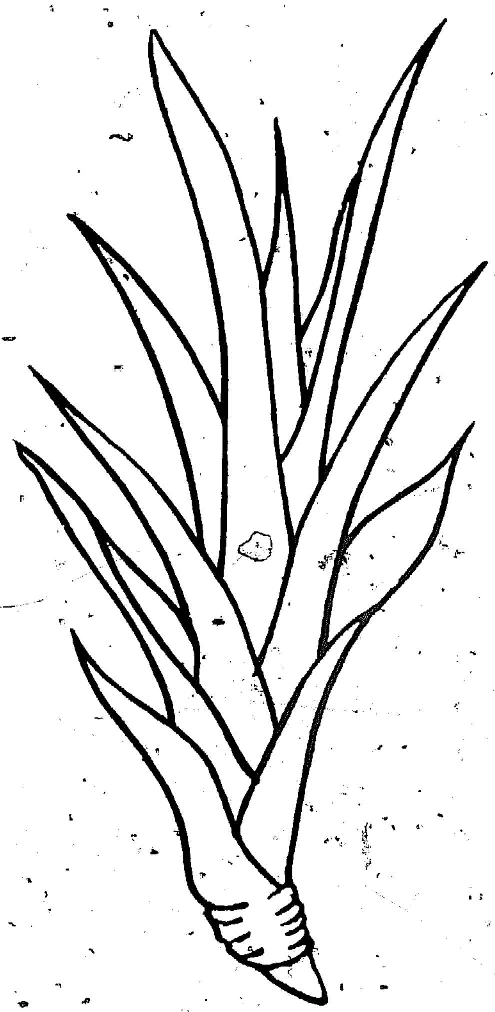
In addition to which there is a growing trade in the importation of unsweetened preserved pulp in bulk.

(ii) Propagation

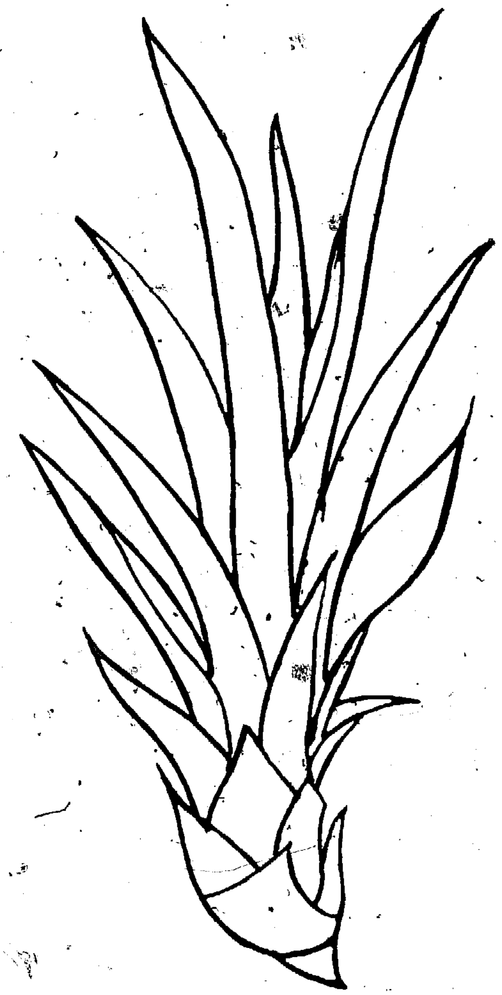
The plants are best grown from suckers taken a month or two after fruit has been reaped. By a careful selection of suckers a crop may be reaped in from twelve to fifteen months.

In selecting suckers, care should be observed in taking them from healthy plants, preferably plant-crop plants. Ratoon crop suckers do not yield as much as those from the plant crop.

The suckers should be twelve to eighteen inches in length from base to tip. Oversize suckers crop earlier, but give light yields.



Sucker prepared for planting. Small lower leaves stripped off



Appearance of sucker before lower leaves were stripped off

(iii) Preparation of the Land

Siting. The ideal requirements for growing pineapples are:

(*a*) Elevation of 500–2,500 feet:

(*b*) A rainfall of about sixty inches, well distributed, but with a dry period for fruit development and harvesting.

(*c*) A free draining, moderately rich soil of acid reaction (low *p*H).

Areas which have most of these requirements and which will be found most suitable for the growing of pineapples are:

(*a*) The soil of the old Blue Mountain series of rocks in St. Andrew and St. Catherine, at Mt. Airy, Mt. James, Golden Spring, Above Rocks, Harker's Hall and Glengoffe areas. These soils dry out easily and are not very fertile. Fertilizer and mulch should be used.

(*b*) The acid clays which occur in the inland basins of the limestone plateau in the St. Thomas-ye-Vale area; Appleton, Maggotty and

Oxford in Manchester; the Queen of Spain's Valley and on the Westmoreland plains. Adequate drainage must be provided for planting pineapples on these heavy clays.

The Red Spanish has not been tried extensively in Jamaica on neutral to alkaline soils. Anyone having such soils should make small-scale trial plantings first.

Several varieties, in particular the Sugar Loaf and Ripley, have given good yields on neutral and alkaline free-draining soils in areas with satisfactory rainfall.

Another consideration in selecting a planting site for pineapples is the question of shade. The planting site should not be a shaded one. Pineapples grown under shade grow less vigorously and do not produce a crop as quickly as plants grown in the sun.

The pineapple may be used as an intercrop for orchard crops as long as the amount of shade from the orchard crop is not excessive.

Cultivation. It pays to prepare the land thoroughly for planting pineapples. In Puerto Rico and Hawaii, six months are spent alternately ploughing and harrowing. Thorough preparation

(*a*) Kills weeds and thereby reduces weeding costs;

(*b*) Reduces the number of ants in the soil (ants transport the worst pineapple pest, the Mealybug);

(*c*) Improves the drainage of the soil;

(*d*) Makes rooting easier.

On level lands, drains should be made at least every twenty-two feet to prevent plants being washed out, and the heavy incidence of root rot which follows a deluge.

Lastly, but most important of all, land preparation should include soil conservation measures where necessary. Rows of plants should be set out on the contour.

Manuring. Although pineapples will grow and fruit on land which is poor in nutrients, it has been found that they benefit greatly from large annual applications of fertilizers.

The fertilizer mixture should be high in nitrogen and potash, but low in phosphate. Where it is planned to plant pineapples on a large scale, farmers should contact their Instructors and get fertilizer advice from the Department of Agriculture, based on the analysis of soil examples.

Where, however, a pineapple field of less than one acre is planned, a good general fertilizer programme to follow is:

100 lb. Sulphate of Ammonia
50 lb. Superphosphate or Local Phosphate
50 lb. Muriate of Potash

mixed together and applied to each acre of pineapples. The first application should go on about one month after planting, and the same dressing should be put on every three months after.

With a layout of about 11,000 plants per acre, this would mean that each plant must get about one-third of an ounce (approximately one teaspoonful).

Apply the fertilizer in the old leaves when rain is expected to fall.

In alkaline and only slightly acid soils absorption of iron may become difficult (even in soils with high iron content), and chlorosis will set in. This may be corrected by spraying with a solution of 2½ lb. ferrous (not ferric) sulphate in 100 gallons of water at the rate of 60–80 gallons per acre.

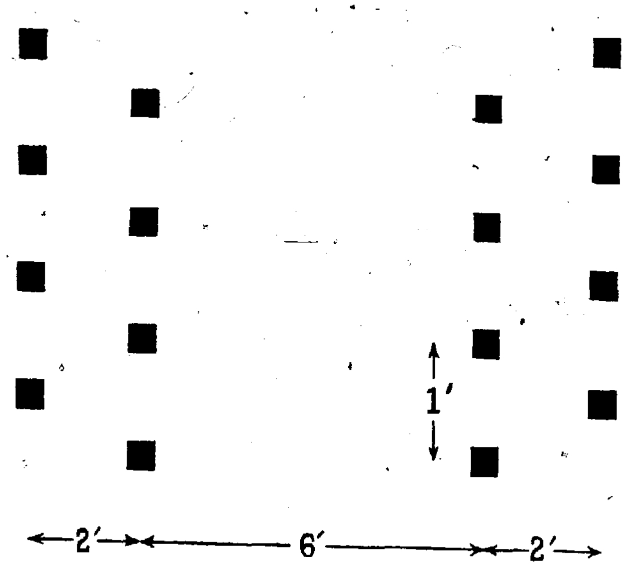
(iv) Planting

Preparation of the Plant. Before planting, it is best to strip off the small bottom leaves of the suckers and pare the ends where these are uneven. After this they should be cured in the sun, ends upwards, for three or four days.

Spacing. Pineapples have very short roots. They are usually not more than a foot long. Plants can, therefore, be planted very close to give mutual support, for they fall over very easily, especially when carrying fruit.

Plants should be set one foot apart, staggered, in rows arranged in pairs, with two feet between the two rows comprising the pair and six feet between pairs of rows. There will be about 10,500 plants to the acre at this spacing.

The first and last pairs of rows should be made to run continuously around the field, that is, surround the field with the edge pair. Mealybugs



Planting distances

spread along the rows, and will thus be kept going round the two edge rows where they can be killed.

Setting out. Planting material of the right size is especially abundant between August and November, and planting is usually carried out during this period.

Use a machette to open the holes and set the plants three or four inches deep. Press the soil around the base of each sucker. Do not allow any dirt to fall in the heart leaves.

(v) Maintenance

Weeding. Pineapples should be weeded regularly with the same persistence as bananas. Weeds reduce yields considerably and lower the quality of the fruit. Also, certain weeds serve to harbour the mealybug.

The push hoe is often favoured for weeding the closely-spaced rows. Labourers can reach farther with it than the ordinary hoe.

Mulching. Provided suitable material may be easily and cheaply obtained, mulching will prove especially useful for pineapples.

Mulch, if sufficiently thick, will:

(i) prevent weeds from growing and thus reduce weeding costs;
(ii) reduce loss of moisture from the soil;
(iii) protect the soil from being beaten by rain;
(iv) shade the soil and reduce the loss of organic matter;
(v) manure the soil.

It is easiest to apply part of the mulch before planting—the part which goes between the closely-planted rows. If all the mulch is applied before planting, it gets in the way at planting time and slows up the opening of holes and the firming of plants in the holes.

Irrigation. Irrigation is essential when rainfall is about thirty inches or less. It may be used profitably to supplement heavy rainfall when the distribution is poor, as is usually the case in Jamaica.

Ratooning. A marked lessening in yields occurs after the first ratoon crop, even if this is healthy.

In Puerto Rico three or four ratoons used to be taken, but nowadays only one is taken with the Red Spanish.

Early replanting is to be recommended under the following conditions:

(1) Where there is a heavy attack of mealybugs or eelworm.
(2) When fields are infested with weeds.
(3) When ratoon suckers are allowed to develop high on the plants and do not establish their own root-systems.

When a ratoon crop is being taken the following additional treatment will be required:

(1) Removal of all suckers except the lowest one.
(2) Hilling up around the ratoon plants.

Filter Press Cake. Recent experiments carried on in Puerto Rico reveal the fact that where the soil is treated with the addition of filter-press cake, the resulting yield arising both in fruit and suckers is remarkable.

(vi) Reaping and Storing

Fruiting. The main crop usually ripens in June and July, four to five months after flowering, which takes place in February and March.

Care must be taken to prevent bruising after fruits are picked. They should not be stacked deeper than two feet during transportation.

If the weather becomes damp during harvest, it will be necessary to take the following precautions to prevent spread of fungal rots:

(1) Cut fruit off plants with short (one inch) pieces of stalk.
(2) Keep collection sites and trucks clean.

(vii) Varieties

Only two varieties, the Sugar Loaf or China and the Red Spanish (or Bull Head) occur in sufficient quantities to assume importance commercially.

The Sugar Loaf is only of importance as a fresh fruit. It is not a suitable pine for canning. It grows to a large plant with broad leaves, well tapered at the end, and edged with fine spines tinted red. The fruit is usually four to six pounds in weight, conical and yellow-fleshed. The flesh is sweet and juicy.

The Red Spanish or Bull Head is a satisfactory canning pine. It is a very hardy variety, easily recognised because spines are usually absent except here and there on the leaf edges. Its leaves are tinted with mauve. Its fruits usually weigh between two and four pounds. They are cylindrical and white-fleshed; the juice is more acid than that of other varieties. In certain areas small, degenerate 'scratch-mouth' Red Spanish are called 'Cow Boy'. Around Long Bay (Portland) this variety is erroneously called the 'Ripley'. At Clonmel, St. Mary and around Linstead and Ewarton, it is known as the Black Pine.

The true **Ripley** is the best known of the other 'principal' varieties. It is the most common pine in the Porus area, and is readily recognised by the dull red colour of the leaves. It bears a two- to three-pound conical yellow-fleshed fruit. The flesh is sweet but not juicy, and is regarded by some as the finest flavoured of all.

The Smooth Cayenne, the principal canning pine of the world, has given an indifferent performance in Jamaica and is now very uncommon.

CHAPTER 31

The Grape Vine

There are two main species of grapes of widely separated origins; the *Vitis vinifera*, indigenous to Southern Europe, and now commonly found in all warm latitudes as well as in the temperate climate zones of the world; and the *Vitis labrusca*, indigenous to North America. The former is the grape of commerce well known for its qualities as fresh fruit and in the wine and raisin trades.

In Jamaica the grape thrives on the warm lowlands, especially the Liguanea plain, the Yallahs seaboard, and the lowlands of Alligator Pond and Bull Savannah. Good crops have also been grown in Westmoreland, in the Whitehouse area.

Cultivation. A hot and moist tropical climate is unsuited to grape cultivation. Conditions necessary for success are a fairly dry and warm temperature, a light soil, or gravelly red earth, and only a moderate rainfall. Lacking the necessary period of winter resting, resort may be had to baring the roots after the fruiting season and exposing them for a few weeks, just before pruning. Moisture at the roots during the period of growth, by moderate irrigation or direct supply, is necessary, but this should cease when the fruit begins to ripen. Unfortunately, on the Liguanea and Yallahs plains particularly, this period coincides with the rain season (June–July) to the detriment of the crop.

Propagation is by cuttings from year-old slips, twelve to fifteen inches long, planted sloping in the beds to about two-thirds of their length, and exposing one or two buds. The earth should be firmly pressed around the cutting.

Pruning and thinning. In discussing pruning we will consider a mature vine trained on the arbor system. Pruning is usually done in the winter months (December to February) when the grape is more or less dormant. All current growth should be pruned back hard to four good buds. This is known as 'long-spur' and is a general recommendation for the various varieties grown locally. As only certain varieties will produce a fruiting lateral from a basal bud this method is recommended unless you know your varieties. Where it is desirable to extend the vine or to fill in a vacant space on the arbor a suitably placed strong lateral can be shortened to about half its length and tied into place. All weakly and diseased growth should be cut right out at the time of the annual pruning. Afterwards when the vines are bearing, excessive or superfluous growth should be removed. It is the stems of the previous year's growth only that should be allowed to carry fruit.

The young fruit should be thinned out with a suitable pair of scissors so that the bunches can produce larger berries, and the bunches if too numerous should also be reduced. Young bearing vines should not be burdened with an excessive number of bunches.

Manuring. Vines respond to good treatment, but are not greedy feeders. Well decomposed stable manure well forked into the surrounding earth twice a year will be sufficient. If a stimulant is needed a 2:1½:1 mixture of muriate of potash, superphosphate, and sulphate of ammonia may be given, but fertilizer needs depend upon soil requirements in the main and should be ascertained by soil tests.

Varieties. There are two varieties commonly grown—the White Muscat and the Black Hamburg or Barbarossa. The former is more commonly found on the Liguanea plain, and while not so prolific as the black, responds very readily to good care and attention, yielding numerous bunches of large, sweet, fine flavoured fruit. Several varieties of white, red and black grapes are known in Jamaica, but the white varieties are the more popular.

CHAPTER 32

Melons

Culture. Rich, moist, sandy, well-drained loam is best for growing melons. The soil should be manured or fertilized with a good vegetable fertilizer such as a 4-7-5 mixture. A good application of manure and fertilizer around the roots will directly affect production. The fertilizer is best applied a week before sowing the seed. A second application may be made when the vines begin to run. Apply about 2 lbs. to the hill, working it well in.

Spacing. Plant 7 ft. apart each way, putting in four or five seeds at intervals in the hill, and thinning out to two or three plants at first, and finally to one plant when well started.

Time of planting. For highlands—March.
For lowlands —August–March.
Cropping—in about 90 days.

CHAPTER 33

The Tree Tomato

The Tree Tomato is a member of the *Solanaceae* family, a native of Peru, and sometimes found in the cool areas of the Port Royal Mountains and Manchester. It is a small evergreen tree producing a great abundance of yellow, smooth-skinned, egg-shaped fruit, about the size of an egg, ripening between March and May.

The fruit is sub-acid, refreshing and agreeable, and is readily stewed, or made into jelly. Used in tarts, it closely resembles the peach in flavour.

Propagation is from seed or cuttings, the plants coming into bearing in twelve to eighteen months and the trees continuing in production for five to six years.

The excellent culinary qualities of the fruit, its easy cultivation in a cool climate and the abundance of the crop, merit for this plant far greater attention than it now receives.

CHAPTER 34

Strawberries

Strawberries will thrive given 2,000–3,000 ft. elevation, care and sunshine. At Mandeville (2,000 ft. above sea) there is a thriving business in strawberry cultivation.

Planting. The plants are grown from runners thrown off from the parent stock and taking root in the bed. Within recent years, however, a runnerless variety has been introduced, propagated by seed.

Soil. Given good drainage, plenty of manure, and freedom from heavy rains, the strawberry will thrive equally well on sandy loams and on red or black earth. A 4–7–5 application of fertilizer after the plants are well established will be found effective. Acid soil is favoured.

Spacing. Allow 3 ft. between rows, and 14 to 16 ins. between plants. In setting the plants the holes should be deep enough to set the roots straight. Heavy mulching to keep fruit off the ground is essential.

The surface soil should come just up to the crown, and be well-firmed around the roots. Deep-planting will prevent growth. Slugs, various caterpillars and worms, and birds are very fond of strawberries and poisoning must be introduced.

CHAPTER 35

Papaws

The papaw or papaya is a typical tropical plant and is a native of tropical America. It thrives best in a soil rich in organic matter, possessing good drainage, in a sunny position free from boisterous winds. It is a fast-growing herbaceous plant possessing usually an erect trunk attaining a height of 10 feet and upwards, which is fleshy and hollow.

The papaw is normally dioecious, i.e. with the staminate or male and pistillate or female flowers produced on different plants, but there is a hermaphrodite or bi-sexual type which regularly produces perfect flowers, is self-pollinated, and yields excellent fruit.

The Fruit. The shape of the fruit varies from oblong to round, depending not only on type or variety; soil, season, climate and cultural conditions seem to have considerable bearing on shape. The fruit when first developed is creamy white, but quickly takes on a dark green colour. The weight varies from 1–10 lbs. when mature. When ripe the skin is smooth, thin, and usually of a yellow to deep orange colour. The flesh is of firm butter texture and possesses a yellow to orange-yellow colour. In the centre of the fruit is a fairly large cavity where are carried numerous round or oblong-shaped black seeds. The thickness of the meat or flesh varies from half an inch to two inches.

(i) Methods of Propagation

The papaw may be propagated from cuttings, by grafts or seed, the latter being the commonest and to date most satisfactory method.

Cuttings are most successfully rooted when small limbs are removed from plants, and care is taken to see that the natural swollen growth at the union of the small limb and parent plant is attached to the cutting.

Although this plant can be grafted successfully, there is little to be gained from this method of propagation, for it has been observed that the parental qualities are not always retained except that the age of the parent seems to be transmitted in the scion. These facts appear to be present to the same degree in rooted cuttings.

As already mentioned, propagation by seed is the best method. Little attention has been paid in the past in the matter of selection, with the

result that many worthless strains are in evidence which are not only unremunerative, but are a menace to the better types growing in the same vicinity.

Seed should be selected from the fully ripe fruit and from a tree known to be of a healthy, robust, heavy-bearing nature. The fruit should possess a thick leathery highly-coloured skin, a flesh of firm texture and good thickness. The shape, if possible, should be oblong, as this appears to be favoured by the trade, and a medium-sized fruit is the most popular. Fruit with a very prominent nipple at the calyx end should be avoided, as this tends to ripen earlier than the main body of the fruit and is subject to bruising, thus detracting from its value when presented to the buyer.

(ii) The Seed Bed

Seed may be raised either in beds or boxes which contain a good rich sandy loam. The seed should be planted soon after being removed from the ripe fruit, but seed will retain a high percentage of germination for twelve months if washed after removal from the fruit and kept in an air-tight jar in a cool place. The best time for raising seedlings is during the spring months. The seed should be planted in rows about 12 inches apart, with 2–3 inches between seeds and covered with about half an inch of soil. The seedlings should be above ground in 2–3 weeks after planting in the spring. Thinning the seedlings out to 6–8 inches will encourage good sturdy growth. The soil should be kept only moist, as excessive watering may cause damping off. If the seed beds are in sunny positions the seedlings should be ready for removal to their permanent positions in two months from planting of seed, when the seedlings should be 6–8 inches high.

(iii) Planting

Several hours prior to transplanting, the seed beds or boxes should receive a liberal watering, and planting out should be done in the cool of the day. After selecting the most robust and vigorous plants, every care should be taken to avoid destroying the roots or the drying-out of roots during transplanting. A thorough watering is advisable as soon after planting as possible, and once the plants show signs of being established, weekly irrigation should be sufficient. In planting out large seedlings, it is advisable to remove the majority of the leaves several days prior to planting, leaving portion of the petiole or leaf stalk attached to the plant.

Owing to the impossibility of determining the sex of the seedlings prior to flowering, it is advisable to adopt close planting and planting in pairs about 18–24 inches apart, allowing 3–4 feet between pairs, is suggested. The thinning out of males, which usually predominate, should be done as soon as detected, and they should be cut up and dug into the soil as they are valuable manure for the remaining plants. No definite advice can be given as to how many males should be left, as position of the plants has a considerable bearing on the matter, but as a guide three or four robust males should be satisfactory if well dispersed amongst twenty to thirty females.

While most plants have the tendency to develop the one upright stem, there are some that will develop lateral limbs early in life, which is very desirable as the plant then tends towards a low type growth, and carries a larger crop of medium-sized fruit low to the ground. To encourage the branching type habit, the growth may be nipped out when the plant is 3–5 feet high, but even this does not always force out the side vegetation. Some growers wait until the first main crop has set before removing the terminal growth, when the branching habit can usually be obtained.

It is usually found that after the second or third year the plant has produced its best commercial crops.

(iv) Maintenance

The plant readily responds to soil cultivation, and liberal supplies of well-rotted organic matter will be of much benefit, bearing in mind that if the plant is kept producing vegetative growth, there will be a constant cropping of fruit.

(v) Reaping and Handling

Like most fruits the papaw attains its best flavour if allowed to remain on the plant until ripe, but this is not practicable if fruit is to arrive at the markets in good condition. The stage to harvest for markets will vary with the season. During the winter months it is possible to allow the fruit to remain on the trees until a fair amount of colour is showing, but in the summer it is necessary to harvest as soon as the yellow colour commences to show on the fruit.

Harvesting should be done during the cool of the day by holding the fruit firmly and giving it a slight twist, when it should come away with portion of the fruit stalk attached. The fruit should be handled with the greatest care, as it is very easily bruised and marked; even the slightest marking in harvesting becomes very pronounced when the fruit is ripe. If possible, the fruit should be allowed to sweat in a cool place for about 12 hours prior to packing. A layer of wood-wool, dry straw or crumpled paper should be placed in the bottom of the case, making sure that a padding of the paper covers the stem end of the fruit. The fruit may be packed either erect or lengthwise along the case. Never place the fruit across the case, for after lidding the case always travels on its side, and fruit so packed is liable to receive damage to the stem or calyx ends. When packed the fruit should be slightly lower than the side of the case, and a

liberal layer of wood-wool or crumpled paper should be placed over the fruit before lidding. The use of dead banana leaves as padding material is not to be encouraged, for it not only detracts from the 'get up' of the product, but produces an unpleasant musty odour to the packed article. Use even grade fruit as far as possible, and upon the end of the case mention the count or number of fruit in the case.

Owing to the fact that in Jamaica papaws suffer from a very serious virus disease, commonly known as 'Papaw Mosaic', several modifications to the cultural practices described in previous pages are necessary, if one is to have any success with papaw culture in Jamaica.

There are no known strains which are not extremely susceptible to this disease. Mosaic is transferred from one plant to another by various kinds of sucking insects, which appear to be particularly prevalent during the summer months. As the effect of this disease is to kill out the crown of the plant often before it has had time to mature any fruit, the only way in which mature fruit can be produced is to grow the papaw at times and places where the sucking insects are not plentiful.

This can be done by growing the papaw in exposed positions along the sea coast, where the sea breezes effectively deter sucking insects. For other situations it is recommended that the papaw be treated as an annual crop. Young plants can be raised in the glasshouse in the autumn for planting out in early January. Given good treatment, i.e., thorough cultivation, plenty of manuring and watering it is possible to mature a crop before the plants succumb to the mosaic, which becomes rampant in the autumn months.

CHAPTER 36

Vanilla

The vanilla vine belongs to the orchid family, having oblong fleshy leaves, and similarly fleshy pods. Originally coming from Mexico, the cultivation of vanilla spread to Madagascar, Ceylon, the East Indies, Mauritius and some of the West India Islands, the cured pods being in ready demand at high prices. Besides the extract for culinary flavouring, the spice was also used for flavouring chocolate and tobacco, and was also employed in the perfumery trade. The discovery, however, of synthetic vanilla essence, coupled with the trouble involved in hand-fertilizing the flowers to obtain a crop of beans, has considerably reduced the general cultivation of the vanilla bean.

At no time has vanilla been grown in Jamaica on a commercial or even a domestic scale, although many districts are suitable for the cultivation of the vine, which thrives in a hot and humid climate at any elevation up to 2,000 ft. The vine requires light shade and protection from high winds and support from low trees, fence, or arbour. Low trees are most favoured, with not too thick foliage.

Propagation is effected from cuttings about 3 ft. long, which must be set at the spot where the vine is intended to grow.

Usually two cuttings are put in on opposite sides of the support and covered with surface soil and compost, the remainder of the slip being tied to the support. They must be kept well-watered.

Spacing for plants is about 8 ft. by 8 ft., and as soon as the slips have 'taken' they throw out aerial clinging roots and begin to mount the support. After this, little care beyond keeping clear of weeds and an occasional watering in dry weather is necessary.

Pollination. The vines begin to blossom about 18 months after planting, and a small crop may be reaped in 9 months. As cross pollination is only carried out by certain very specialized insects, which do not occur in most of the vanilla growing countries, hand pollination is practised.

Pollination must be done in the morning when the pollen and female stigma are fresh. Two adhesive pollen masses are lifted on a small pointed stick and brought in contact with the gummy stigma surface. About six

flowers in a bunch should be treated, and the number of pods allowed to each vine from 15 to 30 according to the strength of the vine.

The pods are ready for picking when the tips begin to yellow.

Curing. The pods are dipped in very hot, but not boiling, water for half-a-minute, and then placed alternately between blankets to sweat and in the sun to dry. To induce fermentation they are then rolled up in a blanket and put in a closed box, then sunned daily for one or two hours, rolled up and closed again, repeating the process for two or three weeks, until the pods are brown and pliable, and have acquired the characteristic smell of vanilla. The more slowly the curing proceeds, the better the quality.

When the curing process is complete (three to five weeks after picking) the pods become covered with a coating of fine crystals, *vanillin*, and the presence of this coating marks the perfection of the cured product.

About 100 good pods go to the lb., and an acre of good vines (say 600 vines) should yield 100 lbs. of cured pods.

The market price varies, but a late London quotation was 30/- per lb.

Prices depend to a large extent on the crop prospects in Madagascar which is the world's largest producer. If there is a crop failure or a political crisis in Madagascar then the price on the world market is likely to increase.

CHAPTER 37

Sarsaparilla

Sarsaparilla of commerce is the dried root of the vine of a species of **smilax** that grows wild in shaded cultivations in Jamaica. Although fair quantities are exported (139,472 lbs. in 1958, valued at £13,141), the vine is nowhere cultivated.

It is propagated by seed or suckers, and thrives best on red-earth limestone soil at elevations of 2,000 ft. or thereabouts. The stem of the vine is prickly and the leaves ovate, large, and glossy-green.

The roots, which grow horizontally not far beneath the surface, are collected by removing the surface soil, cutting them off at the crown and following them as far as possible, care being taken to leave sufficient to support the plant until time for another cutting.

The red colouring derived from the soil in which it has been grown is characteristic of the best quality roots.

Exported chiefly to Great Britain, and used in the drug trade in preparations for rheumatic troubles and ailments of similar nature.

CHAPTER 38

Cereals

MAIZE (CORN)

(i) Introduction

Maize or **Indian Corn** is generally referred to in Jamaica simply as '*Corn*'. It is a quick-growing plant of the grass family with broad, long, strap-shaped leaves, varying in height depending on variety and conditions of growth but usually being from 6 to 9 feet tall at extremity.

The cobs, in which the rows of seed or grain are borne, are sheathed in numerous sheets of parchment-like *husk*. The dimensions of the cobs vary also with variety and conditions of growth, but are commonly between five and nine inches in length with each cob containing from 8 to 16 or more rows of grain. The cobs are borne mid-way up the stalk, a single stalk sometimes carrying two or more cobs but more commonly only one.

Indigenous to the New World, corn is now cultivated in all warm countries or in countries with a pronounced summer season.

The unripe cobs constitute a nutritious article of food which can be prepared in a number of ways, while the dried seed or grain is used either as feed for livestock—including poultry, or is milled into meal for human consumption. Starch may also be obtained from the dried grain.

(ii) General Aspects

The Crop. For various reasons, it is not possible to give exact figures for the total amount of corn produced annually in Jamaica. A considerable quantity is used in the immature stage as 'green corn', much is used in poultry and stock feeding and in 1956, of a total estimated island production of slightly under 16,000,000 lbs., 54% was purchased by the Marketing Department and milled into cornmeal.

The return per acre depends on a complexity of factors, some of which will be considered later.

In Jamaica at the present time, average yield per acre is low and is perhaps no more than 12 to 14 bushels shelled grain of approximately 64 lbs. per bushel. Twenty bushels per acre is considered a fair yield, although yields of 30 and 40 bushels and more have been reported.

The economic yield level must of course vary from farm to farm depending on factors such as natural soil fertility, efficiency of production generally and market outlets. As a guide to possible gross returns, the price per 100 lbs. dry shelled grain, delivered to the Marketing Department in Kingston was in 1959 as follows:

Red grained types	17/-
Yellow grained types	22/-

Districts. Corn is grown to a fair extent in Manchester, St. Ann, Trelawny, St. Elizabeth, Upper St. James, Upper Westmoreland and Clarendon. Small amounts are also grown in parts of St. Catherine and St. Mary. Very little is grown in the eastern parts of the island.

(iii) Production

Propagation. Corn is grown from seed and with the 'open-pollinated' types at present grown in Jamaica, too much care cannot be taken in selecting cobs from vigorous, healthy plants with only the best seed from each cob retained. Cobs selected for seed should be heavy for their size and show no looseness of grain as this may be a sign of cob rot. Cobs should also be well-filled with shiny grain, too hard to be indented with the finger nail. Preference should be given to yellow types.

If seed for planting is to be stored for any length of time, it is imperative to see that it is thoroughly dried and stored in air-tight insect-free and insect-proof containers. It is advisable also to treat it with some recommended insecticide or seed dressing, many of which are on the market.

Preparation of the Land. It is important to bear in mind that the open type of clean-weeded cultivation called for in planting corn is not suitable for steep hillsides and even gentle slopes should be furrowed effectively on the contour.

The land should be ploughed, harrowed or forked to a depth of at least 8 inches and be worked down to a loose condition and until it is free of weeds.

Soil should be free draining or adequate drainage be otherwise provided.

(iv) Planting

Planting is carried out by hand on small areas and by machines on large fields. Seed should be buried about 2 inches if the soil is moist and somewhat deeper under drier conditions.

It is not considered worth while to supply fields of corn. It is better to use a heavy seed-rate and later thin out the stand if necessary. If for any reason a poor stand is obtained, it is better to prepare the furrows over again and replant.

Time of Planting. In Jamaica, two crops a year can be grown in

some areas. The 'fall' crop is planted from August to October and the 'spring' crop from March to May. In either case, planting should be done as soon as seasonal rains appear to have set in.

Spacing. A spacing in which rows of corn spaced 2 feet apart with single plant spaced 1 foot apart along the rows (or two plants spaced 2 feet apart along the rows) has given the highest yields in a number of trials in Jamaica. These spacings are therefore recommended with the varieties at present available. It may, however, be advisable to increase somewhat the spacing between rows if this is found to be necessary to accommodate mechanical implements, a reduction in spacing within the row being made to preserve the population of 21,700 plants per acre.

Fertilizers. The amounts and kind of fertilizer which should be used should be determined by soil test. Responses to fertilizers have been variable and no general recommendation can be given. On some infertile soils, responses have been very large.

Phosphate, if required, should be applied below the seed either at the time of planting or a few days earlier. Potash and nitrogenous fertilizers if required may also be applied along with the phosphate, but it is important that these are not permitted to come into direct contact with the germinating seed as burning will result. It may also be advisable to apply nitrogenous fertilizers as a split dressing, a part at or before planting and the remainder before 'silking', particularly if a heavy application is indicated.

(v) Maintenance

After Cultivation. It is necessary to keep fields reasonably free of weeds at all times, but this is particularly so early in the life of the crop. Weeds are also easier to remove when they are small. There is a possibility that it may soon be practicable to supplement mechanical weeding with the use of appropriate chemical weedicides, but at the time of ~~writing, no~~ specific recommendations can be made.

'Moulding' of the young plants is thought to be beneficial on some soils, but beneficial effects from this practice have not been demonstrated on the 'red dirt' soils where much of the corn in the island is grown.

(vi) Reaping, Shelling and Storage

If there is no threat of rain, harvesting may be delayed until the plants begin to dry. This is better practice than pulling back the husks to see if the grains inside are mature, since the openings thus made invite the entry of weevils. Moreover, allowing the plants to start to dry ensure that all the grains are fully ripe with consequent increased resistance to storage pests later on.

If for any reason, harvesting has to be further delayed, the ears should be broken over as a protection against rain soaking in at the tips. It is essential to remember, however, that unless the ears are fully ripe when broken over, they will dry with a high proportion of sugar in them, and this will make them very subject to attack by weevils.

On a large scale, reaping and husking is done by machines, but in Jamaica, conditions seldom merit the use of such equipment. It is usual therefore for cobs to be picked off by hand and the husks removed and left in the field. Ears found to be infested with weevils should be put into separate containers and kept in a different store from the sound ears. Grain from the weevil infested ears should be fumigated or disposed of as quickly as possible.

Since, in addition to large power-operated corn shellers there are also available small and inexpensive and quite efficient hand-operated machines on the market, the farmer is usually able to avoid the laborious task of shelling by hand. Particularly if the grain is to be used for seed, it is important that it is thoroughly dried on the cob before shelling. Further drying may be necessary after shelling as the keeping quality of grain or seed depends very much on this.

Galvanized iron bins are probably the best storage containers available, provided that they can be properly closed to prevent the entry of weevils and that they are moisture-proof. Jute bags are suitable only if the grain is to be kept for a short time and since second-hand bags frequently contain weevils, they should be treated with insecticide or boiled before use.

(vii) Pests and Diseases

There are a number of pests and diseases of young seedling corn, many of which can be controlled by selection of good seed, planting in moist soil of good tilth to ensure rapid germination and by seed treatment with one or other of the recommended commercial seed dressings or with tar.

Of the insects attacking corn at later stages of development, the most important in Jamaica are the Army Worm (*Laphygma frugiperda*) and the Corn Ear Worm (*Heliothis obsoleta*). Methods of control should be discussed with the area Agricultural Instructors.

GUINEA CORN

This tall annual **Sorghum** resembles maize in its form and growth, the tall variety attaining a height of 6 to 8 feet, and the dwarf variety 3 to 4 feet. It requires similar conditions of soil as maize, and is suited to a dry climate and not too heavy soil. The grain is rich in albuminoids, and the flour mixed with wheat flour to supplement its shortage of gluten is largely cultivated for food in India, East Africa, Egypt, the Sudan and

Mexico. In Jamaica, however, the grain is only used for mixing in poultry feed, and the stem, before arriving at maturity, for cattle fodder.

Cultivation. If sown for seed, the seeds should be sown in furrows about 3½ feet apart, and the seedlings thinned out to a distance of 12 inches apart. About 10 lbs. will sow an acre.

The heads of grain mature in about four months, and should be perfectly ripe before being cut. The heads are cut with a small portion of stalk attached, and after drying for a few days, are ready for threshing. An acre yields about 25 bushels of seed; 40 bushels have been reaped under exceptionally favourable conditions.

If sown for fodder closer planting is necessary, about 50 lbs. being needed for an acre. The grass is cut when half matured at which stage the stalks are succulent and as readily eaten as the leaves. The yield is about 6 tons an acre.

Ratoons

The grass should be cut close to the ground (as with Napier grass), when the plant soon sends up fresh suckers around the stub, the result of which is a heavier second crop of fodder. The process of cutting can be repeated three or four times before it becomes necessary to plough under and re-plant.

BLACK MILLET

This is a variety very nearly related to Guinea corn, and cultivated similarly. The seeds are smaller, black in colour, and readily taken by poultry in a mixed feed. Ground into a coarse flour it can also be incorporated in a cattle mash. The yield per acre is slightly higher than that of Guinea corn. On cutting early it ratoons and serves the same purpose for fodder as Guinea corn.

RICE

(i) Economic Importance

Rice is one of the staple foods of Jamaica and large quantities are imported and consumed annually, but fair quantities have been successfully and economically grown in the parishes of St. Elizabeth, Westmoreland and St. Catherine.

In one year recently the consumption of rice in the country was estimated at 21,000 tons of which 15,527 tons valued at £1,182,384 was imported.

Quick growing rice may take only seventy days to mature, whilst some of the slower varieties occupy the land for seven months.

Yields vary considerably according to the variety grown, the locality, and the method of cultivation employed, but yields as high as 100 bushels of *paddy* to the acre have been recorded.

The two groups into which the rice grown may be divided are **Swamp Rice** and **Upland** or **Hill Rice.**

Swamp Rice

Soil and Climate

(*a*) *Soil.* Economic Crops of Swamp Rice are obtainable on almost any type of soil but heavy clayey loams will give the best results and moreover will retain better the water which is essential to the proper development of the rice plants. Preferably there should be a hard pan or impermeable layer not lower than 2 feet below the surface to avoid waste of water by downward percolation.

Other authorities suggest that rich, light loam top-soil of about 6 inches overlying a clay sub-soil is best. This top-soil should be slightly acid or neutral, but not alkaline.

(*b*) *Climate.* Swamp rice needs a hot climate and full exposure to sun. A high rainfall is not essential, if plenty of irrigation water is available, but it must be remembered that the crop may use as much as 6 or 7 feet of irrigation water during growth, and therefore, a good rainfall is an asset. Cold weather conditions and low temperatures tend to arrest the general development and activity of plant growth, to delay flowering and ripening and to destroy the vitality of the plant.

Upland or Hill Rice

Soil and Climate. Upland or hill rice does not differ botanically from swamp rice. It does, however, require different climate and soil conditions.

(*a*) *Soil.* A clayey loam that will not quickly dissipate water received, either from rain or irrigation gives the best results. Preferably the top-soil should be friable and the sub-soil more impermeable. A richer loam is required than in the case of swamp rice.

(*b*) *Climate.* Like swamp rice, the upland needs a hot climate and full exposure to the sun. At the same time, unless irrigation water is available, there should be adequate and frequent rainfall. Cold weather conditions will arrest the general development of the crop.

(*c*) *The Upland or Hill Rice varieties* generally mature in a shorter period of time than is required for the swamp varieties. As a rule they are planted in the spring. These varieties will produce satisfactory yields when kept flooded for at least a part of the season.

(ii) Propagation

Swamp Rice is grown from selected seed planted in nurseries or sown broadcast on the site. In both cases the presence of water is necessary. In

modern mechanized farming on dry ground intended to be irrigated, a drill is used for dropping the seed.

Upland Rice is not grown from nursery stock but is sown direct into the prepared land where the seed will germinate and the field be established.

(iii) Preparing the Land

Swamp Rice. The land which should be as level as possible for irrigated or swamp rice, is ploughed, harrowed and cross-harrowed to a depth of 9 inches. If possible, the last harrowing should be done when the soil is slightly wet, but not wet enough to clog the tines of the harrow. The fields must now be divided into compartments by means of low banks about 3 feet wide at the bottom and 2 feet wide at the top. The height of the bank should not be less than 18 inches, and they should be compressed firmly to ensure that they retain water within the compartment. If the sides of the banks are well smeared with wet clay, they will be much less permeable to the seepage of water through them. The size and shape of the compartments is determined by the contour of the land, the banks being arranged to hold the water at an even depth throughout each compartment.

In swampy areas it may be found impossible to get the field ploughed before the land becomes too wet. In this case quite good results are obtainable by billing down the weeds and pushing the nursery plants into spongy soil.

Preparation of Nursery. The land is prepared and the banks made as described above. Any pen manure available should be incorporated with the soil. Water is then run in and the land allowed to soak for several days. The soil should be puddled with the water, either by using a wooden rake or a small mule-drawn harrow. A properly prepared nursery should contain a soft sticky mud of gravel-like consistency 6 inches to 1 foot in depth. The size of the nurseries should be about $\frac{1}{20}$th of the land to be planted. 20 lbs. of seed is sufficient for a nursery, $\frac{1}{20}$th acre in area, and will plant out an acre of land. The best months for sowing the nursery are April, May and June depending on the rainfall. The seed should be placed in a sack and soaked in water for 24 hours. The sack is then placed in a sunny position and covered with another sack to keep out the light.

After a further two days, the seed will have started to germinate. The germinated seed can then be sown in the mud of the nursery. The grain does not sink into the mud, but lies on the surface giving the nursery an appearance of having been dusted with sand. From five to seven days afterwards, the nursery will be covered with a bright green carpet of seedlings that quickly grow into sturdy young plants and after six or eight weeks they will be ready for transplanting.

Upland Rice. Preparing the land for establishing upland rice follows more or less along the same lines as those for irrigated swamp rice. The land is ploughed, harrowed and cross harrowed to a depth of from 6 to 9 inches. The last harrowing should be done when the soil is slightly damp. Also care should be taken to see that all stumps and tree roots have been removed, and rough surfaces smoothed over.

(iv) Planting

Selection of Seed. Great care should be exercised when selecting seed for planting to secure the entire supply of a single variety whatever the variety may be. The reason is that if mixed varieties are planted in one field, grains of various sizes will be reaped, instead of a uniform size, and in the process of milling, the grain of the variety with larger sized seed will be broken, while those of the variety bearing the smallest sized will pass through unhulled. Planting seed of mixed varieties, also produces lighter yields than similar plantings from pure seed. This is due to the difference in dates of maturity. One variety will have to be harvested rather green or over ripe which will result in a loss in either instance.

Swamp Rice may be sown broadcast or by transplanting from nurseries. As soon as the rains of April or May have softened the soil sufficiently the land is ploughed and harrowed. The weeds and grasses are removed if excessively abundant. The seed (80–100 lb. per acre) is then scattered broadcast over the surface of the soil which is given another harrowing to cover the seed as far as possible; if irrigation water is available the rainfall may be supplemented by occasional flooding, otherwise the rest is left to nature.

In some areas it may be advisable to make furrows at regular distances (6–12 feet) in the fields. These furrows will serve as drainage channels in case of too abundant rainfall during the germination period.

Transplanting. The fields or compartments should be prepared in a manner somewhat similar to the nursery. Water is then run on to flood the fields to a depth of 4 to 6 inches. The seedlings are pulled up from their muddy home, the excess of mud is knocked off and the bundle is then shaken into shape by dumping its roots downwards on to a little platform or table fixed in the nursery. The bundle is then laid on the table and a short length of the stem is cut off with one blow of a knife. The bundles are then put aside, with their roots in water until they are required for use.

The process of transplanting is done by taking three to five of the decapitated rice plants in the hand and plunging them through the water into the soft mud beneath. The ideal planting distance is 12 to 14 inches, though some authorities recommend two to three plants at a distance of 8 to 9 inches apart.

It is common practice to let all the water out slowly after planting, and

to re-flood the beds only after three to four days, when the seedlings stand up and become green again.

Upland Rice is sown either broadcast or by a mechanically operated drill that drops the seed at regular intervals. The sowing operation, where irrigation is not available, should be carried out immediately after or before rain.

Upland rice is planted in a similar manner to corn; the land is ploughed or forked in the usual way and the seed is sown broadcast, or drilled in rows up to 3 feet apart, the seeds being 6 inches to 1 foot apart in the row. These spacings may be altered to suit conditions of high or low fertility. About 30 to 40 lbs. of seed will plant an acre, depending on the variety and size of grain and various other conditions of planting. Cultivation is usually confined to two weedings, which should take place while the plants are small. Cultivation by means of animal drawn implements can only be carried out if the crop is planted in rows. Once properly established, the plants produce numerous tillers or suckers, and form a dense cover effectively preventing the growth of weeds.

The crop period varies with the variety, but about six months is the average. Planting usually takes place at the beginning of the rainy season and the crop is reaped some six months later.

(v) Maintenance

After Cultivation of Swamp and Upland Rice. The only attention required now is occasionally weeding in the early stages and irrigation in times of low rainfall or if otherwise necessary. If the water in the fields shows signs of stagnation it should be run off and replaced. In some parts of the world, for example Italy and Siam, a slow stream of water passes through the fields, and this practice might be possible in certain parts of Jamaica.

Intermittent Irrigation is recommended where the fields are irrigated. The benefits claimed are:

(*a*) The cost of cultivation (water consumed) is less.
(*b*) The yield is heavier.
(*c*) The straw is strengthened, allowing the plants to retain an upright stand and so facilitating easy mechanical reaping and binding.

(vi) Reaping

Harvesting. When the ears are full but still green, the fields can be allowed to dry up, and at this stage a green manure crop can be sown. The rice will ripen from late in October to early December depending on the variety of seed sown and the local climatic conditions. The plants should be cut low down on the stems and made into small bundles. These can be laid on the stubble to dry. When dry, the grain can be threshed out by beating the bundles on a wooden ladder in a threshing box.

(vii) Varieties

Although varieties of rice may be divided into the two classes swamp and hill or upland, there is no hard and fast rule restricting varieties to each class, thus a variety, e.g. Buffalo, although primarily designated a swamp rice will be found to do very well when grown under upland conditions. It is a matter of climate and water supply.

Swamp Varieties. The best known and recommended is the **Buffalo.** It is hardy, a heavy cropper, bears large grains and possesses excellent table qualities.

Another recommended variety is the **Champion.** It is a heavy bearer, and the grains are large.

Two other recommended varieties from India are the **Rajah** and **Dhobo** or **Dover**. The crops of these come in between October and December, irrespective of how early they are planted.

Upland or Hill Varieties. The best recommended variety is the **Surina Precoz** (**Precoce 6**). This is the quick cropper, maturing in four months. Its qualities are excellent but it suffers the disadvantage of not having an attractive appearance when milled.

Other Varieties. As mentioned before, given a sufficient rainfall, overhead or level irrigation, many varieties of so-called swamp rice, e.g. the **Buffalo,** will do well in upland situations.

Thirteen varieties are being grown in a yield test at the Bodles Station. These varieties can be seen there.

CHAPTER 39

Pulses

THE SOYBEAN OR SOYA BEAN

(i) General Characteristics

The soybean is an annual leguminous plant, of erect, bushy habit, varying in height from $1\frac{1}{2}$ to $3\frac{1}{2}$ feet. It is a native of south-eastern Asia, and its history is lost in antiquity. The first mention on record of the plant was made by the Chinese Emperor Shen-Nung about 4,800 years ago.

Soybeans were introduced in Jamaica primarily for the purpose of improving the diet and agriculture of the peasant farmer. The bean is far richer than any other, and by comparison with red peas yields on the average twice as much weight of peas per acre. It is a vigorous growing crop and enhances soil fertility by the fixation of nitrogen. It could be further made to fill a prominent place in agriculture through augmenting the stock feed of the Island by being reaped in the green state and used as fodder.

(ii) Propagation

Propagation of the soybean is from seed. In common with the other legumes it lives in close association with certain bacteria which form tubercles or bacterial colonies on the roots of the plant. The bacteria, in return for support and food provided by the plant, obtain nitrogen from the air, fixing it in a form which may be used by the plant. When soybean seeds are planted in an area for the first time, it becomes necessary to inoculate the seed with bacteria. This is most easily accomplished by obtaining tubercles or nodules from the roots of growing plants, crushing them in milk, and wetting the seed with the mixture.

(iii) Preparing the Land

On the whole, the soybean crop is not tolerant of all the soil types; most successful crops have been grown on red limestone soil, and sandy alluvial soil; moderate crops have been grown on heavy clay alluvial soil in some localities; poor crops have always resulted when planting took place on acid inland basin soils as occur at Wakefield, St. Catherine, or

Good Hope, Trelawny and on soil derived from conglomerate in the Blue Mountains in Portland. The crop appears to be tolerant of a considerable range in altitude, growing equally well at sea level and at two thousand feet. All other factors being equal, moisture is the factor controlling the success or failure of the soybean crop.

The site for planting should be well ploughed and harrowed or forked and refined. Hills in a yam field also lend themselves for the purpose.

(iv) Planting

Seasonal variation affects the crop to the extent that short-day crops planted during the period September to January will mature earlier and yield less than long-day crops planted during the period February to August.

There are two main types of soybeans under cultivation in the Island at present, with an intermediate third stage. The first, represented by large, more or less round coarse seed of varying colours from cream to chocolate, should be planted at the rate of 45 to 50 lbs. per acre, or two seed 12 in. × 24 in.; the second type, represented by smaller, more elongate seed varying in colour from black-eye, cream to black, should be seeded at the rate of 35 to 40 lbs. per acre, or two seed 8 in. × 18 in. The third type should fit in somewhere between the first two in planting rates and distances.

(v) Maintenance

The soybean crop requires very thorough cultivation, for weeds must be controlled to prevent competition for moisture, and a deep loose seed bed must be provided. Irrigation can be an adequate substitute for rainfall, but it is an important fact that irrigation practised immediately after planting will result in very poor germination. In the event of irrigation being necessary at planting time, the water should be laid on, and then free moisture allowed to evaporate or drain away before planting takes place, and no further irrigation should be practised until young plants have appeared through the soil.

(vi) Reaping and Yield

The harvesting of the soybean crop is relatively simple, and may most easily be accomplished by snapping the plants when mature at the soil surface, and then exposing them to the sun on a barbecue or similar surface. When perfectly dry, a considerable amount of automatic shattering will take place, and this action may be completed by a light flailing.

(vii) Varieties and Yield

Maximum net yields of dry soybean seed have reached 2,000 lbs. or 31 bushels per acre on irrigated sandy alluvial soil, and 1,900 lbs. or 29–30

bushels per acre on non-irrigated red limestone soil. Average yields of the most productive variety now under cultivation in the Island, namely, the 'Trinidad', may be expected to range round 1,400–1,500 lbs. or 21–23 bushels per acre. The crop will mature in 12–16 weeks.

THE RED PEA OR FRENCH OR KIDNEY BEAN

(i) Economic Importance

In Jamaica the 'red pea' needs no description, as it is undoubtedly the most popular pulse in the Island.

The various names taken together give a fair description of the plant. Red, because the seeds are commonly red or red-brown, sometimes mottled; kidney, because the seeds are of that shape; French, possibly because the tender immature pods may be sliced and boiled in the green state.

The red pea enters very largely into the dietary of the people, being used daily, usually boiled in combination with rice and seasoning.

(ii) Propagation

The red pea grows from seed, preferring light rich soils in a relatively cool climate, hence it thrives better in the hilly districts. The seed is sown direct into the prepared soil and germinates in four or five days. The plants are shallow-rooted, and require regular showers of rain throughout the growing season. Light mulches may be used to supplement insufficient rainfall in some areas.

Districts suitable. All parishes possessing areas between 1,000 ft. –3,000 ft. in altitude, and in the case of Portland, St. Mary, St. Ann, Hanover and Westmoreland, it is possible to utilize areas of 1,000 ft. and under during the cooler months.

The 'red earths' are very satisfactory, but for best results they must have been previously cultivated and contain plenty of organic matter.

(iii) Preparing the Land

Preparation of Land. Although red peas are quick-growing plants, they rarely grow much taller than 1 foot, and never smother weeds in the way cow peas may do. It is, therefore, essential that the lands should be very thoroughly cleaned before sowing. Track forking is not sufficient, and the whole area should be ploughed or forked to at least 6 inches, and then broken down to give a loose, clean seed bed.

(iv) Planting

Choice of Seed. There are a great many varieties of red peas, some good and some bad, and it is advisable for growers to use only seed of a variety which is well known in their particular district. Mixed seed of several varieties should never be sown together, as it nearly always includes some inferior low-yielding types. Care should also be taken to obtain seed from plants that are free from diseases and pests, and special care should be taken to avoid seed infested with weevils.

Time to Sow. Sowing should be timed as far as possible to give the plants six to eight weeks of fairly rainy weather, and thereafter somewhat drier weather to ripen off the pods. This means that in normal years successions of red pea crops could be sown in different districts from mid-September to the end of May. If growers feel uncertain about the weather to be expected at any particular season, it is a sound practice to divide up the seed into two or three lots, sowing these lots at two-week intervals.

Seed rate. Large seed varieties, 1 bushel (64 lbs.); medium (56 lbs.); and small (45 lbs.) per acre.

Sowing and spacing. Red peas should be sown in rows 2 ft. 6 ins apart, with single seeds placed 8 inches apart in the rows. If the soil is moist at sowing time, the seeds ought to be placed 1 inch deep; but if the soil is rather dry, 1½ inches deep.

(v) Maintenance

After Cultivation. Hoeing between the rows and hand-weeding in the rows should be started as soon as the seeds germinate and be continued, to keep the land free of weeds, until all the bean pods are full-sized.

(vi) Reaping and Storing

Harvesting String Beans. Good quality string beans can only be obtained by hand-picking every two days. The right stage at which to pick the pods is when they are full-grown in length, but before the seeds start to swell up inside. At this stage the pods should snap with a clean break when bent. Two or three days later, the same pods will tear instead of snap and will be stringy, and therefore of much less value for selling purposes.

Harvesting Mature Beans. The usual practice in obtaining the dry peas is to collect the whole plants when they have withered and hang them, tied in bundles, in a shed to complete drying. This is satisfactory as long as much rain does not fall during the two or three weeks before harvest. If it does, the seeds inside the older pods will become thoroughly

wet, and may start to germinate. Should this seem likely to happen, all the ripe pods should be hand-picked as soon as they become brittle. In all cases drying should be done in places free of debris that might contain weevils.

Yield. 10 to 15 bushels of 64 lb. or in other words, 640 to 960 lb. per acre.

(vii) Varieties

The True Red Pea is sometimes called the round-red and, as the name implies, is characterized by a full roundness and a bright red colour.

Miss Kelly is not so bright a red as round-red, and is mottled with brown splashes. The grain is long, and this variety is the most popularly esteemed.

Portland Red appears to be restricted to the parish whose name it bears. The grains are small and of a dark red colour.

THE COW PEA

(i) Economic Importance

Cow Peas are widely grown throughout the tropics and provide food for man and beast, as well as cover crop and green manures. There are many varieties, but the clay-coloured is the most popular. The young pods can be cut and eaten like string beans. An important advantage of the cow pea is its rapid development, the crop being ready to harvest in two to three months.

Used as a cover crop for citrus and other orchard trees the cow pea forms a thick mat, does not climb, and adds much nitrogen and organic matter to the soil. It makes an excellent green manure crop to improve the fertility of land following a crop of corn. Where old banana plantings are to be cut down and replanted, a crop of cow peas put in before the new suckers are planted should be very beneficial. The plants provide good forage and hay for livestock. Sown in contour rows on slopes, they help to check erosion or soil wash.

Cow peas are grown to some extent in Jamaica, but they have not received the attention that they deserve. Any grower interested in improving his land and in establishing sound rotations should give careful consideration to the merits of this crop, both for the provision of food and the addition of nitrogen and organic matter to the soil.

Districts and Climate. Cow peas do well in conditions that suit corn, and will stand up to a fair amount of drought. If high altitudes and heavily shaded or damp, cool places are avoided, they should do well in most districts of the following parishes: Lower St. Andrew, St. Catherine, Mid-Clarendon, South Manchester (below 2,000 ft.), St. Elizabeth, St. Ann, Trelawny, St. Thomas, and the coastal lands of Portland, St. Mary and St. James.

(ii) Propagation

Cow peas are propagated from seed, germinating in a few days after sowing. In selecting the seed for planting, care should be taken to make sure that it has been produced on plots free from attack by weevils. Seed reaped from plots infested by weevils carry the eggs to new plots.

(iii) Preparing the Land

Best results are obtained if the land is first forked or ploughed, and then worked down to a fine tilth. If cow peas are sown through corn or after root or vegetable crops, hoeing will usually be sufficient preparation.

(iv) Planting

Sowing and Spacing. For a pure unmixed crop it is desirable to sow cow peas in rows about 3 feet apart with single seeds spaced at 6 inches in the rows. If sown through corn which is growing, in four-feet rows, two rows of cow peas can be sown between the corn rows, the rows being 2 ft. apart and the seeds 1 ft. apart in each row.

Seed Rate. If sown as a pure crop in rows, 5 to 7 quarts (15 to 21 lb.), depending on size of seed, will plant one acre. If broadcast as a green manure or cover crop, one bushel (60 lb.) of seed should be sufficient for an acre.

Time to Sow. About six or eight weeks before the spring or autumn rains are expected to end if seed is required, or two to four weeks earlier than this if the main purpose is to grow a green manure or cover crop.

(v) Maintenance

One hoeing shortly after the seeds germinate should be the only cultivation needed, unless quick-growing weeds like nut grass are prevalent. Care should be taken in doing this not to damage the young plants, which are easily broken at this stage.

(vi) Reaping

Harvesting and Threshing. For seed purposes the pods can be hand-picked when dry, or the whole plant can be cut when most of the pods are mature and threshed subsequently. The pods should be dried thoroughly in the sun, and then collected in bags and beaten to remove the seeds. The peas should always be sold as soon as possible after harvest, as they are very subject to attack by weevils. If this is not possible it is desirable to

delay threshing until just before the peas are to be marketed, as weevils do not usually do as much damage to peas inside their pods as when shelled.

Yield. Seven bushels is poor, fifteen bushels good. A bushel weighs approximately 64 lbs.

(vii) Varieties

Besides the clay-coloured cow pea, there are two principal varieties:

The Black Eye Pea, similar in all respects to the cow pea in growth and grain, but instead of being clay-coloured the black eye is creamy white and, as the name indicates, is distinguished by a small black border around the eye.

The Caroline is also similar in all respects, but has a slightly pink border around the eye.

LEGUME COVER CROPS

(**a**) **The Edua Bean.** In 1938 a small quantity of this legume was introduced from the Gold Coast by the Department of Agriculture. Now it has been established throughout the Island, being very tolerant of soil types, and unaffected by elevation or changing seasons, although the ideal climate for it is one with moderate rainfall during the first half of its development period, and fairly dry weather for the second half.

The Edua bean is primarily a cover crop for weed control, green manuring and fodder, owing to its rapid and profuse growth. For the improvement of heavy stiff clay soils and light sandy soils, when ploughed under, it has few rivals.

The beans are not recommended as an article of food.

Planting out. Seed should be planted two to each hole, 12 ins. × 24 ins. Fodder cut at flowering time may exceed 9,000 lbs. per acre. Complete maturity of dry seeds requires 120 to 180 days and for fodder 40 to 60 days.

(**b**) **The Jerusalem Bean.** This has been a long-established but little-cultivated legume. It is characterized by its very small red or straw-coloured seed borne in long pods. As a quick-growing, hardy, cover crop it is second only to the Edua bean, and the same method of cultivation as for the Edua may be followed.

THE GUNGO, CONGO, OR PIGEON PEA

(i) Economic Importance

The Gungo Pea is grown over a wide area. Its popularity is due to the ease with which it may be grown and its good yields, to its exceptionally high feeding value (proteins approximately 20%, carbohydrates 50%), and to its pleasant and distinctive flavour, whether the green or dried. In

Jamaica it is at present grown mainly in St. Elizabeth and St. Thomas, but its cultivation is nothing like so extensive as it deserves to be.

It will be noted by poultry farmers that while poultry will not take any of the other peas, they readily accept the Gungo pea—hence possibly the name pigeon pea. When fed to poultry, however, it is advisable to crush the seed coarsely through a mill, as the entire grains are very hard.

(ii) Propagation

The pea is grown from seed sown direct into the field intended for it, either by hand, or by drill if a large area is being put under cultivation.

(iii) Preparing the Land

Preparation of Land. The land, especially if at all compact and heavy, should be ploughed or forked to at least 8 ins. to give the tap root a good chance to develop. Where rains interfere with these operations, it is possible to hasten the preparation by track-forking along the rows, 4 to 6 feet apart, billing weeds in the spaces between the rows, and later, after the seed is sown, forking or hoeing between the rows. It is important to remember that before a new crop is sown all old pigeon pea plants should be destroyed, as these harbour plant lice which may attack the new crop.

(iv) Planting

Sowing and Spacing. The spacing required is 4–6 feet between rows and three to four feet between plants in each row. Three seeds should be sown in each hole, 1½ to 2 inches deep. When seeds germinate, they should be thinned to leave one plant.

(v) Maintenance

Intercropping. The Gungo pea does not develop to full size for some months, and it is therefore possible to use the land between the rows for a crop of cow peas or, if the area is suitable, of red peas. It should also be possible in some instances to establish Gungo peas through sweet potatoes that are nearly ready to be dug.

After-cultivation. Hoeing to keep down weeds is particularly important in the early stages. In dry areas, such as St. Elizabeth, mulching is desirable.

(vi) Harvesting

Harvesting. The Gungo pea is a perennial, and may give two crops each year. The main crop comes in January and lasts until March. The highest yields are obtained by hand-picking the pods systematically as they mature. For home use, some can be picked and shelled green, but for

general market purposes it is desirable to pick and shell the pods as soon as they are dry. It is worth noting, however, that Gungo pea plants provide good fodder for stock, and in cases where cattle owners find themselves short of feed it is possible to remove the whole plant, thresh out the seeds, and feed the shoots to stock.

BEANS. LIMA AND 'SUGAR' OR 'BUTTER'

Bush Lima Beans. In general the cultural requirements of Lima beans are similar to those of other legumes. Fertilizer or well-rotted compost should be worked into the soil at least ten days before planting.

Plant in rows 3 ft. apart, dropping the seed at intervals of 6 ins. and cover 2 ins. deep. Practically all the pods mature at the same time, each pod containing three to four large plump beans.

Seed. It is advisable to procure freshly imported seed for each successive planting. There are two or three standard varieties.

Pole Lima Beans

The cultivation of the pole variety is similar to that of the bush, but seed should be spaced 3 ft. apart to allow for development on the pole. Unlike the bush variety the crop does not all mature at the same time, but progressively over four or five weeks.

The pods are larger, containing four or five seeds, larger than the bush variety, but equally succulent.

Seed. There is a local variety, commonly called 'broad beans', that matures only in December and January and is usually planted in June and July. The imported seed matures in four months irrespective of the time of planting. Consequently it is more advantageous to make successive plantings of imported seed.

Sugar or Butter Beans

This bean is a perennial climber, preferring walls, and fences, and low-branching trees to mount. The seeds are smaller than the Lima, but are considered finer eating, with a more delicate flavour. It is hardy and a prolific bearer.

CHAPTER 40

Fibre Plants

(a) SISAL HEMP

This perennial stemless plant is a native of Central America, but has been introduced into and is now largely grown in the West Indies, East Africa, the Philippines and the Dutch East Indies. The commercial fibre is obtained from the thick succulent leaves, 3 to 5 ft. long, terminating in a sharp dark-brown spine.

(i) Propagation. The plant is usually propagated by fully-formed young plants produced by the flowering stems, as well as by suckers which are thrown up around the roots.

The seeds (which are fully-formed young plants) are borne in large numbers on the lateral branches of a 'pole' thrown up by the mature plant when it attains six or seven years, after which the plant is exhausted and should be destroyed.

Suckers are planted out at about a year old, but plants grown from suckers tend to 'pole' earlier than those from seeds.

(ii) Cultivation. The plant thrives on well-drained limestone soil where the climate is warm and dry. It does only moderately well in a wet situation, although the leaves may here attain a greater length. It is drought-resistant, and once established needs little cultivation apart from keeping weeds and suckers in check.

On good soil the plants may be spaced 8 ft. × 6 ft., and on poor soil somewhat closer.

(iii) Reaping. The first leaves may be cut about three years after planting, only the mature lower leaves being taken. About 25 leaves per annum constitute the crop from a plant, in two reapings. The subsequent reapings extend over four or five years, at which stage it is advisable to take out the old plants, leave the land fallow for a year, then treat the soil with a little nitrate and re-plant.

It is estimated that 1,000 leaves will give 50 lbs. of fibre.

Preparing the Fibre. This should be done within 24 hours of cutting the leaves. Special decorticating machines are made for the purpose. The fibre is then cleaned and hung on lines in the air for drying, after which the hemp is ready for baling.

(b) ROZELLE

The Rozelle (more commonly known in Jamaica as 'sorrel') is a hardy annual belonging to the *Hibiscus* family, thriving at elevations from sea level to 2,000 ft., but requiring at the higher elevations a moderately dry soil.

(i) Propagation and Planting. The plant is propagated from seed borne in small round pods along the branches of the tree when it attains maturity. When fully ripe the pods split open at the ends, disclosing the dark-brown seeds about the size of small pepper grains.

The seed may be sown in drills about 12 ins. × 18 ins., to secure erect stems producing good jute-like fibre from the inner bark. If grown for fruit and not for fibre, a space 3 ft. × 3 ft. should be allowed, to encourage branching.

(ii) Maintenance and Reaping. Except for keeping free from weeds during the earlier stages of growth, the Rozelle needs but little attention. The crop (for fibre) is ready for cutting in five to six months after planting, the yield of fibre being between 1 and 1½ tons per acre. If grown for the fruit (making jams and jellies) the crop comes in December–January, and should be picked before the fruit is fully ripe, as they then harden and tend to be tough.

(c) LOOFAH

The Loofah belongs to the *Gourd* family and is an annual, of climbing habit, hardy and thriving at elevations between 1,000 and 3,000 ft.

It is propagated from the black melon-like seeds contained in the ripe cucumber-like fruit, and does well on walls, fences, arbours or stone heaps, producing scores of oblong fruit 10 to 12 inches long, attaining when ripe a spongy network of fibre which when retted yields the loofah of commerce, used for bath and pantry scrubbers, shoe insoles, etc.

Although little cultivated in Jamaica, it is largely produced and exported in Japan.

(d) SANSEVIERIA

The Sansevieria or Bowstring Hemp is a herbaceous plant with rigid, succulent, concave leaves, mottled yellow-grey, and thriving in dry stony soil up to elevations of 2,000 ft., although it prefers the lower levels.

It is propagated by seed, sucker, or leaf. Planted in rows 2 ft. × 1 ft., it matures in two to three years, yielding about 1 ton per acre of silky tough fibre used for weaving into fine mats and twine.

Although it grows plentifully in the wild state in Jamaica, it is nowhere cultivated.

(e) RAMIE

The Ramie (Rhea fibre, China Grass) is a perennial shrub of the *nettle* family, attaining a height of 5 to 7 feet, with large heart-shaped leaves, grey-white on the underside. It is largely cultivated in the East (China, Japan, Formosa), and has recently come in for considerable attention in Florida where machinery has been perfected for dealing with the fibre, which is prepared from the inner bark of the stems, strong, pure white and silky, used for the manufacture of fine linen, gas mantles, etc.

The plant thrives in loamy soils up to 3,000 ft. elevation, requiring a moist warm climate. Good cultivation and manuring are essential, as the crop is of an exhausting nature.

Propagation and Planting. Propagation is from suckers. The plants are spaced in deeply-ploughed, well-prepared earth about 2 ft. × 3 ft.

Reaping. Cuttings can begin at one year, and may be made two or three times a year for five or six years, after which replanting will be necessary.

The yield is about 20 tons of cane per acre, giving about 1 ton of ribbon and ½ ton of finished fibre.

CHAPTER 41

Oil Seeds

PEANUTS

(i) Economic Importance

The peanut is a crop of world importance, meriting close attention in all aspects of its production, processing, marketing and consumption.

At present the consumption of peanuts as an article of food is restricted mainly to the sale of salted nuts in small packets. The expansion of a peanut industry depends on local consumption of the edible oil—at present, nil.

It is doubtful whether an export trade could be developed, as the local product is not likely to compete in the open market with nuts from other sources with low cost of production. There is, however, ample scope for a market for fine edible oil, and for the protein-rich oil cake left after the oil has been extracted from the nuts.

It should be borne in mind, however, that if the peanut were to be grown on an extensive scale to supply factory needs, growers would probably be required to submit to some form of planned marketing, where prices would be lower than those now enjoyed by growers who supply the limited salted-nut trade. It is only by pursuing a policy based on these lines that the peanut can be established as an important crop.

(ii) Propagation

The peanut is grown from shelled seed sown direct into the beds of the field where they are intended to grow. The young plant does not stand transplanting.

(iii) Preparing the Land

Peanuts thrive best on light alluvial and terra rossa soils. Wet districts and heavy clay soils are not suitable.

The land should be well ploughed and harrowed, or forked and refined, manure and fertilizer being worked in at the same time. The type of fertilizer will depend on the type of soil, on which the local Agricultural Officer will advise.

The peanut being a legume, no furrows or ridges are necessary, the seed being dropped in and covered over in just the same manner as with peas.

(iv) Planting

About 4 lbs. of selected shelled seed will plant out 1 square chain. It is essential that fresh seed be used, as peanuts rapidly lose their germinating powers after being shelled.

Time of Planting. Dates for planting vary with the particular districts, but the periods should be moist for early growth and dry for maturing and harvesting.

Spacing. The space allowed between plants should be about 2 ft. × 1 ft., and the seed planted about 2 inches deep and lightly covered over.

(v) Maintenance

Regular hoeing to keep down weeds is necessary, and light earthing-up to assist the penetration into the soil of the 'pegs' or fertilized flower stalks. This should be done shortly after the maximum flowering. Mulching around the roots should not be heavy, as this tends to hinder the penetration of the 'pegs'.

(vi) Reaping and Storing

Bush types take from three-and-a-half to five months to reach maturity, which is shown by yellowing of the leaves and examination of the pods. The lining of the shells should not be too soft, and should show dark veins. Experience will soon be gained as to the best harvesting time. Harvest should not be put off to the point where the nut drops off the plants easily. After digging, it is the practice in most countries to cure the nuts in heaps in the field, but here it will probably be necessary to bring the crop into a barbecue in order to safeguard it. The nuts should not get wet during curing nor be exposed directly to the sun. It is therefore inadvisable to pick the nuts from the bushes, but to pick the plants in heaps in such a way (i.e. pods in the centre) that the bush protects the nuts from the sun. Curing should take time (two to four weeks). If the heaps are too small, the nuts will tend to shrivel and become discoloured; if they are too tightly packed and large, mouldiness may develop.

It is suggested that an average yield of unshelled nuts should be between 100 and 160 lbs. per square chain, or 5 to 8 bushels (of 20 lbs.) per square chain.

(vii) Varieties

There are two main strains—the runner and the upright bush. The runner takes longer and is more difficult to reap, and although it gives

heavier yields the bush type is generally preferred. The best bush varieties for different districts have not at present been proven by experiment, and until this is done the best course to adopt is to seek the advice of the most experienced local grower. Several varieties have been introduced from time to time, principally from the United States. Fortunately, crossing and hybridization of peanuts do not occur in the field, and it is easy to maintain a pure variety provided the original seed is unmixed, or to select a pure variety from a mixed plot of peanut plants.

Special machinery for cultivation, harvesting and hulling has been developed, particularly in the United States, and will be required here if the industry develops.

CASTOR BEANS

(i) Economic Importance

The United States is easily the largest importer of Castor Beans and Oil, the bulk of her imports coming from India.

Other important producing countries are China, Japan, Brazil, Venezuela and the Argentine.

Many of the producing countries manufacture their own oil, but it is claimed that the best extraction is at present done in the U.S.A.

Owing to the high oil contents of the seed, castor oil extraction by pressure requires rather specialised machinery, and solvent extraction methods are now the most popular.

The castor bean of commerce consists of (1) a soft non-fibrous kernel containing approx. 62·9% of oil; (2) a thin brittle seed coat, easily cracked or chipped in handling, containing approx. 10% oil.

(ii) Propagation

Castor beans may either be grown as an annual crop (maturing five to seven months) or, as is done in the Argentine, the plants are cut back to a height of 5 or 6 inches after the first crop and a ratoon crop taken off. Sometimes this is repeated for a second ratoon crop. Annual planting is in most countries, however, considered more profitable.

The plants are grown from seed, which may either be dropped in on the site to be covered or set out in a nursery.

(iii) Preparing the Land

Good deep ploughing or forking before planting is necessary, so as to ensure the soil being in a state of maximum water-retaining capacity and aeration at the time of sowing.

Soils. The castor bean does not like soils excessively acid or alkaline in reaction: best yields are secured on neutral soils, of medium texture, with good water-retaining capacity and fairly rich in nutrients. Phosphate is apparently the nutrient on which the crop draws most, but as will be seen from the following analysis by Semler of the ash of castor and corn, it is less soil-exhausting than corn.

Semler's analysis of ash of castor and corn:

	Castor	*Corn*
Phosphate	38·65	46·00
Potash	29·52	30·00
Lime	11·31	2·49
Magnesium	7·35	15·00

It has been found that on soils that are too rich in nitrogen the plant will produce exuberant vegetative growth rather than a heavy yield of seed.

In Jamaica the castor bean has been found to thrive on a large variety of soils. It seems to do especially well on soils of limestone formation, rich alluvial soils or well-drained clayey loam. The plant likes a dry atmosphere, and given a fair supply of water in the initial stages, withstands drought conditions fairly well.

Time of Planting. The time of planting depends to a large extent on the occurrence of the rainy seasons, and September would appear to be the most propitious month for planting.

(iv) Planting

Sowing. About 12 lbs. of seed of large varieties, or 3–4 lbs. of dwarf varieties, will be required to plant each acre of the crop. To hasten germination it will be found advisable to soak the seeds for 24–48 hours in water, or preferably, pen manure mixed with water. The seeds are then sown four to a hole in holes spaced 5 in. × 5 in. dwarf, 6 in. × 6 in. large, and about ¾ in. deep. On sowing the seeds in the hole, it is advisable to space them in the form of a square 3 in. to 4 in. apart one from the other, so that when the seedlings reach a height of 10 in. to 12 in., the least vigorous may be pulled up and discarded without unduly damaging the root system of the one seedling left to the hole.

(v) Maintenance

Subsequent cultivation, with the object of restraining weed growth and retaining soil moisture, will be advisable as often as the necessity becomes apparent. In some localities mulching will be found an efficient substitute for implemental tillage.

If the plants show a tendency to provide height rather than fruit, the trees should be topped at a height of about 3 ft. This topping also serves to encourage branching which is so necessary for heavy yields, since the fruit-bearing spikes are developed largely on the branches.

In five to six months from sowing the tree will be in bearing, and harvesting will commence at about the seventh month.

(vi) Reaping

Harvesting. On ripening and drying, the capsules bearing the seeds open on the trees, scattering the seed. It is necessary, therefore, to pick the mature seed shortly before this stage is reached. The proper time for harvest is indicated by the spikes turning brown, and the capsules just beginning to open, assuming a yellowish colour. The spikes are then cut with shears and put in a dry place and protected from rain and moisture. The seed is extracted by careful beating with rods, so that the seed is extracted without damage to the thin brittle seed coat.

Yields. In the Argentine yields higher than 700 lbs. per acre are seldom obtained, but yields of 900 and 1,000 lbs. per acre have been obtained elsewhere.

It is asserted by many that conditions in Jamaica are especially suited for this crop and yields up to 1,000 lbs. per acre could be anticipated. Until the crop is fairly tried out it will be quite impossible to gauge the truth of this assertion, but an estimated return of 600 lbs. per acre is not regarded as being unduly pessimistic.

Storing. In handling the beans extreme care must be taken to prevent breaking of the seed coat and the elimination of such broken beans from the samples to be exported, as broken beans rapidly deteriorate, the oil being converted to glycerine and free fatty acid which causes the production of a highly coloured acid oil during the process of manufacture. In commercial practice an extraction of about 36% oil is obtained.

CHAPTER 42

Roots and Tubers

CASSAVAS

(i) The Plant

The Cassava (sometimes called Mandioc) is native to the West Indies and Central America, whence it was introduced into the East and to Africa. From the earliest times the root has been an important form of food.

There are two distinct kinds, the 'Bitter' and the 'Sweet', and of these there are many varieties.

The 'Bitter' is characterized by a high percentage of hydrocyanic or prussic acid, making it necessary for the roots to be processed and subjected to heat in order to dissipate the poison before it can be used for food. The 'bitter' is also the kind chiefly used in the production of starch.

The 'Sweet' is most commonly boiled and used as a vegetable, and constitutes a valuable and tasty addition to dietary. The principal 'sweet' variety can easily be distinguished from the 'bitter' by a characteristic yellow colour when boiled, and generally the 'sweet' possesses a less acrid smell when cut open.

The cultivation of cassava is cheap and simple. The plant is drought-resistant, and thrives best in light alluvial soil or in well-forked or ploughed red earth, and the nitrogen content of the soil taken by the plant (chiefly in the formation of the hydrocyanic acid in the tubers) can be readily restored by raising an alternating crop of legumes.

(ii) Propagation

'Sets' for Planting. The crop is propagated by planting suitable sections of the stem. Green stems having very close leaf scars hard and less pithy, and as a consequence least liable to white ant attack, are to be selected. The 'sets' are to be selected from the middle and the lower portion of the sound and mature stems of branches. The woody parts near the base and the tender ends of the branches should not be used. Cuttings 6 ins. long with four to six nodes would suffice. The bottom ends which grow into the ground are dipped into ashes before they are planted.

(iii) Preparing the Land

The site should be on a gentle slope, or otherwise well-drained and exposed to the full day's sun. The ground should be deeply forked or ploughed and all large clods of earth refined. Exposure to the elements for a few weeks will achieve this. The crop will be greatly enhanced by the addition of manure or fertilizer well mixed into the soil.

There are three systems of preparing the land, namely: (*a*) ridge, (*b*) mound, and (*c*) flat.

(*a*) *Ridge.* In this system the ground is ploughed three or four times, the turf and weeds are collected and heaped in rows three feet apart. From between the rows earth is taken and thrown on either side, covering the turf so as to form ridges about 1 to 1½ feet high, leaving a trench just a foot wide in the middle. On the crest of the ridges the 'sets' are planted.

(*b*) *Mounds.* Ridges are formed as above, but narrow cross-channels are made, separating the long ridges into little mounds. Each of these little mounds receives a 'set'.

(*c*) *Flat.* In this system the ground is well dug. First a furrow is made close to the boundary edge and leaves are applied along the furrow. The first furrow is then covered with earth taken out for making the second furrow, and this latter is covered with earth from the third furrow. Thus the whole field is worked up. Along the rows supplied with leaves, as stated above, 'sets' are planted. The flat system is the best; the heaviest yield is obtained by this system.

(iv) Planting

The distance allowed between plants is usually 4 ft. × 3 ft. In hilly country pits 1 ft. cube are made 3 to 4 ft. apart, and the 'sets' are planted in them. The distance between the plantings depends upon the nature of the soil, the intensity of cultivation, the method of irrigation, etc. In some countries 'sets' are planted at 3 ft. × 3 ft. or 3 ft. × 2 ft. distances. Poor soils allow closer planting than rich ones. The 'sets' are laid either in a slanting position making an angle of 45 degrees with the surface of the soil, or planted in a vertical position. The sticks are covered lightly with soil, leaving only an inch or an inch-and-a-half of top uncovered. Care should be taken to see that 'sets' are not planted upside down.

Another Method. Full-length shoots immediately after harvest are planted in channels 2 ft. wide, 3 ft. deep and 10 ft. long. The set is said to be ripe for planting usually after ten to twelve days, when leaf buds just begin to put in their appearance. The latex in the shoots at this stage will be at a maximum. Each shoot is cut into 9-inch long 'sets' and planted. On no account should a 'set' be allowed to mature for more than a fortnight or till the leaf buds change into leaves, as it then indicates that rotting has taken place at the bottom. 'Sets' from such over-mature shoots make poor seed material. The latex content in over-mature shoots is considerably less and shoots also become pithy.

Time of Planting. The time of planting depends upon the local conditions. A certain amount of moisture is necessary to start growth. The best time for planting is just before the season of rains, when the soil is moistened by early showers.

(v) Maintenance

Inter-cultivation. Cultivation begins when the plants are about 1 to 1½ feet high. Every month thereafter for three months weeding should be done. When the plants have grown about 2½ feet high, hilling should be done gradually. Hoeing between the rows is done once a week in the first two months and once a fortnight the next four months. Irrigation is given once a week, when there are no rains. After hilling the plants may be left unweeded, for a dense shade will have been formed by the leaves above the ground, preventing to a large extent the growth of weeds. Further, any disturbance of the soil near the base of the plants may seriously disturb the development of the storage roots. When the plant attains the height of about 3 feet, the terminal buds should be nipped. This ensures higher yield. Nipping can be done a second time also with good results.

(vi) Reaping

Harvest and Yield. The plants should be ready for lifting after eight to ten months, according to the variety grown. When the plants begin to shed leaves and the flowers are formed, the tubers are considered to be ready for lifting. A couple of plants may be lifted to see the stage of maturity. It is advisable to harvest early, i.e., when the crop is six to eight months old for marketing the crop as a vegetable. But for making starch, tapioca, flour or chips, it is better to allow the crop to stand for the full eleven or twelve months. Even where the plants are fully twelve months old, the tubers can be kept on in the ground for another six months without damage. For making meal or manufacturing starch, the roots cannot be gathered until they are well beyond the best age for direct use as human food; thus, in Africa they are eaten fresh, when about nine months old, and not used until twelve to fourteen months old for making meal. The best time to harvest is to be determined locally. As between twelve and eighteen months of age, the general result is that for the sake of greater yield it is decidedly better to have the plants a year-and-a-half. The percentage of starch begins to decrease before the plants are twelve months old, but the total amount continues to increase rapidly, and the slightly increased woodiness does not seriously interfere with its extraction.

It will be necessary at times to estimate the yield of a standing cassava field at a given time, either to have an idea of its yield for purposes of sale, or at intervals of one month to determine if the maximum yield is already obtainable. To estimate the yield of a field it is recommended that every tenth row be sampled, harvesting plants from every ten hills in each tenth row and determining the yield. From the yield obtained from the number of hills harvested, the yield of the total number of hills in the field may be estimated. When the yield is no longer increasing, the field is at the proper age to harvest.

Harvesting. Actual harvesting operation is done by a man gripping the bottom end of the shoot with both hands firmly with legs planted squarely, and pulling out. If portions of roots remain lodged in the soil, they are dug out. Steeping in mud may be necessary for preserving freshness. By this means the tubers can be kept fresh for four days. Unlike other root crops, cassava requires more careful attention in harvesting. The simplest lifter is a straight wooden stick 8 to 10 feet long, strong enough so that it will not break, which is used as a lever. If the field permits ploughing, a furrow is run alongside of each row, making the roots pull up more easily and with less breaking.

Yield. A well-developed plant produces six to eight tubers, some even ten to twelve according to treatment and variety. On an average three to four edible tubers can be obtained from a single plant twelve months old. If cuttings are planted 3 feet apart there will be 4,840 or 5,000 plants per acre. Clusters of roots ordinarily weigh from 5 to 10 lbs., though they often reach 20 to 30 lbs. each.

(vii) Varieties

As mentioned before, the cassava may be divided into two classes—'Bitter' and 'Sweet'. In appearance both are disquietingly similar.

The skin of the stem or stick of one variety of the 'bitter' is silvery in colour, and there is another with a reddish skin. Of the 'sweet' there are also two varieties, one with silvery skin, the tubers of which are white when boiled; the other with a reddish skin, the tubers of which are yellow when boiled.

In obtaining 'sets', therefore, great care should be taken to get them from a very reliable source, so that 'bitter' and 'sweet' can be clearly differentiated.

SWEET POTATOES

The Sweet Potato is a trailing perennial producing succulent tuberous roots, which are a nutritious article of food, and is a native of the American tropics. It is generally cultivated in all warm countries. The sweet potato thrives in an ordinarily good soil of a not too heavy texture, but prefers a lighter type of soil at a cool elevation or with good rainfall.

Economic Importance. Its economic value as an article of diet does not rank as high as that of the other main crops produced, and it is accordingly consumed in smaller quantity and marketed at a lower price. Notwithstanding this, however, it is of sufficient value to make it impossible to be dispensed with by the farmer, the more so as it serves to provide an excellent cover crop.

(i) Propagation

Propagation of sweet potatoes is effected by two methods. The first and most generally practised is that of growing from sections of the vine. Cuttings are selected from the mature middle section, about 12 inches in length, and planted in mounds or banks.

If extensive planting is to be made, it will usually be found that the supply of slips from the best varieties is insufficient, in which case recourse to the second method must be had. This consists of growing plants from the potato itself.

Method of growing plants from potatoes. Prepare a pit about 18 inches deep, sifting the earth and mixing it with rotted manure. Put in the entire potatoes, placing them about their own thickness under, and spacing them about 1 foot apart. Cover lightly with straw or grass. Water regularly, at least once a day.

Numerous shoots will be thrown out by the potatoes, which can then be lifted out with a light fork. The shoots are severed from the tubers and set out in the field immediately. The bunches of roots should then be cut away, and the remaining portion of the potatoes replaced in the pit for a further growth of plants. In this way sufficient plants will be obtained from 100 lbs. of potatoes to plant out one acre.

(ii) Preparation of the Land

Hill Method. If the hill or mound method is followed, the mounds should be spaced about 2 feet 6 inches apart, well dug, like a small yam hill, and supplied with wood ashes, decayed compost, or stable manure, with fertilizer added, being worked in at the bottom of the hill.

The Ridge or Bank Method, though less practised, is the better method, especially as it lends itself to soil conservation practice. The soil is prepared by fork or plough, thrown into shallow ridges 3 feet apart. The ridges are then levelled by hoe or rake, or by a 6-ft. length of 3 ins. by 3 ins. or 4 ins. by 4 ins. scantling drawn by mule or donkey walking between the rows.

If the soil is heavy and the rainfall high, the land should be drained.

(iii) Planting

Plants should be spaced about 30 inches apart, if the hill or mound method is followed, or 18 inches if the ridge or bank method, and 3 feet allowed between rows.

The most favourable time for planting is mid-April to June and October to mid-November, in order to get the benefit of the May and October rains.

If slips are being planted these should not be more than 18 inches long, set 2 to 3 inches down. Small plants cut from tubers should be set just deep enough to cover the bit of potato, and the earth pressed lightly all round and kept cool with a little light mulch.

(iv) Maintenance

Sweet potatoes are specially liable to damage from weeds when neglected. The weeds soon get the advantage, so attention should be paid to weeding until the vines are strong and cover the ground, when no more weeding will be necessary.

(v) Reaping

Under good cultivation sweet potatoes mature in five to nine months. They should be gathered as soon as ripe. If planted in ridges they are more easily taken out. The vines are thinned out (the vine is relished by pigs and cattle) and the potatoes are then lifted. The main crop will be found at the site of planting, but the vines have a habit of developing tubers a short distance from the parent root. The main vines should, therefore, be followed a little way for indication of a secondary crop. Some potatoes will still be overlooked, but pigs can then be turned in with profit to glean the remainder of the crop. Besides being a good food for man, the potato (chopped) makes fine feed for all livestock. Milk and butter returns show marked improvement when a ration of sweet potato is regularly fed to the cows.

(vi) Yield and Storage

The minimum return should be 3 lbs. from each plant, but much depends on the cultivation and type of soil. A well-manured and fertilized plot on not too heavy soil and kept free from weeds can yield as high as 8 to 10 lbs. per plant.

The preservation of potatoes depends on exclusion of air and light and perfect dryness. Also the crop should be well-matured and air-dried in the shade before storing. Cover with dry grass and keep off the rain. Better still, construct a shed with an earthen floor, covered 1 in. deep with fine earth or sand. Lay in the potatoes and cover about 3 ins. deep with fine dry earth or sand. Avoid all moisture.

(viii) Varieties

The most popular variety, both for eating and for good returns, is the Flog-All. Growers are recommended to establish this variety and produce their own slips and plants.

Another popular variety is the Red, which also eats well and bears well.

Other lesser-known varieties are Blue Bud and Mother Edwards. These are all of very similar appearance in the vine, and with regard to the tubers again, with the exception of the red with its characteristic colour, there is a disconcerting similarity in appearance. The grower must depend on the reliability of the source of supply for purity of breed.

IRISH POTATOES

(i) Economic Importance

In Jamaica Irish Potatoes have been grown for a number of years, and, as far as can be ascertained, the pioneers concentrated their efforts in those areas where latitude and climate resemble the conditions in temperate countries, but for some time past cultivators in other areas at a lower altitude have successfully grown crops.

The principal potato areas are in the Devon district of Manchester and the general run of high land in that parish, the heavier clay soils of Northern Clarendon, and the red and brown earth areas in St. Ann, particularly around the Bamboo district. Other areas include the higher lands of St. Elizabeth and St. Mary, the lower slopes of the Port Royal Mountains in St. Andrew, and the Guy's Hill district. It is estimated that the Manchester area produces 80 per cent of the local crop. In this area the main crop is planted between February and March, whilst in the early-crop areas the period November to January is more suitable. Local production is now in the region of 5,000 tons per annum and Government subsidises the price of imported seed potatoes to the grower. There is great variation in yields from area to area and between individual growers, but it is estimated that under reasonable weather conditions and with good cultural practices a yield of at least 8 : 1 or 12,000 lbs. per acre, should be obtained.

(ii) Propagation

The plants are developed from 'seed', which may be either sections of a large tuber or entire small ones. The best seed are the imported, and the use of the local product is not recommended. In former years most of the imported seed potatoes came from Canada, but at the present time they are obtained from Britain, Holland and Germany.

Our local regulations require that they must be certified as being free from pests and diseases by the government of the country from which they are imported. Seed potatoes may only be imported into Jamaica by the Jamaica Agricultural Society, the Government Marketing Department and the Irish Potato Growers' Co-operative.

The seed potatoes are shipped in crates or bags of 100 lbs. each and are usually ready for planting when they arrive in the Island. If it becomes necessary to hold the seeds for any time before planting they should be stored in dark, well-ventilated rooms.

The seeds should be spread out thinly in a cool place and covered with straw, away from light and the sun, and at the same time avoiding damp. The potatoes should not be planted till they have sprouted.

The sections, if a potato is being cut into bits, should not be too small, about two eyes should be left on each 'set', and the cut surfaces lightly dusted with ashes. The practice of cutting and planting 'bits' at the same time is not recommended. They should be cut in the cool of the afternoon and planted on the following day. The knife used for cutting should be frequently sterilized to prevent the carry over of disease from one infected tuber to another. Sterilization of the seed pieces by placing them in a sack and dipping this in a barrel of cold Formaldehyde (1 pint in 30 gallons water) is advisable. The seed pieces should then be taken from the sack and put to dry in the shade.

(iii) Preparation of the Land

The land should be well ploughed or forked, and harrowed or 'refined' to a good depth about four weeks before planting time, and then allowed to settle so that the soil is not in a too light condition. Drains should be made to prevent heavy rains from washing away the soil, and precautions taken to ensure that surplus rainwater does not settle in any part of the beds.

After the harrowed earth has settled, shallow trenches or drills are run in parallel lines, about 24 inches apart from centre to centre, and the earth mounded on either side.

On sloping land these drills should follow the contour. Generally it is better to have wider spacing between the furrows, and closer planting of the seeds along the furrows, as this facilitates moulding up and provides better protection for the tubers against the sun.

It has been found locally that the application of artificial fertilizers is essential if a good crop of potatoes is to be obtained. Fertilizers should be applied at the rate of 7 to 10 cwts. per acre, the selection of the best fertilizer mixture being determined chiefly by the type of soil. For instance, the Chudleigh Clay or 'brown bauxite' which covers a large area in Manchester, (e.g. areas in the vicinity of Devon and Grove Place) is chiefly deficient in potash and a 6 : 6 : 18 fertilizer mixture is recommended for this soil type.

St. Ann Clay Loam or 'red bauxite' is another very widespread soil in the potato growing districts and it responds well to additions of phosphate and potash. The brown shotty soil of the Darliston-Hopeton area in Westmoreland is also deficient in phosphate and potash. A 6 : 18 : 27 fertilizer mixture gives good results on both of these soils.

Potatoes are also grown abundantly on acid clay soils developed over Yellow Limestone Shales and volcanic tuffs. These soils, found mainly in the Guy's Hill and Christiana potato areas, are chiefly deficient in phosphorus and a 4 : 12 : 6 fertilizer mixture is the most suitable of the mixed fertilizers available in the Island. This mixture would also be suitable for potato growing on Carron Hall Clay which is an alkaline soil developed over Yellow Limestone.

Fertilizer application should be made at the time of planting, either by spreading the mixture in the bottom of the furrow and covering lightly with earth before putting in the seed, or by spreading the fertilizer along the face of the furrow, thereby allowing for it to be mixed in with earth when the furrows are being covered. The practice of a second application as a side dressing is not recommended.

(iv) Planting

As soon as the 'bits' or seed have well-sprouted, they are set out in the bottom of the drills, about 14 inches apart, and lightly covered with earth from the adjacent mounds. The 'sets' should not be planted so shallow that the sun will dry out the soil around them, neither should they be planted too deep so that they lie in cold, damp soil.

As soon as the 'sets' begin to grow the moulding should begin, further away from the plant, towards the row, and care should be taken not to injure the roots that have already been thrown out.

Seed Rate. About 100 to 150 lbs. of seed potatoes are planted to every square chain of land, dependent on the size of the 'bits' or tubers used. Large 'seeds' require cutting, but care should be taken that one good or two medium sprouts are on each bit.

(v) Maintenance

The space between the rows of plants should be kept deeply forked so as to encourage the development of the roots, but as soon as the plants begin to flower, moulding and all other forms of cultivation should cease.

Spraying with Bordeaux should be undertaken just before the first moulding. 4–4–40 Bordeaux has been found to give good control of blight, especially if a sticker in the form of a little Triton is added to the Bordeaux,

3–4 oz. to 100 gallons. In spraying, care should be taken to see that the spray reaches the underside of the leaves. Spraying should be once every seven days throughout.

The earth throughout the potato patch should be kept loose and free and not allowed to bake. A Dutch hoe or small hand-plough or a heavy rake will accomplish the work.

(vi) Harvesting

The tubers should be reaped by carefully digging them from the rows by forks. If the soil is in really good condition they can be pulled up by hand on the lighter land. Careless lifting with the fork will lead to damage and loss. Too much stress cannot be placed on careful handling of the crop at this stage. After exposure to the sun for an hour, the crop should be gathered up into boxes and taken to a shed. What is needed for home consumption should be kept in well-ventilated boxes in a cool, dry shed, away from light.

(vii) Storage

Tubers for storage should be fully mature and free from damage of any kind. They should be treated gently to avoid bruises and should be stored in a dark, well ventilated room. They should not be kept in bags but should be spread out on the ground to a depth of not more than two to three feet. Best results are obtained by storing the tubers in shallow crates or trays which may be stacked on top of each other provided the crates are not overfilled. *The upper crates in the stack should on no account be allowed to rest on the potatoes in the crates below.*

Varieties

The chief varieties now grown in Jamaica are:

Sebago, a very attractive table potato which is the first choice of the local housewife. The skin is clean and thin and the variety is very desirable for making 'chips'.

Arran Consul, this variety is very popular as it produces fairly high yields and is resistant to blight disease.

Alpha, a high yielding variety which is very resistant to blight.

Green Mountain, a good general purpose potato. Long cropper and heavy yielder.

Other varieties which will do well here are: **Voran, Ulster Torch, Maritta, Capella and Suzanna.**

YAMS

(i) Plants

Yams, as we eat them, are truly portions of underground stems known as tubers. The aerial portions of yam plants are climbing vines which have an annual habit, that is they die after each growing season, and in nature it is the function of the tubers to store up food and other materials to start the growth for the following season.

Under conditions of artificial culture portions of tubers only, instead of entire tubers, are used for propagating yams, as the greater part of each tuber is normally required for food. These portions are usually called 'sets' or 'heads', and are most commonly taken from that part of the tuber from which the aerial vine arises. In a number of varieties like St. Vincent and Renta, however, whole yams are sometimes cut up into 'bits' for planting, and in others which produce multiple tubers—more than one to each vine—like cush-cush and yampie, the smaller tubers are used whole.

Yam tubers are generally reaped whole at the time when the vines begin to yellow and die; 'heads' are cut off then and allowed to cure in readiness for planting. Some yams, like Negro and Yellow, may be dug before this stage, when the vines are still green and growing vigorously; care is taken to disturb the roots as little as possible, and the tubers are cut or 'slipped', leaving a very small head in place still attached to the vine in each case. This small head continues to grow, and 'swells' into a relatively large secondary tuber by the time the vine dies and final harvesting is done; the secondary tuber is frequently split up into a number of 'heads'.

Yam 'heads' and 'sets' are sprouted before they are planted. The sprouting is best done in a cool dark place, and an accepted method is to spread out the heads in a shaded location and cover them with trash. In two or three weeks the 'eyes' begin to grow and the heads are suitable for planting.

One other type of planting material for yams should be mentioned, although it is not widely used and is not of major importance. Reference is to the occurrence of 'yam seed' or small aerial tubers borne on the vines in the axils of the leaves. They grow readily when planted out, but produce vines of low vigour and yield small tubers.

(ii) Preparation of the Land

Yams require good soil and proper tillage. The old practice of cutting down woodland each year has been abandoned as the forests have vanished. Today proper methods of continuous farming are being forced on farmers by the hard fact of dwindling fertility.

Land in which yams are to be planted must, if worth while yields are

to be expected, be ploughed or forked, and be worked into hills lined on the contour, or into continuous banks of earth also run on the contour. At intervals depending on the factors of soil type, rainfall, and degree of slope, drainage must be provided. Well-rotted compost, or manure, and mulch should be used liberally, the former worked into the hills or banks below the depth of planting, and the latter spread over banks to conserve moisture, as well as to provide additional fertility by rotting. Fertilizers also should be used where soil analyses indicate soil needs.

(iii) Planting

As soon as the sprouts developing from 'eyes' of yam heads have attained a length of between three and nine inches the heads should be set out. The rule to be observed is simple, but must never be departed from. Put in the plants 'heads down and tails up' on a slant so that the young shoot strikes upward from the down-set 'eye', while the roots starting out from around the eye will without any feeling around strike out immediately into the earth. Even when putting in small yampie and Chinese yam plants, set them on a slant, heads down. The method ensures a strong quick anchorage and a robust vine.

Spacing. For the larger varieties, white, negro, mozella, yellow, renta, the plants should be spaced about 6 ft. apart. For the small, yampie, Chinese, St. Vincent, allow 4 ft. 6 ins.

Set in lightly. In setting the plants do not bury too deep down. The tops should be just on a level with the earth in hills or banks.

(iv) Maintenance

If due care has been observed in the preparation of the land, the selection of good plants and the correct setting in, yams will thereafter need very little attention.

Sticks. The first requirement will be the provision of good sticks, for yams are climbers. For preference, sticks that are not too smooth, and stout enough to serve for two or more seasons, should be selected. For the white, renta, negro and mozella varieties, the sticks should not be less than 12 feet long, 2 feet for planting in the earth and 10 feet for the vine. The other varieties can do with less. If the continuous mound system is used, the expenditure for sticks can be halved by placing a stick midway between two plants to serve for both.

Mulching. A not too heavy mulch is advisable, for conservation of moisture in dry weather (the yam cannot thrive without an adequate supply of moisture), but care must be used to prevent slugs taking refuge under the mulch, as young yam shoots are very susceptible to slug damage. The rotted mulch will also help towards providing manure for the next season.

Weeding should be continuous, to eliminate competition for moisture.

Pruning. In the early stages of growth, go through weekly and cut out all side growths from the vines. Continue until the vines are well established on the sticks and there are no more side shoots within reach.

Tying. In the early stages, especially when there are two vines to a stick, it may be necessary to lead the young vine to the stick and there to secure it with a soft quickly-rotting binder—banana bark, or wild slip, for example. In guiding the young vine up the stick remember that all varieties except yampies twine around from right to left. The yampie alone twines the other way, from left to right.

(v) Reaping and Storing

The yam is very delicate and rots quickly from bruised spots. In reaping, therefore, great care should be exercised to keep the tubers free from cuts and bruises.

With the exception of the white yam, the cassava (a negro yam variety), and the renta, yams do not keep well, and should be used shortly after being reaped. The white yam and the renta will, however, keep for months if 'cured' just after reaping.

Curing consists of rubbing into all cut surfaces a handful of sifted ash or lime and exposing to the sun for a day or two.

Yampies may be stored after reaping for one or two months by laying them on the ground in a shaded spot and lightly covering with trash or grass.

(vi) Varieties and their Characteristics

The White Yam is considered the best of the yam family, and is a heavy bearer when planted in the right soil and climate. It does not thrive in the plains, preferring the cooler altitudes. At elevations of 1,000 ft. and upwards, and where not exposed to high winds, it thrives. It should be planted in April and May, maturing in February and March.

There are three or four varieties of the white yam, but the finest is that known as the flour yam.

The Yellow Yam is very popular with planters and does well almost anywhere, preferring a sunny situation with a gentle slope. It does not keep well, and must be used within a few days of being dug. It improves considerably in yield when manured.

Heads begin to sprout for planting in March and April, but by reaping late, successive plantings of heads can be arranged until as late as August. The main crop begins in mid-October, in immediate succession to the negro and Lucea yam crop.

Negro Yam. The negro yam is liked by cultivators, as it produces a heavy yam and is sold easily in the markets. The yield of this yam varies

very much, on account of the methods adopted by the cultivators. A yield of 10 lbs. per hill is about the average yield got by most planters, but 20 to 25 lbs. per hill is fairly common. This yam does not lend itself to curing well.

A particular variety of the negro yam, called the cassava yam, is grown in the Guy's Hill area. It is a heavy bearer and, unlike the negro yam, it can be 'cured' and stored for some months. Curing improves its quality.

Negro and Lucea yams should be planted early in the year—January and February. They begin to ripen in August, and the season lasts until the yellow yam crop begins to come in, about the middle of October.

Lucea Yam. The Lucea yam, a soft, white, well-flavoured yam, is grown in the hills of Hanover and in the hills bordering Western Westmoreland. It is the yam most liked by purchasers in our markets, and it seldom retains its texture when planted anywhere else but in Hanover and the borders of Westmoreland.

Renta or Trinidad. The renta or Trinidad is a heavy bearer, and is grown and kept by the cultivators of Clarendon for family use. This yam is generally planted on the banks of trenches in ginger fields, those banks being raised for the purpose. Here the tuber grows and produces an abundant crop. This yam will grow on soils poorer than that which any other yam requires, and with less care. It may either be trained to climb on sticks or to run on the ground. It 'cures' well and keeps well like the white yam, and is very palatable when well-cured.

This yam tends to develop a hard or woody top portion if planted too early. For best results it should be planted in June and July. The growth of the heads can be retarded by storing in a dry place, and breaking off the sprouts from time to time as they start growing.

St. Vincent. The St. Vincent is a heavy bearer, but it must be used when freshly cut. This yam grows easily.

The St. Vincent need not be provided with sticks upon which to run. It will do very well fending for itself along banks, like the sweet potato.

Taw or Thaw. The taw or thaw resembles a cross between the negro and the yellow yam, both in tuber and in leaf. This yam is a heavy bearer, producing a large crop on lands that would produce a poor crop of yellow or negro yams. On account of its hardy nature, it will do well almost anywhere. It is planted like the negro yam or yellow yam and matures in the same time.

Mosella. The mosella is a most prolific bearer. It requires large mounds, rich soil, and a tall stick or tree to twine on. The mounds should be dug and left open to the sun for some days, as is the case with all yams, and then filled in with earth and manure mixed. This yam is mature when the vines dry down.

The planters in the hills of Clarendon often dig away the earth around the head, cut off that portion which they require for planting, allow the cut portion of the yam to be exposed to the sun for a few days, and then cover again with the earth.

The heads used for planting should weigh from 5 lbs. to 10 lbs. It is a very common occurrence for one hill of mosella to produce 1 cwt. of yams. This yam is a soft white, well-flavoured, good eating yam, but the texture varies in different districts.

The Yampie or Indian Yam. While belonging to the yam family, the yampie as if conscious of its table excellence chooses to differ in many characteristics from the remainder of the yam family. For instance, it bears in clusters three or four marketable tubers and half a dozen or more 'plants' around the parent vine.

There are three principal varieties—the white, red and purple, so named from the colouring of the inner tissue of the tuber.

The yampie needs a cool climate and a good rainfall. The parish of Portland lends itself admirably to these conditions.

Plants are set out in March and April and the crop comes in in December, lasting till February. It keeps well when kept in a cool dry spot, with a slight covering of leaves. In bulk this crop should keep well in cold storage.

The Chinese Yam. This is a variety of the white yam, with its own peculiar characteristics, thriving under similar conditions as the 'white', whose table qualities, if anything, it surpasses. It resembles the yampie in that the parent plant produces a cluster of tubers, two or three weighing two or three pounds and half a dozen or so smaller ones suitable for plants.

It keeps well if care is taken when lifting to avoid cuts and bruises. When being cooked it should be first parboiled and then steamed.

COCOES

The Coco (also known as Taro and Tannia) is a tuberous perennial with large handsome leaves grown in nearly all tropical countries.

The plant thrives best in moist, well-manured soil, preferring low-lying ground or shady glades in the mountains, although one variety (the 'Left-man' or 'Red Commander') does best on gravelly hillsides where the rainfall is good and the sun not too oppressive.

(i) Propagation

The Plants are obtained from the root-stalk or 'Head' after the tubers have been detached. The head is divided into numerous sections or 'bits'. Each 'bit' should have an 'eye' or bud knot, and should weigh about half-

a-pound. About 12 cwt. of 'heads' should suffice for an acre. The 'bits' are laid on the ~~ground in~~ a cool moist situation and lightly covered over. The plants will begin to sprout in two or three weeks. Otherwise the 'bits' may be planted direct into the mounds prepared for them.

(ii) Preparation of the Land

Preparation of Ground. A rich alluvial soil and shaded pockets of soil occurring in stony places are preferred. Good results, however, can be obtained on clay soils, provided the slope is sufficient to afford good drainage.

The holes in which the 'bits' are to be set should be properly cleared of roots and stones and should be about 12 inches deep. They should be left open to the sun for some days before being dug, and then filled with surface earth mixed with manure or fertilizer.

The spacing should be about 4 ft. by 3 ft. or 5 ft. by 4 ft. in very rich soil. On stony land the distances will vary according to the lie of the stone.

(iii) Maintenance

Apart from keeping them free from weeds, and an occasional pruning of dead leaves, the coco needs very little attention. As has been mentioned above, they will thrive better in a cool and shaded situation. A little manure stirred in around the root after a month or two of growth will be found beneficial.

(iv) Varieties

There are many varieties, but the most popular are:

(i) The red commander or left man.
(ii) The white commander or bourbon.
(iii) The sallie (similar to the commander, but soft).
(iv) The minty.
(v) The melanga.
(vi) The dasheen.

The Red Commander is a hard coco, and thrives best on sloping gravel or stony soil not too exposed to the sun. It is distinguished by its dark-green leaves and a reddish or purple edge running down the edges of the stalk.

The White Commander or Bourbon and The Sallie are like the red in appearance, but the cooked tubers are softer.

The Minty thrives in almost any location, but does best in cool, damp spots. It is often used as a cover crop in banana and coconut groves, and serves as shade for young cocoa and coffee plants. The leaves are smaller than those of the commander and are light green in colour.

The Melanga is a large, soft, white variety, excellent for the table and deserving of more extensive cultivation. It is exceedingly popular in Cuba. It is distinguished by having very large heavy-textured light green leaves, and the tubers have heavy thick 'necks', in contrast to the slender 'necks' of the commander, bourbon, or sallie.

The Dasheen is a comparatively recent importation from the East, where it is very largely grown. Its table qualities are excellent. Unlike the other varieties mentioned, it does not throw off tubers, but the large root-stem or 'head' is cooked. The leaves are distinguished from other varieties by having less pointed and more rounded leaves, with a purple tinge along the veins and in the centre.

Coco tubers vary in size. The average weight is five or six ounces, but well-cultivated specimens often weigh a pound. They are cooked and served in various ways, the smaller ones in soups, and the large soft varieties as a separate vegetable dish.

In addition to the tubers, the tender unfolded leaves of some varieties can be cooked like spinach or chopped and incorporated in a green soup.

CHAPTER 43

Vegetable Gardening

Where to Go

The following points should be considered when a spot is being chosen.

The garden should be as near as possible to the home dwelling and a water supply.

The site should be exposed to the early morning sun and, indeed, for as many of the daylight hours as possible; if shade must be accepted, it is best to locate the site in such a position that only the afternoon sun is hidden. No gardening should be attempted on a spot where tree roots come so near to the surface as to interfere with forking and hoeing. *It is better* that land at the site chosen should be level, or almost so; otherwise, if the land slopes steeply, it will be necessary to go to the trouble of terracing or contour stripping it.

How to Grow

When a site for a garden plot has been selected and seed purchased for planting, one of the first problems to consider is how to handle the various kinds and sizes of seeds. Large seeds will germinate and sprout in a fairly coarse soil, but small seeds require soil that is fine and well-prepared. The best type of soil for small seeds is a mixture of sandy soil and well-rotted organic matter, or very fine compost. About two parts of sandy soil and one part compost is a good mixture. Too much sand dries out too quickly and causes the soil to form a hard crust on top, which is bad for young germinating seeds. Too much compost may cause the young plants to die from a disease called 'damping off', a fungus disease which attacks young tomatoes, cabbages, cauliflower, egg plants and peppers in seed beds when the soil is badly drained. If no compost is available, the grower should at least use good, sweet, clean soil, not taken from a sour old rubbish hole. The soil and the compost should first be thoroughly sifted, so as to remove all small stones or other coarse material.

Seed boxes or trays should be used for small seeds, about 4 inches deep with bottoms of zinc in which nail holes are punched. Practically the whole box is filled with very fine sand mixed with fine soil and compost. When filling seed boxes, at least one inch of coarse material should be put in the bottom of the boxes to keep the openings free for drainage. On top of the 1-inch layer of coarse material, the fine soil and compost is mixed with sand, and the boxes filled to within half an inch of the top and carefully levelled off.

If planting is to be done at once, it is much more satisfactory to moisten the soil before filling the boxes. Moisten the whole pile of soil, stir it thoroughly, and add sufficient moisture so that when a handful of the soil is clasped it forms a ball in the hand which will crumble quickly when touched. Then fill the boxes as described above, and plant the seed.

All cabbage, lettuce, cauliflower, callaloo, garden egg and tomato seeds should be planted in this way. Other seeds may be planted directly into the garden beds.

Small seed should be planted in the following manner. First, select a bit of straight stick and shorten it until it will fit inside the width of the seed box; lay this straight stick across the box on top of the soil about two inches from one end of the box, and, using another shorter bit of stick with a sharpened edge, cut a furrow in the soil, using the first stick as a guide. When this is done, move the guide stick about two or three inches and cut another furrow. Repeat this until the desired number of furrows are opened. The seeds must not be planted too deeply. A fairly safe rule to follow is to cover the seeds with about two to three times their own thickness of soil. This will mean that a very small seed gets a very thin coating of soil. The depth of the furrow should vary according to the size of the seed being sown.

Open the seed packet and take out as many as it is intended should be planted; mix this quantity with about six times as much sand, so that a teaspoonful of seed will be mixed with six teaspoonfuls of sand; then take up some of the mixture and let it slip slowly between the fingers into the furrows already prepared. This method will ensure that seeds are not planted too closely. As soon as the required quantity of seeds from one packet has been sown, use the guide stick to push the little ridge of soil raised from each furrow back into each furrow, and finally, lay the guide stick on top of each covered furrow and press it down gently. The seed is now sown. Write on a label the name of the seed sown and the date, wedge the label in a stick, and place this stick against the last row planted. This will prevent any mistake being made between different varieties of the same type of vegetable.

The Growing Seeds. Once the seeds are in the soil their care begins. First, they should be watered, but the watering should be light. If too much water is given, 'damping off' may be increased, and also the seedlings are likely to 'run away', i.e. shoot up too rapidly in a day or so and then fall over because they are too weak. Water the seeds very lightly and put them in the shade, protected from drying winds; do not let the soil dry out, as this will kill the young shoots just as they emerge from the seed.

Just as the seeds appear above the ground, the work of toughening them, by putting them out in the sun, should commence. At first the weak sunlight of early morning and late afternoon is enough, but little by little the plants must be accustomed to the full sun in preparation for the time when they are set in the garden. This is done by lengthening the time of exposure to the sun, both morning and afternoon, until finally the little plants can stand the sunlight all day.

Continue to give just what water is needed to keep the seedlings growing slowly. Do not leave the boxes out in a rainstorm thinking to lessen the work. The results may be bad. Do not put the boxes out and forget them either by day or by night.

Transplanting the seed

While the young plants are developing, the grower must be preparing the place to which they will be taken and set. There comes a time in the growth of the seedlings when they must be set out, and if that time is allowed to pass by they never do as well as they would have done had they been moved at the right time. It is usually best to set out plants when a few inches high and when they have from three to five leaves. If the work of preparing the garden for the plants is left until the plants are ready to be set out, there is grave danger that either the work of preparation will be rushed and done badly, or that the plants will grow beyond the proper planting-out stage.

The garden site should be well worked and dressed with compost or well-rotted manure.

When possible, choose a cloudy day to do the transplanting. If this is not possible, then plan to do it after 4 o'clock, when the heat of the sun is less. This will give the newly-moved plants the cool night in which to begin their new life. At least one hour before trying to lift the plants, they should be given a thorough soaking with water to cause as much soil as possible to stick to the roots. It is best to carry the box to the garden; if this is not possible, make sure that the plants are well protected, and that the roots are not exposed to sun and wind while they are being transplanted.

With a trowel, or other similar tool, cut the soil around the plants, then put the tool underneath the plants and carefully lift them out. Separate the plants with the fingers as carefully as possible, leaving as much earth around each plant as possible. Carry the plants in a flat pan or box, and have them covered. Once in the garden, open a hole, making quite sure that it is both large enough and deep enough for the roots of the plant with the adhering earth. Carefully lift the plant, taking care not to dislodge the earth from the roots, set it in the prepared hole and do not turn the roots up. They must be down. Set the plant into the ground; the roots with the tips of the fingers, and not with a flat hand. Make the soil firm, to force out any air pockets, but do not make it solid, and do not press hard enough to break the roots.

Once the plants are set, water them. Do not put water in the holes before planting and then set the plant in mud, for this may do harm by causing a hard clot to form around the roots. Now arrange shade over the newly-set plants before you leave them. Twigs with green leaves from any shade tree will serve, and will usually last until the plant no longer requires shade. In the wet season no more watering should be necessary and the shade can be taken off in a day or two; but in the dry season, or when the rains are uncertain, more waterings may be necessary and the shade may have to stay on a bit longer.

Coarse or hardy seeds can be sown direct into the ground. Such seed include carrots, beets, corn, peas and beans, pumpkin, squash, cucumber, onions, radish, and okra. The main problem to be met in connection with these types of seeds is that of controlling ants, especially in respect of onions, radish, lettuce, beet and carrot seed. These seeds should be planted in properly prepared beds, with furrows made in a straight line. To control ants the soil should be dusted with Agrocide.

What is Rotation of Crops? The farmer divides his land into equal parts, perhaps three or four, perhaps seven or eight, according to the crops he wants to grow. For example, suppose the ground or the farm is divided into three fields, *A*, *B* and *C*, and the crops are to be cabbage, corn and beans. The planting is done according to the following plan:

	Field A	*Field B*	*Field C*
1st year	Cabbage	Corn	Beans
2nd year	Corn	Beans	Cabbage
3rd year	Beans	Cabbage	Corn

Each crop is grown every year, but in a different field.

Here is another rotation table:

	Field A	*Field B*	*Field C*	*Field D*
1st year	Tomatoes	String Beans	Cabbage	Carrots
2nd year	String Beans	Cabbage	Carrots	Tomatoes
3rd year	Cabbage	Carrots	Tomatoes	String Beans
4th year	Carrots	Tomatoes	String Beans	Cabbage

In any rotation plan, one crop should always consist of a member of the pea and bean family, because these crops have the power of taking nitrogen from the air and storing it in their own systems for their own use and that of the following crops. Some plans for rotation are better than others, so ask your Agricultural Officer before you make out the plan for your own garden or farm.

How Rotation helps the Soil. Some plants have long roots, some short roots. When these succeed each other, different layers of the soil are brought into use, instead of the same layer being used constantly by one crop.

Certain insects and diseases are injurious to certain crops; if crops are changed regularly, then pests and diseases are checked. For example, blight of Irish potatoes does not affect corn or red beans, and if one of these crops succeed Irish potatoes in a field, there is a good chance that the disease will die out before the rotation programme brings Irish potatoes back to the same field; on the other hand, if Irish potatoes should be planted in the same field in the same year that a crop of Irish potatoes was harvested, then it is very likely that blight will appear very early in the growth of the crop.

Rotation of crops helps to check erosion of the soil; also, weeds do not grow so rapidly when crops are rotated; finally, each type of crop varies in its food requirements, and rotation brings about a better balance in the various plant-food elements in the soil.

Preparation of Garden Beds

Before the planting of seeds, tubers, bulbs or cuttings direct into the garden bed is dealt with, something must be said about garden beds.

The garden bed at its best should provide the same conditions as a seed box, namely, loose crumbly soil, rich in plant food, with plenty of air spaces, and ability to hold moisture without becoming water-logged; it should not cake on the surface. Heaps of rubbish, dried grass and weeds must be removed from the area cleared for planting; they must not be burnt on the site of the garden. Such materials are best disposed of in compost heaps.

Nearby rubbish, brush and weed growth must be removed so as not to offer shelter for mice, slugs, crickets, millipedes and other garden pests.

The destruction of pests, however, must not include frogs, toads, lizards and birds, for they eat harmful insects.

Dig a trench at one end of the garden the depth and width of the spade, carrying the soil removed from the trench to the far end of the bed; then dig steadily along the bed, filling the first trench and making another as you proceed row by row. Add manure to each trench as you go along; fill the last trench with the soil that you took from the first. Leave the finished bed with a good fine tilth, level and with tidy edges. It should then be ready for planting. Rows of plants should run east and west rather than north and south, otherwise tall plants will shade short ones.

Growing of Large-seeded Crops

Seeds. Large seeds such as corn, beans, peas, okras, etc., should be planted about an inch deep; it is usual to sow seeds of this nature several together at a distance at which they will remain throughout life. Mistakes commonly made are—spacing of the holes too closely or too far, and the planting of too many seeds in each hole.

It is difficult to overcome close spacing once the seeds are growing, so be careful to get them at the proper distance when the seeds are being planted. The crowding of seedlings in the holes can be dealt with by thinning to one or two in the hole.

Seeds such as beetroot, carrots and radishes are best sown in drills of good soil. Keep the soil wet and covered until the seeds germinate; before planting these seeds, soak them in a cup of water for twelve hours, and the period between sowing and sprouting will be reduced by several days.

Bulb crops such as shallots, onions and escallions should be planted so that one half of the bulb is exposed above the ground and the other half is covered with soil.

Artichokes and yam heads should be buried to about their own depth in the soil, yams being planted in hills. Sweet potato slips should be planted in hills or banks, each slip having at least five buds; three buds should be covered by the soil, leaving at least two above the ground to form shoots.

The next Stage of Plants in Garden Beds. The next step is to take measures to make the plants grow as quickly as possible. Cultivate the soil so as to loosen it when it becomes hard, without penetrating so deep as to disturb roots; keep weeds under control, for they rob the crops of both food and water; apply as much manure as is possible to the crops, both before and after planting, and if manure is not available, make a compost heap to make use of all weeds and crop refuse. The use of artificial fertilizers when manure is scarce or too expensive will be found to be profitable; fertilizers must be used with great care, and it is best to ask the advice of the Agricultural Officer.

It is realised that it is not always easy to get water for a garden; water is needed certainly for seedling boxes, and for a few days after transplanting for most seedling crops; the amount required for these purposes is small, however, and could be found from clean waste water from the house. Where there is a water shortage, more care has to be taken in the selection of crops to be grown, choosing those which need little or no water. It should always be remembered that the more manure and compost that is worked into the soil, the less watering will be required, for decayed vegetable matter increases the water-holding capacity of the soil enormously. The use of mulches during dry periods will also greatly reduce the evaporation of moisture from the soil surface. Mulch eventually rots down and adds more organic matter to the soil.

General Recommendations

Classification. Vegetables may be divided, roughly, into four groups as follows:

(1) Roots or tubers, including turnips, carrots, beets, radishes, onions, escallions, etc., parsnips and Irish potatoes.

(2) Green leaves and flowers, including cabbages, cauliflowers, spinach, celery, lettuce, broccoli and rhubarb.

(3) Fruit and pods, including peas and beans, pumpkins and melons, tomatoes, peppers and garden eggs, and cucumbers, okras and chow-chows.

Manures and Fertilizers. As a guide to the use of manures and fertilizers, it should be remembered that every vegetable requires nitrogen for the development of green leaf and shoot growth, phosphate for root and seed development, and potash for fruit and tuber growth, as well as lime and many other lesser-known elements; this means that all crops require at least a certain amount of each of the food elements in the soil, and that the different crops require different amounts of the various elements. For example, the carrot produces a large underground root, very fleshy; this plant requires much more potash than does the lettuce plant, which on the other hand requires more nitrogen for its leaf growth than does the carrot.

Compost and manure both supply all the necessary food elements to garden vegetables, and if sufficient quantities of compost or manure can be obtained, it will not be necessary to buy artificial fertilizers, save in certain exceptional cases. In general, if horse or cow manure is to be used without composting, then one pound should be applied to every square foot of the garden surface before the soil is forked for planting; if rabbit or poultry manure is being used without composting, then one pound should be applied to every 10 square feet of the garden surface before forking.

It is much more practical to use animal manures in the manufacture of composts; cow and horse manure composts should be applied at the rate of two pounds to every square foot of garden surface; poultry, sheep, goat rabbit composts should be applied at the rate of one pound to every five square feet of garden surface.

It should be specially borne in mind that when green leaves or grass are cut for making mulch or for the manufacture of compost they should be placed in position right away; as soon as green leaves or grass have quailed, rain or heavy dew will have the power to penetrate right through them, and carry away into the ground much of the fertilizing elements they contain; these elements will be lost unless the green material is placed immediately on the compost heap or on the spot which is to be mulched.

It should also be specially remembered that it is both a waste of time and of money to apply phosphate fertilizer to the red soils of Jamaica, i.e. the red dirt soil of Manchester, St. Elizabeth, St. Ann and Clarendon. When phosphate is applied to red soil, it is changed into a form which plants cannot use; it is therefore very important that phosphate fertilizer for use on red soils should be first mixed with compost heaps, at the rate of fifteen pounds of phosphate to every ton of compost. The compost mixture will absorb the fertilizer in such a way that it will be available to plants.

It is safe to say that nearly every vegetable garden in Jamaica would be benefited by the use of lime. Lime corrects any acidity which exists in the soil, and a great deal of this does exist in Jamaica; lime also improves the physical structure of soil, especially heavy clay soil, and makes it very much easier to work; again, lime improves the conditions in the soil necessary for the proper activity of soil bacteria which are so important for plant growth; finally, lime is needed by the plant itself, for use in building plant structures. Lime should be applied to the garden soil either in the form of burnt lime at the rate of one pound to every 20 square feet of soil surface, or in the shape of fine marl at the rate of one pound to every 10 square feet of soil surface. Lime may also be used in gardening by mixing it with compost at the rate of 50 pounds of burnt lime to every ton of compost, or 100 pounds of fine marl to every ton of compost. Lime should not be mixed with the compost when it is being made into a heap for the first time; it should be added when the compost heap is being turned for the second or third time; otherwise, when the manure used is still fresh, lime will cause nitrogen to be lost from the manure.

In the following sections, the principal vegetables in the three main groups will be discussed individually.

ROOTS AND TUBERS

Beets

Seeds. Beet seeds generally remain good for two or three years if they are not kept in a place that is too hot or damp. To find out if the seeds are still good, count fifty seeds from a packet and place them between two sheets of wet blotting paper; put the paper in a dark place and keep it damp until the seeds germinate, when the number of young plants may be counted; if few of the seeds have germinated, it will mean that many of the seeds must be planted in a garden row in order to get a good stand of plants. The better the germination of the seed in the blotting paper, the more thinly may the seed be sown in the garden.

Before planting out, soak the seed for at least twelve hours in a cup of water; then plant immediately.

Soil. Beets are very sensitive to acid conditions in the soil, and it is almost certain that it will pay a beet grower to mix lime with compost and dig it into the soil before beets are planted. Beets also need potash, and on the lighter coloured red soils of Manchester, i.e. north of Williamsfield, it is practically certain that applications of potash will be profitable. Potash should be applied at thinning-out time at the rate of one ounce to every eight feet of surface occupied by beet plants; it must not be placed

closer than two inches from beet plants, or burning of the roots will be caused.

When potash is not obtainable, it is possible to apply a very weak solution of ordinary coarse salt as a fertilizer. One tablespoonful of coarse salt, dissolved in a two-gallon watering can of water and watered into the soil as far as the solution will last, will help. This application of salt may be repeated three or four times during the life of the beet plants. Caution is necessary, for this salt solution should never be applied to beets when they are growing in heavy, sticky clay land; salt will make clay even more sticky and greasy.

Planting. Each seed, if good, will produce two or even three plants; thinning will be necessary when seed are good. In this case, plant seed four inches apart along the rows, with rows twenty inches apart; when the young plants have produced three leaves each, thin out to one plant in each hole, and transplant the excess number taken out. Beets should be kept moulded.

Carrots

Seeds. Carrot seed should be given the same germination test as for beets, if their vitality is thought to be poor.

Much time will be saved if carrot seeds are soaked for at least twelve hours in water before they are planted out. In order to reduce the tedious labour of planting these small, wet seed very thinly—at least two inches apart—the wet seed should be mixed with dry sand or very fine dry earth at the rate of one teaspoonful of seed to six teaspoonfuls of sand or earth; the mixture of seed and sand should then be planted all together, and it will be found that the seed have been so well spaced that little thinning will be needed.

Soil. Carrots will thrive on most soil types, and on soil which is too poor for many other vegetables. Carrots are not sensitive to acid conditions, though they will respond to the application of manures and fertilizers. Carrots also do well under comparatively dry conditions, provided the soil is well stirred and manured.

If the soil should be heavy, and likely to dry out and crust on the surface, it will be necessary to keep the soil surface moist or broken up after seeds are planted and until the seedlings have appeared above the surface.

It is natural for this crop to grow straight and deep into the soil; if the ground is very stony, or contains lumps of hard earth or unrotted manure, carrots are likely to be stunted and deformed; it is therefore best to plant this crop in loose, deep soil, and only well-rotted manure or compost should be applied. When seedlings are transplanted after thinning, it is likely that the mature plants from these seedlings will be deformed as a result of the disturbance of the root system during thinning and transplanting, unless very great care is used.

Planting. Plant as above along rows twenty inches apart; when the seeds have germinated, if necessary thin out to two or three inches apart, and transplant the surplus seedlings. Carrots should be kept well moulded so that the tops of the roots will not be exposed to sunlight and turn green.

Onions

The onion is one of the oldest vegetables known to man and is a native of Western Asia. The onion is very high in food value, and will grow anywhere where the soil is fertile and well-drained.

Seeds. Seeds should be sown in boxes or in prepared nursery beds.

In either boxes or beds the soil should be more sandy than otherwise, and a great deal of well-rotted manure or compost should be worked into it. Onions are sensitive to acid conditions, and will not grow in heavy, sticky soil.

Seed should be sown very thinly, about two inches apart in shallow furrows, and the soil should be firmed down after planting. The seed should germinate in a week, and six weeks later the young seedlings should be ready for transplanting.

Transplanting. In order to make transplanting easy, water the nursery beds or boxes the evening before thoroughly, so that each seedling will leave the soil easily without breaking roots. Transplant the seedlings into well-prepared beds to which a great deal of manure and compost have been added. Planting distances should be four inches in the row and nine inches between the rows. Water after transplanting, and unless the weather should be rainy, water every day in the evening for at least a week, so that plants will not receive a setback and become stunted.

Onions cannot stand competition from weeds, so that weed growth must be controlled; when conditions become very dry, onion beds should be mulched so as to keep moisture in the soil.

After about three and a half months, onion seed stalks or 'poles' will appear. These should be cut off as soon as they appear, or they will rob food from the onion bulb.

Reaping. When the leaves of the crop begin to droop, after turning yellow, and the outer skin of the bulbs appears dry, the crop is ready for harvest. This should occur at 4½ or 5 months after transplanting. The harvesting period should arrive during dry weather, so that onions should be planted in October and November so as to be reaped in February and March (or to suit local climatic conditions).

Mature plants should be pulled out of the ground, and roots and leaves should then be cut off; the outer, papery skin should be rubbed off, and

the bulbs should then be placed in the shade to dry. They should be kept in as cool and as dry a place as possible.

Shallots

Planting Materials. Bulbs of the best quality from the crop reaped must be kept for planting. These may be got from growers during the months of March and April from the lowlands, and in August from the uplands. It takes about 4–6 lbs. of the bulbs to plant one square chain of land according to the size of the bulbs. When the bulbs germinate they should give enough seedlings to extend the area another square.

Soil. Shallots do best on a light soil, and seem to produce well in soil which contains some amount of gravel, providing there is a fair depth of soil. If shallots are to do well on heavy soil great care should be taken to have the soil well drained.

Time of Planting. In the uplands, February to April; in the lowlands, October to November.

Preparation of Soil. Three months before the planting season the soil should be forked and mulched. At the time of planting, the soil is refined and drills cut along the contour of the land.

Manuring. Shallots respond readily to manuring, but care must be taken not to give too much nitrogen, which will result in a lot of leaves and few, small bulbs. Potash gives splendid results. Stable manure should be applied well in advance so as to get the best results.

An application of 4 : 8 : 16 has given very good results on St. Ann soils. This fertilizer was added at the rate of one teaspoonful to each plant just before moulding the plants.

Distances. Drills are laid down 2 feet apart; and bulbs are planted 1 foot apart along the drills.

After Cultivation. (*a*) *Weeding.* It is necessary to weed the plants twice at least before reaping. The first weeding will be necessary about four to six weeks after planting, and the other about six weeks after.

(*b*) *Moulding.* Shallots are to be moulded to a depth of about four inches. This should be done just as the seedlings are showing signs of making bulbs. This very often coincides with the second moulding.

(*c*) *Mulching.* It is good practice on red soils, after the seedlings have been thinned out, to have the plot mulched with grass or other light mulch.

Harvesting. Reaping takes place when the leaves have all dried down. Very often the plants bear two layers of bulbs. In this case the upper layer dries down before the lower, and so can be reaped. When these are removed the lower bulbs should be earthed in again.

Radishes

The culture of this vegetable has come down to us from a remote period in history; it is thought to have originated in China, and in Roman times was well known.

The radish is one of the easiest of all vegetables to grow, as it will thrive in almost any soil that is not too heavy and wet, provided a moderate amount of fertility is present.

Seed. Seed should be planted half an inch deep, about three inches apart in the row; rows should be about six inches apart. Each row should be in the form of a shallow furrow, so that when the radish roots commence to swell, it will be possible to mould them properly and keep them covered with soil.

Planting. This crop requires only three to four weeks from planting to harvesting, so that it may be used as a quick rotation between two such crops as lettuce reaped in June or December and corn planted in August or February. Soil should be well forked before planting, and if possible manure should be worked into the soil. Radishes require phosphate fertilizer for maximum development, so that manure or compost in which phosphate has been previously mixed is recommended.

Turnips

This crop is related to the radish, cabbage, cauliflower, and broccoli, and no one of these species should be planted in the same bed from which another has just been reaped, for fear of insect pests and diseases. Rotation is very important among these crops, and entirely different crops such as corn, peas and beans, lettuce, beets, or carrots should be planted in a bed from which one of them has been reaped.

Seed. Turnip seed will usually last for four years, if they are kept in a cool, dry place; if seed are thought to be poor, they should be given a germination test between sheets of wet blotting paper.

Planting. Shallow furrows should be cut in well-prepared soil, about two inches deep; if seed have been proved to be good, then they should be dropped carefully in the furrows, about four inches apart; furrows or rows should be eighteen inches apart; after seed have been planted, they should be covered half an inch deep. When plants have commenced to grow, they should be moulded so as to keep the roots covered with soil.

The main weakness found in turnips is that of sensitivity to dry weather—turnips cannot stand drought; if the weather is not suitable, then the plants must be watered, or the crop will be a failure. Like radishes, turnips need phosphate, and it will be profitable to make use of manure or compost in which phosphate has been mixed previously. Unlike radishes, however, turnips are not likely to thrive on just any kind of soil; they

require good, deep, fertile soil, so that it is necessary to prepare beds properly and to make good use of manure or compost.

Common varieties of turnips will require from two to three months from planting to reaping.

GREEN LEAVES AND FLOWERING HEADS

Cabbages

The cabbage crop has been cultivated from the earliest times, and can be traced back to a wild cabbage which originated on the coast of England or on the continental sea coast on the opposite side of the English Channel.

This crop will flourish on a wide variety of soils, but prefers a deep, fertile loam well supplied with lime for maximum development. The cabbage plant feeds very heavily on lime.

Seed. Cabbage seed should be planted in seed boxes preferably, or in nursery beds; if at all possible, the soil in box or bed should consist largely of compost and sand, with an eighth of an inch of almost pure sand on the surface. Heavy, sticky lumpy soil should never be used. Sowing should take place in shallow furrows, and seed should be scattered thinly so as to leave spaces of an inch or more between each seedling, for ease in transplanting. When seedlings grow closely together, roots are broken and soil displaced from the remaining roots at transplanting time; this must be avoided, else the seedlings will be set back. When seedlings grow an inch or more apart in bed or box, it is possible to remove each one with no root damage and with soil still adhering to the roots.

Cabbage seedlings should be transplanted when the first three true leaves are well-developed.

Planting. Cabbages will not grow in poor soil, so that it is necessary to apply manure and compost to the soil where they are to be planted. Lime is also necessary in most cases.

Spacing distances should range from eighteen inches apart for the small Early Jersey varieties to twenty-four inches apart for the large Drum Head variety. It pays not to crowd the plants of this crop, for cabbages are very heavy feeders, and when roots are crowded, yield suffers.

When the crop has become well established, just before heading begins, the crop should be moulded, and if at this time the leaves of the plants appear to be pale green in colour and smaller than is normal, nitrate fertilizer should be applied at the rate of a teaspoonful scattered around the stem of each plant.

Varieties. Early Jersey Wakefield and Charleston Wakefield are the commonest quick-growing varieties. All Head Early is a slower variety; Drum Head, Flat Dutch and Copenhagen Market are later varieties which produce large heads.

Cauliflowers

In respect of the culture of this crop, everything said of the cabbage crop holds true here, with the reservation that the cauliflower cannot stand any setback at all. If cauliflower seedlings are transplanted with broken roots and no soil attached to them, they are very unlikely to produce good profitable heads; it is therefore necessary to space the seed of this crop widely, so that each seedling may be lifted for transplanting very carefully, with a lot of soil adhering to the roots. For the first few days after planting they must be watered unless the weather happens to be rainy.

Lettuces

Lettuce is a very easy crop to grow, and its main requisites are moisture and nitrogen; it will succeed on a wide variety of soils.

Seed. Lettuce should be planted in a seed box or in a very carefully-prepared nursery bed; as much manure as possible should be used. Seed should be sown in very shallow furrows, as thinly as it is possible to drop the seed; they should be covered not more than an eighth of an inch and be watered frequently.

Planting. Lettuce seed should be transplanted twice, first, from the seed bed or box to a larger nursery, and later to a larger bed. At the first transplantation, they should be planted two or three inches apart when at least two true leaves have developed; the second transplantation should take place when six true leaves have formed, and care should be taken that as much soil as possible is removed with the roots of each individual plant, to prevent a setback. The young plants may now be planted fifteen inches apart, in well-forked soil. Before planting out, it will be profitable to spread the bed with finely-divided mulch, compost or manure, so that the bed will remain moist. Beds should be lightly shaded with bamboo slats on posts.

The lettuce plant uses a great deal of nitrogen, and it will be profitable to sprinkle this crop with nitrate or any nitrogen fertilizer dissolved in water, at the rate of two tablespoonfuls of fertilizer to two gallons of water.

Celery

Celery is a comparative newcomer in the field of vegetables, and its known history is told in hundreds rather than thousands of years. It is a difficult and exacting crop to grow, but properly-grown celery is so good that it repays all care spent on it. At feasts and big dinners all over the world celery usually plays an important part.

Seed. It is very important to soak celery seed in water for at least twelve hours before planting, otherwise germination will be delayed for at least two weeks, and probably longer. After soaking the seed may be mixed with dry sand for ease in handling at sowing time.

Planting. The most practical method of planting celery seed is as follows: After soaking the seed and mixing with dry sand, scatter broadcast over a seed box or bed that has been very carefully prepared with plenty of manure. After scattering the seed, dust or shake over the surface of the bed or box sufficient very fine compost or earth to cover the seed an eighth of an inch deep. Then spread a thin cover of dried grass over the surface of the soil, and water. Water frequently so as to keep the soil moist, and do not remove the dried grass until germination takes place.

Seedlings should be ready for transplanting six weeks later, when they are about four inches tall; select only stout, healthy plants—discard tall and spindly seedlings.

Transplanting should take place in trenches specially prepared. A trench should be a foot to fifteen inches wide, and six inches deep, and should be cut in a bed that has already been forked and manured. Manuring should be as heavy as possible.

Seedlings should be set out in a trench in staggered rows, six to eight inches apart, i.e. at one end of a trench plant a seedling three or four inches from one side of the trench; then plant another on the other side of the trench, three or four inches from the side and about six inches ahead of the first seedling along the length of the trench.

Celery requires lime and artificial fertilizers, for it is a very gross feeder. Applications of lime should be made. Applications of fertilizer should be made with a complete mixture, for example, a 4–8–10 mixture at the rate of half an ounce to each plant twice during its lifetime; the first application may be made as soon as the transplanted seedlings have commenced to grow rapidly, and the second a month later.

Above all else, celery requires to be kept moist all the time.

Celery stalks will remain green, and somewhat tough, unless they are bleached, or blanched. Bleaching brings out the flavour of celery, and makes it very much more tender. The simplest method of bleaching is that of moulding up the plants with earth until the stalks are covered all the way up to the leaves at the top. This should take place when the stalks measure about an inch across at the base, where they leave the roots. Bleaching will be accomplished by this method in about two weeks. Often, however, slugs and other ground-infesting pests will cause much damage to moulded celery, in which case it is better to bleach with boards, two of which are placed on each bank of a trench and leant inwards to rest against the stalks just where leaves appear, or to confine each celery plant within the two halves of a split bamboo joint, the bamboo reaching from the ground to the leaves, but not covering the leaves.

FRUIT AND PODS

String Beans

Beans are one of the few modern vegetable crops which originated in the Western hemisphere—the Americas; they were unknown in the rest of the world until after Columbus discovered America.

String beans may be grown from a number of varieties of beans, including those known as Miss Kelly, Round Red, Portland Red. The imported pole variety, 'Old Homestead', is also an excellent variety.

Land should be well forked for this crop, and it will be profitable to apply manure or compost to the soil; rabbit manure is specially good for string beans.

Seed should be selected before planting, so that the very small seed, and those partially eaten by weevils, may be discarded. They should be planted at the rate of two in a hole, an inch and a half deep, with the holes six inches apart. Rows should be at least twenty-four inches apart.

When the bushes are well-grown, but before they commence to flower, the ground should be weeded and the bushes should be moulded up; weeding and moulding after flowering has commenced often cause the dropping of flowers.

String beans should be reaped when they are fully grown, but when they are still in a condition to 'snap' or break cleanly in the fingers; when they have become tough and unable to break without crushing, they are no longer in prime condition as string beans, and should be kept as a seed crop.

English Peas (Green Peas)

Peas are among the oldest of all vegetable crops. There are two types of this crop—tall and dwarf, though the culture of both is similar.

Planting. Moisture, good-growing conditions and elevation are the limiting factors in pea cultivation; the crop will stand neither drought nor excessively wet weather; it requires a moderately fertile soil, and the use of manure will usually be repaid by greater yield. It is not recommended to try growing this crop at elevations under 2,000 ft. above sea level.

Land should be forked well before planting; shallow furrows should be cut three feet apart; seed may be planted at the rate of six to nine seeds to every foot of row, or about an inch apart.

As soon as germination has taken place, the crop should be staked; later staking will cause root disturbance and damage. Staking is simple; all that is necessary is for each plant to be provided with some sort of a stake or pole upon which to climb; dwarf varieties will be satisfied with two-foot stakes; tall varieties will require four-foot stakes. Tying will not be necessary, as this plant is equipped with its own tendrils.

Tomatoes

It is generally accepted that the tomato plant originated in South America, for it was found growing there when Spanish ships visited the coast, soon after Columbus discovered America. However, there is on record a minute description of the tomato crop given by a Greek physician fully 1,300 years before the time of Columbus; the Greek described the fruit of the tomato vine as we know it today, and stated that it had been brought from Egypt.

It is easy to grow tomatoes with moderate success; in order to obtain maximum yields, however, which are at least double the average yields, it is necessary to devote more attention to the crop. For maximum development, the crop requires well-drained soil, careful handling of seedlings, plenty of moisture, and fertilizers.

Seed. Tomato seed will usually last a long time in storage, provided that it is not too hot or too wet; if seed are suspected of being poor, the sensible thing to do is to discard them and purchase a new supply. Seed should be sown in a seed box or a nursery bed, the soil in either of which should be sandy rather than clayey; compost rather than manure, unless it is very well-rotted, should be mixed thoroughly with the soil in bed or box; in case of a nursery bed on the ground, it should be raised at least six inches above the surrounding soil surface, to promote drainage. Seed should be sown in shallow furrows, spaced at least an inch apart so that roots will not be torn at transplanting time; seed should be covered a quarter of an inch deep, and then an eighth of an inch of sand should be dusted over the surface of the bed or box, so as to ensure surface drainage.

Planting. Before transplanting takes place in the field, rows should have been marked out, and holes should have been dug; a hole for a tomato plant should be dug several days before transplanting, and should be four inches deep, four inches wide and four inches long; if the season is dry and no irrigation is available, the planting site should be mulched thickly, leaving only the holes exposed.

Transplanting should take place when seedlings are eight to ten inches tall, so that roots may be set into the ground four inches deep; deep planting in dry soils has an important effect on the success of the crop, in that it helps to prevent blossom-end rot of fruit. Planting holes should be three feet apart each way; watering should take place after plants have been transplanted, when a thorough soaking should be given. If possible transplanting should take place on a shady day, or in the cool of the late afternoon. Unless the weather should be wet at the time of transplanting and for several days thereafter, young plants should be watered twice daily, particularly in the late afternoon.

Tomatoes are heavy feeders, and in addition to manure and compost worked into the ground, artificial fertilizers will pay for their application by increased yields of fruit. Nitrogen, phosphate and potash are needed, but at different stages; also the red soils of Jamaica render phosphate fertilizers unavailable to plants when applied directly to the soil; therefore, a complete fertilizer mixture should not be applied to tomatoes.

On red soils phosphate should be incorporated in compost and not applied direct to the soil; on other soil types, phosphate should be applied in the form of superphosphate at the rate of an ounce per plant, mixed in with the soil of the hole into which young plants will be transplanted; this should take place at least a week before transplanting, as phosphate is not immediately available to plants.

Potash should be applied at transplanting at the rate of half an ounce per plant, thoroughly mixed with the soil in and around the transplanting hole; at the time that the first tomato fruits are halfway mature, a second half ounce of potash should be applied and moulded into the soil around the plant.

Nitrogen, either nitrate of soda or ammonium sulphate, should be applied at the same time and at the same rate as potash.

Lime is not an essential for tomatoes, and unless the soil is extremely acid, it is not necessary to apply lime save for a general soil-improving purpose.

The tomato crop should be staked on the same day as transplanting takes place, in order to avoid disturbance of roots when growth has started; stakes should be firmly driven into the soil.

The tomato crop should be moulded at least twice, and possibly four times after transplanting, in order to promote root growth from the section of stem moulded each time; the first moulding should take place at the time the first truss appears on a plant.

Tying of plants to stakes should commence as soon as plants have grown tall enough to bend over; using dried banana bark, raffia or any other suitable material, each vine should be tied around the stem, then the remainder of the string should be tied around the stake; it is a mistake to tie the stem to the stake in one operation; tying should be so accomplished as to give the fruit room for development without contacting either string or stake; contact of the fruit with stake or string causes bruising.

Plants should be kept free from side shoots or 'suckers' by cutting with a sharp knife; snapping the suckers by hand often causes tearing of the bark, which affects the flow of sap.

If tomato plants are to be watered or irrigated, it must be specially remembered that such watering or irrigation must be regular. Irregular or interrupted watering will almost certainly cause blossom-end rot. Always water or irrigate at the same time of day, and at set intervals; do not skip a watering period. It is better to give plants a thorough soaking twice or three times a week than to give a little water every day.

Garden-Eggs

The Garden Egg or Egg Plant is a native of South America, and was unknown to the rest of the world until Columbus discovered America. Like the tomato, the egg plant is related to the tobacco, Irish potato and pepper; all of these crops should be planted separately, and should never follow one another on a plot of land in a garden.

Seed. All the recommendations given for tomatoes should be followed for the garden egg crop.

Planting. Similarly, recommendations given for tomatoes apply for this crop also, save that spacing should be four feet each way.

Sweet Peppers

This crop is also a native of the Western hemisphere. General recommendations for its culture are much the same as for the tomato and the garden egg, save that spacing may be reduced to thirty inches apart.

Cucumbers

The cucumber is one of the oldest of all vegetables in use; it was known and cultivated long before the ancient Greek and Egyptian civilizations arose; it is supposed to have originated in the East Indies.

The cucumber does not thrive on a wide variety of soils; it will not stand acidity, and it requires soil that is open, loose and porous. It is a gross feeder, requiring a great deal of manure or compost, and artificial fertilizers as well, to produce maximum yield. Ample moisture is very important to this crop.

Seed. When planting out, three times as many seed as are required should be sown, and after the young plants have commenced to grow, the two poorest should be pulled out.

Planting. This crop may be planted in rows or in hills; in the former case trenches should be dug six to eight inches deep and filled halfway up with well-rotted manure before filling in completely with soil; after filling in the trench, heap up more soil to raise a ridge four inches above the surface. Plant single seed at four-feet intervals, and after germination has taken place thin out to one foot apart. The most suitable type of staking for this system is afforded by the use of bamboo stakes with side shoots still adhering, one stake provided to each plant, so that side shoots will interlock and make a continuous support.

When hills are required, holes two feet in diameter and one foot deep should be dug; each hole should be half-filled with soil, making a round heap above the surface. A shallow depression should be scooped from the top of the hill, and from five to ten seeds should be planted in each hill for later thinning to three plants. Hills should be spaced three feet apart.

A very satisfactory method of growing a few cucumbers for home use is as follows: Saw a barrel in two at the middle; knock the ends out of the half-barrels; up-end each half so that the smaller ends are uppermost; fill each half-barrel with manure and cover with an inch of soil or an old sack; plant three hills of cucumbers around the base of each half-barrel; twice a week pour a couple of buckets of water in at the top of each half-barrel. Provide stakes around each half-barrel for the vines.

In addition to manure, a complete fertilizer mixture is recommended for cucumbers at the rate of an ounce per plant from a 4–8–10 mixture. On the red soils of Jamaica, the three fertilizing elements should be purchased separately, and the phosphate should be mixed in with manure or compost some weeks before use. Nitrates and potash may be applied at the rate of half an ounce each to each plant after growth has begun.

Pumpkins

The pumpkin is a native of North America, and is now to be found growing in all parts of the world.

Seed. More than a sufficient quantity of seed should be planted, in order to select the best plants and to weed out the remainder.

Planting. This crop thrives best on well-prepared, loose, sandy-loam or loam soils; the application of manure or compost will pay for itself; the use of phosphate fertilizer is also recommended.

Pumpkins are not usually planted in regular rows in a field, but more often are found scattered along fences or in a field of corn, or Congo peas. It is best to plant this crop where space will be afforded for the vines to run as they like, and where the vines will not climb up and weigh down any other crop.

Holes three feet across and one foot deep should be dug, eight feet apart; each hole should be filled halfway with manure, and then filled up to a heap with soil; seed should be planted at the rate of five to each hill in a shallow depression in the crown of each hill; after the young plants are several inches tall, these seedlings should be thinned out to two sturdy plants.

It is good practice to have at least two or three pumpkin vines in close proximity to one another, in order to facilitate pollination; male and female flowers often appear separately on a single vine, with the result that very few fruit are set.

When pumpkin fruits have reached the size of a tennis ball, it is good practice in wet areas to lift each pumpkin and place beneath a handful of coarse mulch which will not hold moisture and rot.

Peppers (Chilies, Capsicums)

The pepper is a small, perennial, shrubby plant 3 to 4 ft. high, and is cultivated in all warm countries for its pungent fruit, which is popular for

flavouring the food of those who live in the tropics. The dried red pods of the pungent varieties are ground and used in pickles and sauces under the trade name 'Cayenne'. A less pungent variety, the *Paprika*, a sweet pepper dried and ground, is used for flavouring salads, and many dishes, while in the fresh state, green or ripe, it is used as a vegetable in salads, etc. Sweet peppers, lacking pungency, but well-flavoured, are also included in the group.

Peppers thrive best in rich, well-tilled soil, growing in all locations up to 3,000 ft. and preferring a moderately dry climate. Seeds may be sown in beds and transplanted when 3 to 4 ins. high, spacing them 2 or 3 ft. apart. They come into bearing in six months and yield about 2,000 to 3,000 lbs. of dried pods per acre.

Varieties. There are very many varieties, but the following are the best known in Jamaica:

Bird or Bird's Eye Pepper, not cultivated, but growing half-wild. About 4 to 5 ft. high, with very small and exceedingly pungent fruit, red when ripe. The principal source of 'Cayenne'.

Sour Pepper, of similar growth and habits as the Bird, but bearing a much larger fruit, 1 to 1½ ins. long, slender and equally pungent. Largely used when ripe and freshly gathered for making the various brands of hot pepper sauce.

Scotch Bonnet. Large, round, wrinkled with flattened base. Very pungent, but with an excellent flavour. The fruit ripens yellow.

Dog Tail. Long (about 3 ins.), not very stout, terminating in a blunt-pointed end, very pungent, very red when ripe.

Cherry. A dwarf variety bearing a multitude of small round berries, cherry red when ripe and exceedingly pungent.

Sweet Pepper. A non-pungent variety, edible as a vegetable. Ripens red. The fruits under good cultivation are about 3 to 4 ins. long and 2½ to 3 ins. across. The powdered dry pods make *Paprika*.

Besides the above, there are many un-named varieties grown in gardens, some red and some yellow when ripe.

The Okra

The Okra or Achro (Gumbo in the U.S.A.) is an annual belonging to the hibiscus family. The tree ranges from 4 to 6 ft. in height, with large roundish or palmate leaves, and bears erect horn-shaped pods 4 to 6 inches long. When gathered young they constitute a pleasant-tasting mucilaginous vegetable which can be eaten boiled and seasoned with butter and pepper or chopped and incorporated in stews and soups. The mature pod is tough and inedible.

Cultivation. The okra thrives best in warm and not too elevated areas. The seeds of the dry pods are sown in rows 3 ft. apart, thinned out

ANALYSIS OF LOCAL FOODSTUFFS

Common Name	Botanical Name	Product	Moisture %	Crude Protein %	Fat %	Fibre %	Ash %	Carbohydrates %	Remarks
Bananas	*Musa* sp.	Ripe bananas	75·3	—	—	—	—	—	
		Banana flour	13·3	5·91	0·24	0·73	3·20	76·63	
Breadfruit	*Artocarpusincisa*	Breadfruit meal	10·9	3·7	0·6	3·6	8·0	73·2	
Calabash	*Crescentia Cujete*		87·9	1·31	0·34	1·59	0·94	7·93	
Cassava	*Manihot utilissima*	For starch manufacture	13·93	7·07	0·27	1·54	2·24	75·85	
Coco	*Colocasia* spp.	Red coco head flour	11·74	11·12	0·67	4·78	4·28	67·41	
		Jeremic coco head flour	11·42	7·11	0·63	5·30	3·3	72·24	
Coconut	*Cocos nucifera*	Coconut cream	57·8	2·9	32·8	—	0·70	—	Total Reducing Sugars: 2·2% Glucose 0·65% Sucrose 1·5%
Corn	*Zea mays*	Red corn	8·73	8·60	3·46	1·68	1·26	76·27	
		Yellow corn	8·22	8·82	3·50	1·47	1·36	76·63	
		Corn meal	9·8	10·2	4·2	0·8	1·2	73·8	
Food Yeast		Food yeast	13·5	39·1	1·4	3·7	8·9	33·4	
Locust	*Hymenaea Courbaril*	Locust fruit	17·0	5·7	—	—	—	—	
Kola nut	*Cola acuminata*	Powdered kola nut	13·82	8·75	0·11	2·83	3·03	71·46	
Mango	*Mangifera indica*	Mango flour	6·5	5·2	11·6	1·5	1·5	73·7	
Okra	*Hibiscus esculentus*	Okra seeds	10·7	—	15·0	—	—	—	
Peanuts	*Arachis hypogea*	Peanut meal	13·3	33·2	3·8	24·9	4·6	20·2	
Plantain	*Musa sapientum*	Plantain flour	11·3	2·0	0·3	0·5	1·6	84·3	
Sweet Potatoes	*Ipomoea batatas*	Florida white	68·8	—	—	—	—	—	Starch 19·6% Sucrose 1·5%
		M.S. variety	13·29	2·09	0·22	4·64	1·30	78·46	
		Local varieties	68·68	1·72	0·27	0·74	0·78	—	Starch 26·4%
Pumpkin	*Cucurbita pepo*	Pumpkin meal	12·1	6·8	0·3	58·7	3·1	19·0	
		Pumpkin starch	13·6	2·1	0·1	—	1·0	83·2	
Rice	*Oryza sativa*	Imported rice	11·6	7·8	0·1	0·04	0·4	80·06	

ANALYSIS OF LOCAL FOODSTUFFS (*Contd.*)

Common Name	Botanical Name	Product	Moisture %	Crude Protein %	Fat %	Fibre %	Ash %	Carbohydrates %	Remarks
Soya Bean	*Glycine hispida*	(1) Soya bean milk	94·0	2·50	0·5	—	0·57	—	Total Sugars 0·925% Glucose 0·58% Sucrose 3·2%
		(2) Soya bean milk	87·0	6·68	2·20	—	0·81	—	Made by mixing 1 lb. meal in 2 quarts of water and straining through muslin
Oats	*Avena sativa*	Imported rolled oats	8·7	16·0	4·1	0·8	2·0	64·4	
Yams	*Dioscorea* sp.	Wild yam or bitter jessica flour	13·21	2·18	0·05	0·0	0·45	84·11	
		Accam flour	13·56	6·75	0·42	2·43	2·76	74·08	

to 24 inches between plants. They can also be sown in well-manured beds and transplanted when 3 or 4 inches high.

Cropping. Plants begin to bear at one to two months, and continue producing pods for the remainder of the year.

Once trees are well established, the pods can be gathered daily, as growth is rapid.

Varieties. There are several varieties, ranging from stubby podded pods covered with hairy spines to the 6 inch 'lady's finger', which latter is the kind chiefly cultivated.

Asparagus

Asparagus is not commonly grown in Jamaica, but it has been demonstrated that the crops can be grown successfully. The main handicap commonly experienced is the lack of a supply of roots and the need to plant out imported seeds.

A loam soil, neither sandy nor clayey, is suitable for asparagus, and once a suitable soil medium has been provided, it is necessary only to maintain a high standard of fertility with considerable quantities of animal manures in order to produce good quality asparagus.

Planting should take place in trenches, 18 inches apart with 5 feet between trenches; crown roots one year old make the most satisfactory planting material, but in this country it is likely that most growers must obtain seed first to provide their own supply of year-old crown roots a year later. In this case seed should be planted one foot apart in well-manured shallow trenches, for transplanting at the age of one year. Once crown roots have been established, constant heavy manuring will result in the production of asparagus shoots suitable for consumption.

The Chow-chow

The Chow-Chow or Cho-Cho is a robust perennial vine with leaves resembling the cucumber, thriving at elevations between 1,000 and 3,000 feet above sea. The fruit is in fair demand as a vegetable, especially in stews.

Propagation is effected by planting the entire seeded fruit *in situ* in a well-manured mound situated in a cool location. The fruit should be fully ripe.

Maintenance. The vine requires natural or artificial supports—a trellis of wide-mesh wire or an arbour of wood that will not decay quickly. In cool limestone land piles of heaped-up stones will be found suitable.

Fruiting. The pale green or sometimes white fruit, between four and six inches long, are borne throughout the year, the plant beginning to fruit in about six months. When cooked it somewhat resembles vegetable marrow.

CHAPTER 44

Orchard Trees

Mangoes

The mango is indigenous to Asiatic tropics, is particularly cultivated in India and was introduced into the West Indies from the East Indies, in the eighteenth century. It is a quick growing tree of spreading habit, bearing fruit early. The crop begins in early May and continues into July, the round or oblong fruit weighing about half a pound. The skin when the fruit is ripe is yellow, and in some varieties reddish or green. The flesh is pleasant tasting with a distinctive flavour and in the centre of the fruit is a large flat ovoid seed covered with fibre. The green fruit is used for preserves and chutneys.

The mango thrives best at low elevations, where it is warm and not subject to much rain. It grows at higher elevations but does not fruit readily.

Propagation. Mangoes do not grow true to variety when reared from seed, the tendency being to revert to original and coarser stock. Plants have therefore to be obtained by budding or approach-grafting on a seedling stock of a vigorous variety.

Budding

Previous Methods. There are two common methods of propagating mangoes, namely, by grafting by approach and by 'T' or shield budding. The former method is in common use in India; it assures of almost 100% success, but it is wasteful of scion material and plants and is only used when the number of plants to be raised is small.

'T' or shield budding has been in general use in the Ministry of Agriculture's nurseries, but the method has a grave disadvantage in that the buds do not readily grow out and much time may be lost in producing a saleable plant.

Introduction of Plastics. With the introduction of plastics and the manufacture of thin transparent plastic sheets it has become possible to produce a plastic budding tape. This tape has many advantages over raffia and other tapes prepared for tying-in grafts in that it is capable of stretching and so is not liable to strangle the plant. Moisture is unable to pass through the film, but gases can readily pass through, so that there is less likelihood of the buds drying out or being suffocated. With the use of plastic tape difficult propagation techniques have become everyday practices.

Two budding techniques are now recommended:

Chip-budding for use on very young rootstocks which have been raised in pots. This allows budding to be carried on from June up to December or January.

Terminal-grafting for use on older stocks which have been raised in nursery rows. This is carried out in the summer months beginning from April. It is also used to re-work rootstocks on which the chip-buds have failed.

Chip-Budding

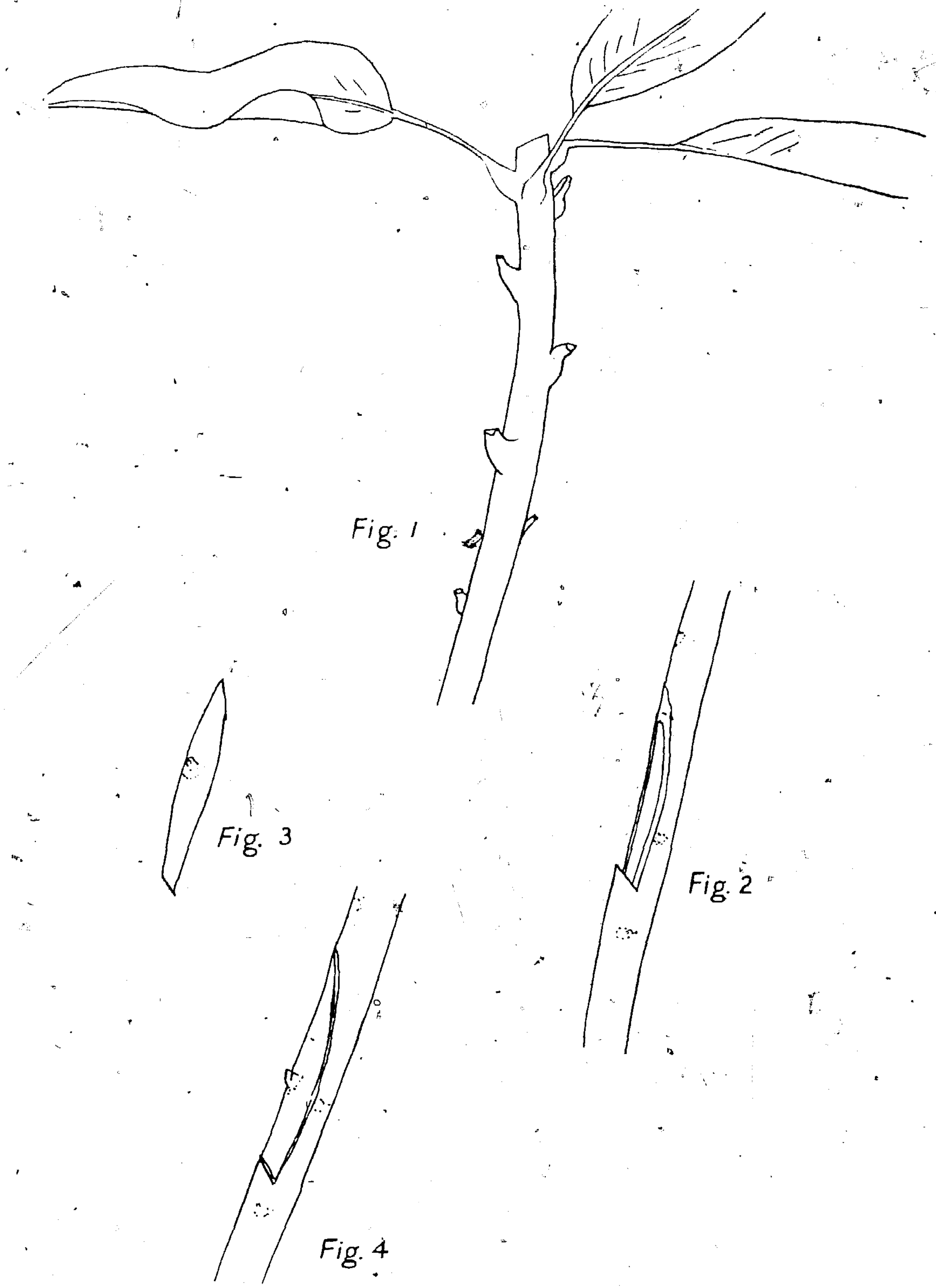
This is a method which has been developed for use on rootstocks from four to six weeks old. Under suitable conditions using seedlings raised from prepared seed set in pots, a saleable plant can be obtained within six months of sowing the seed.

Preparation of Seed. The seed obtained preferably from 'Bombay' or 'Number-eleven', is prepared by freeing it from the fruit or pericarp and cutting round the seed coat with a rollcut secateur to extract the kernel. The kernels are sown without being allowed to dry out, in a friable rooting medium, such as, coir waste, sawdust, sharp sand, etc., set with the convex edge of the seed upwards. In about ten days they will be germinating and the shoots (plumules) will be appearing. At this stage the sprouted seedlings can be easily lifted with all the roots intact and potted in tins or basket pots. After another two or three weeks the seedling will be ready for budding.

Preparation of Budwood. Terminal growths which have hardened or are in the last stages of pink stem, from $\frac{1}{4}$ to $\frac{3}{8}$ inch in diameter should be selected. One or two inches of topmost growth is cut off and two or three of the top remaining leaves are left. All lower leaves are cut off leaving about $\frac{1}{8}$ inch of the leafy-stalk (petiole) attached to the stem. If the tree is in a good condition the buds will be swelled and ready to use within one or two weeks (Fig. 1).

Method of Budding. The bark of the rootstock, which is now more than four weeks old, is becoming green and there is a well-defined cambial layer. A chip of bark and wood is removed from the stock by a downward cut penetrating through the cambium into the wood for about 1 inch and by a second downward 45° cut at the joint which will be the bottom of the exposed cambial area (Fig. 2).

A typical chip-bud of size and shape is cut to fit the prepared stock (Fig. 3).



Chip-budding of mangoes.

The bud is tied in with plastic tape by beginning the wrap below the lowermost cut and proceeding upwards, binding tightly, making a loop above the top cut, slipping the end in and drawing tight (Fig. 4). The eyes are not left exposed.

In dry weather it is advisable to carry out these operations and store the plants in a shade house. During the wet season the shade house can be dispensed with.

Three weeks after budding the plastic tape is untied to examine the bud. If it is still green it has probably united and the plastic tape can be retied this time leaving the bud exposed. One week later the stock should be ring-barked about two inches above the bud, or alternatively the head of the stock may be broken over to the opposite side of the bud. When the bud has grown out three or four inches the head of the stock should be cut back to two inches above the union and the young shoot loosely tied with raffia to the snag.

When the stem of the budling has become sufficiently strong and firm (generally from eight to twelve weeks after budding) the snag should be cut off just above the union. This is done with a sharp knife making a sloping cut from just below and opposite the union and carrying the cut through to just where the top of the shoot meets the rootstock. No snag should be left and the cut must be smooth and clean to obtain rapid healing. The cut surface should be painted over with paint and not with tar, to exclude water and disease.

When the callusing is seen to be formed all around the cut the plant will be ready for sale or for setting out in the orchard. At this time there should be at least three hardened flushes of the young shoot, and, if the bud was inserted in a six-week-old seedling, the plant should be less than six months old from the date of sowing the seed.

Terminal Grafting

Preparation of Rootstock. The rootstock to be budded should be about eight to nine months old and at least the thickness of a lead pencil. It should be vigorous and the sap moving so that the bark will lift readily if cut and peeled off. The sprouted seed will probably have been set out in the nursery row the previous August or September. It is then ready for grafting in April. The stock is prepared by selecting a portion of the stem above the first or second whorl of leaves, removing the leaves from the stem so as to leave a length of stem about three inches long free from leaves. An upward slanting cut about $\frac{3}{4}$ inch long is made through the stem 3 inches above the whorl of leaves, and the top of the plant removed (Fig. 5).

Preparation of Scion Wood. The scion or graft of the variety which it is desired to propagate, must be carefully chosen from a healthy tree. It

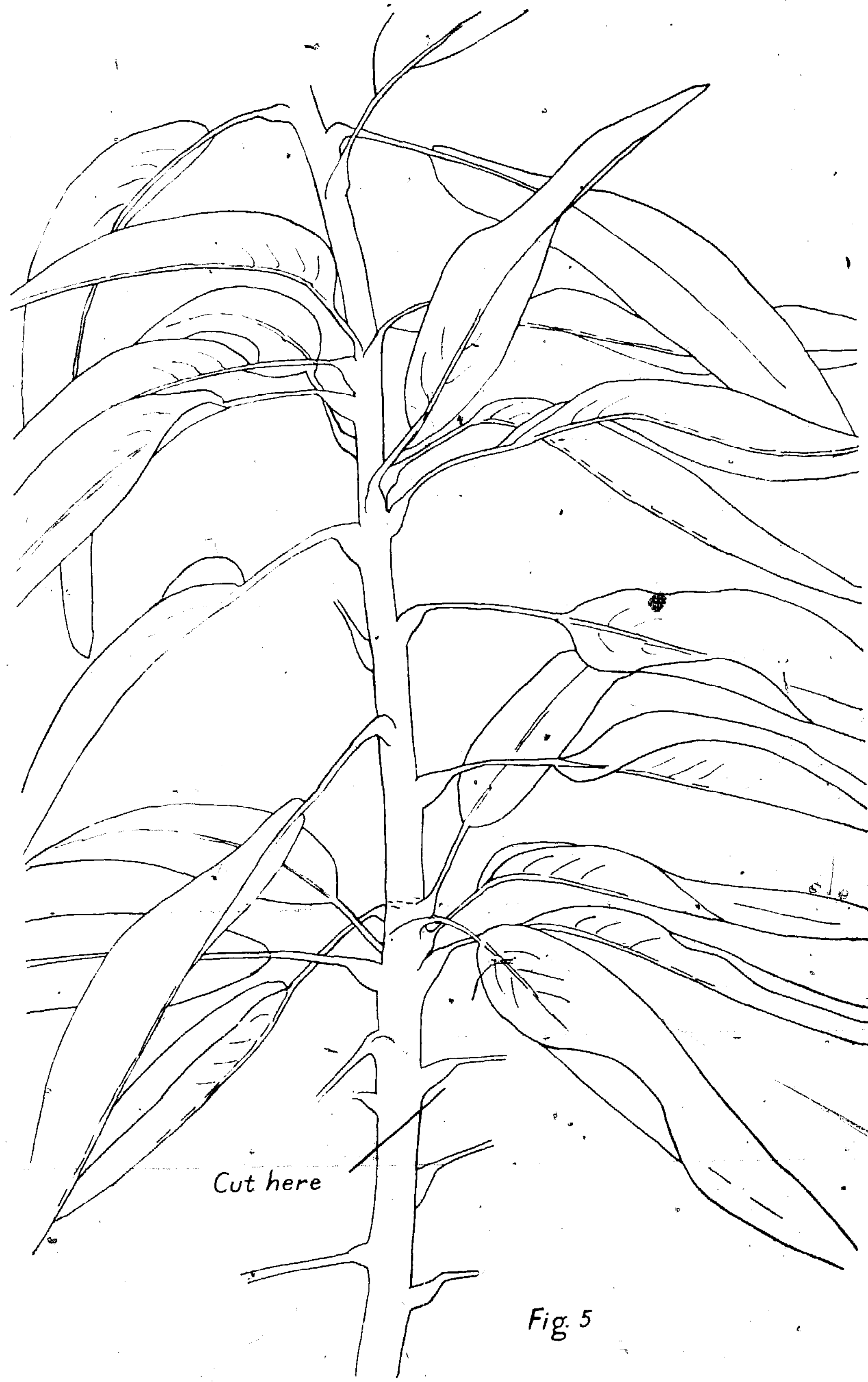


Fig. 5

Terminal grafting of mangoes

should be a terminal shoot, well developed, cylindrical and at least $4\frac{1}{2}$ inches long. It must be fully hardened and should have a well developed terminal bud which is showing initial signs of making renewed growth. The swelling of the bud can be stimulated by removing the leaves from one to two weeks before detaching the scion (Fig. 6).

Method of Grafting. At the time of detaching the scions, all leaves should be removed if the scions have not already been pre-cured. A long slanting cut is commenced 2 inches below the tip and continued through to the other side, making a tapering wedge $2\frac{1}{2}$ inches long (Fig. 7).

On the rootstock a vertical cut $2\frac{1}{2}$ inches long is made just through the bark to the cambial layer beginning from the topside of the oblique cut (Fig. 8).

The wedge of the scion is then pushed home firmly until the top of the cut in the scion coincides with the top of the oblique cut in the stock. The whole is firmly bound with plastic tape beginning from below upwards to cover all cut surfaces. The end of the tape is slipped through a loose loop and is drawn tight.

Within three weeks the terminal bud of the scion should commence to grow out. It is not necessary to remove the plastic tape.

Lifting. When the grafted plants in the nursery rows have developed three hardened flushes they are ready to lift. But only those plants which are fully hardened and dormant should be lifted. Any plants which are flushing must be left until they have reached the proper stage. The nursery should be given a good soak the day before lifting the plants. The plants should be lifted with a ball of soil intact around their roots, and potted immediately into suitably sized containers. As the roots will have been severally pruned in lifting the plants should be placed for two weeks in an underground pit heavily shaded to allow them to form new roots. They should then be transferred to a shaded house and kept well watered for a further three weeks before attempting to plant them out in the field. The spacing for dwarf varieties, such as Julie, need not be more than 25 feet each way. But for strong growing varieties, such as the Bombay, 40 feet apart is not too wide.

Varieties. There are numerous varieties in cultivation, the fruit varying in size, texture, shape, flavour, etc. The following are the best known kinds:

Bombay. A comparatively late importation from India. Round, medium sized, stringless and of good flavour. Favoured as a dessert fruit.

St. Julien or Julie. Similar to the Bombay but with fruit more flattened. Tree of dwarf habit and therefore popular in gardens and small housing lots.

Number Eleven. The most popular of the stringy varieties. Flavour delicious and slightly sub acid.

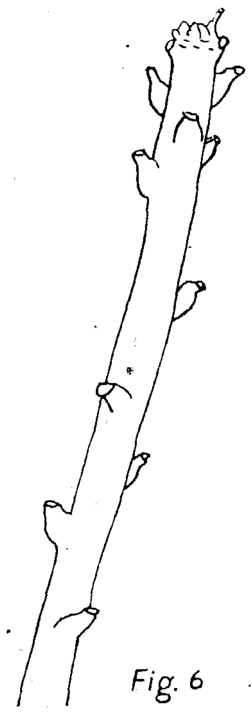


Fig. 6

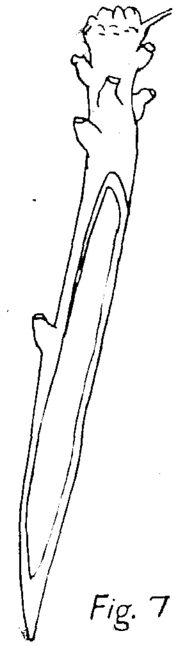


Fig. 7

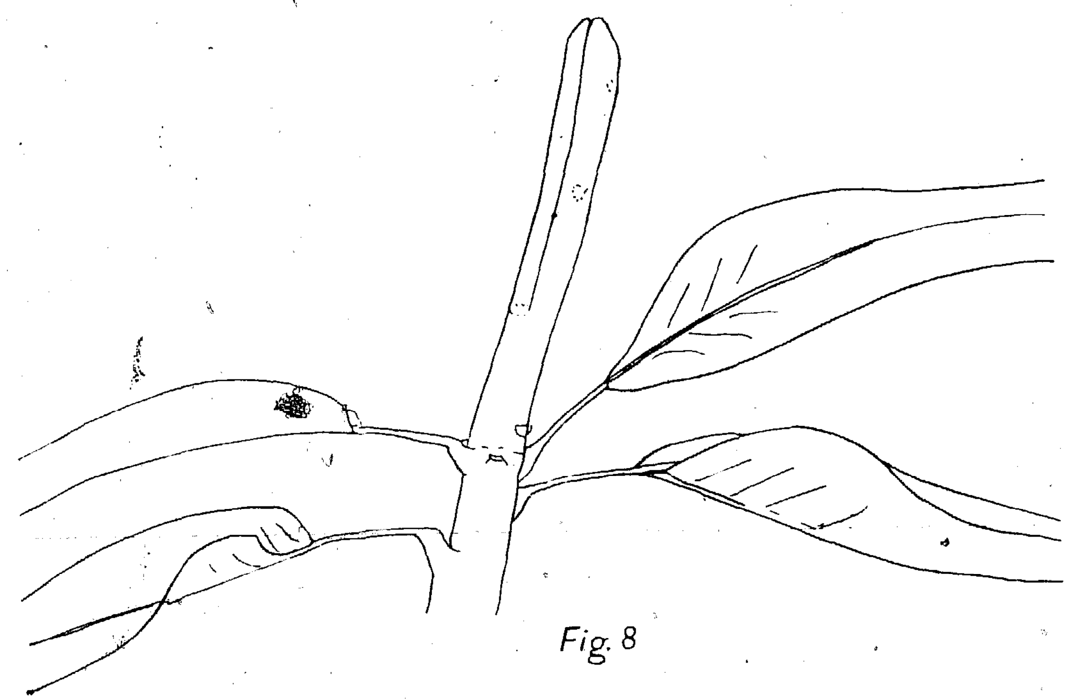


Fig. 8

Terminal grafting of mangoes

Common or Hairy. Very plentiful. Ripens a bright yellow. Pulp very sweet.

Black. Of delicate flavour, small, colour green when ripe. Skin very thin.

Robin. Found chiefly in the lowlands of St. Elizabeth. Ripens with a pinkish tinge on one side. Very sweet, but hairy. A very popular though not largely cultivated variety.

Haden. A variety bred in Florida not very plentiful in Jamaica. A very large fruit, round to oblong, mostly yellow with red cheeks when ripe. Flesh juicy, nearly fibreless with sub-acid flavour, good quality. Has a thick easily removed skin, suitable for shipping as fresh fruit.

The Garden Cherry

The Garden Cherry or Acerola, also known as Barbados Cherry and West Indian Cherry, is a large shrub or small tree which has been grown for many years in most of the Islands of the Caribbean as a garden fruit.

The correct scientific name is *Malpighia glabra L.* Both this name and *M. Puncifolia L.* have been used, the latter mainly in Puerto Rico. Dr. R. Bruce Ledin has shown that there are no reliable characters which can be used to separate the two species, and, as *M. glabra* was the first of the two scientific names to be used, it has been accepted as the true scientific name.

The Garden Cherry belongs to the natural family Malpighiaceae and is not to be confused with the true cherries of the genus *Prunus* nor with the Surinam or Pitango Cherry, *Eugenia uniflora L.*, which is a member of the Myrtle family.

The Garden Cherry was first brought into prominence in 1946 when Asenjo and Guzman in Puerto Rico showed that the fruit possesses a very high amount of ascorbic acid (Vitamin C), varying from 1,030 to 3,309 mg. per 100 grams of edible matter.

In August 1955, the Ministry of Agriculture and Lands obtained from Puerto Rico a dozen cuttings of each of two clones 'A 1' and 'B 17', which had been selected for high Vitamin C content and for other desirable fruit qualities. These were originally multiplied at Hope where a half-an-acre plot of each strain was established in February 1956 for observation and recording of yields and production of planting material. Recent developments in another direction will, however, make it necessary to transfer these plots to another Station.

Ecological Requirements. The Garden Cherry is successfully grown over an area extending as far north as South and Central Florida, as far west as Central America and in most of the Caribbean Islands. It can be assumed that it thrives under wide variations of climate. The Garden Cherry occurs on a variety of soils in Jamaica. It is known to grow well on

calcareous, rocky soils as well as on the acid sands of Florida and has been reported as growing well on clay soils in Puerto Rico. The plant dislikes stagnant water and poor drainage conditions and may show symptoms of calcium deficiency on very acid soils. As is the case with most fruit trees, it thrives best on deep, well drained soils, and very acid soils, badly drained soils or excessively shallow soils should therefore be avoided.

As far as altitude may affect its behaviour, there is little indication that this factor would preclude the growing of the cherry anywhere in Jamaica, although, naturally, it may be slower in coming into cropping at higher altitudes.

Recommended Husbandry Practices. For the present, supplies of plants will come exclusively from the Crop Agronomy Nurseries of the Ministry of Agriculture and Lands and from the Yallahs Valley Land Authority's Nursery at East Albion. The plants are raised in beds from cuttings, are potted into bamboo-joint pots and are ready for distribution between nine and twelve months of age.

For those who intend to set out orchards of the Garden Cherry, preparation for planting should include ploughing (or forking) and harrowing, following which the land can be marked out for the digging of holes. The ideal size of the hole is 2 feet by 2 feet by 18 inches deep and the holes should be dug from two to three months before it is proposed to plant in order to allow the soil to weather. The holes may be filled in two to three weeks before planting, first putting back the subsoil and trampling it firm and then returning the top-soil so as to leave a slight mound. The young plants should be planted on the mound at the same level in the ground as they were in the pots. The usual care must be exercised to see that the plants are moist before being taken out of the pots, that the pots are carefully split and removed and that the plants are set very firmly in the ground.

Spacing will depend upon the strength of the land; if it is very fertile the plants should be set as far as 18 feet apart each way. On land of average fertility the spacing should be 12 feet by 12 feet or 15 feet by 15 feet. Now-a-days planting in hedgerow formation is in vogue with other tree fruits and this method could profitably be used for the Garden Cherry, in which case the rows should be from 15 feet to 18 feet apart and the spacing of the trees in the rows as close as 6 to 8 feet.

The Garden Cherry should be planted at the beginning of either the spring or fall rains and should be mulched after planting. Mulching should be repeated at least annually as it helps to conserve moisture, moderates soil temperature and controls weed growth as well as maintaining the organic content of the soil.

Not a great deal is at present known about the fertilizer needs of the crop. In Florida the recommended application is a 10 : 0 : 10 mixture applied in February or March at about half-a-pound per tree for each year of age. Additional fertilizer applications are made in May, July and September of a 4 : 7 : 5 : 3 or a 6 : 4 : 6 : 3 mixture (the fourth figure '3' refers to Magnesium) at one pound per application for each year of age. This seems very high but is in keeping with the Florida fertilizer recommendations for other crops.

Coming nearer home, recommendations made in Puerto Rico are for one-half to one pound of an 8 : 8 : 13 mixture applied twice per year for trees up to three or four years of age, and three to five pounds per year for older trees.

Here in Jamaica we have been putting out a general fertilizer recommendation for fruit trees consisting of a 10 : 10 : 10 mixture applied in equal quantities three times a year. For the first year or two not more than half-a-pound per application is needed. As the trees begin to fruit the applications can be stepped up.

Reaping. Nothing much will be reaped until about twelve months after planting, from which time onwards two crops per year can be expected. The timing of the crop depends upon the commencement of the rains or on the time of the first application of irrigation water and reaping will be spread over several weeks. Some strains have two very pronounced peaks in harvesting, whilst in others the harvesting period is spread out over a relatively long time.

As the value of the fruit depends upon its Vitamin C content, the fruit should be picked at a stage when the Vitamin C is at its maximum, i.e., when the fruit is turning from yellow to red. At Hope reaping has so far been done by daily-paid labour but it would be more profitable to pick 'on contract' at a fixed rate per pound. It has also been suggested that the fruit could be shaken off the bushes on to a cloth laid on the ground, thereby reducing the cost of picking.

Pruning. This is a very necessary operation as it is essential to develop a manageable type of tree and to avoid the branches breaking during a heavy crop. One should aim at producing a bush on a single stem or leg about twelve inches long. Branches should then be encouraged to radiate out from the central stem which can be stopped at four or five feet height to form an open centre which will let in light and air and facilitate picking. The branches should be well spaced and not crowded together. The result should be a symmetrically shaped bush. Subsequent pruning should be carried out as soon as the fall crop has been reaped and should be confined to removing broken branches and those which cross over or grow inwards. The main branches should be shortened back so as to make a stocky bush. Any branches which are likely to touch the ground should also be removed. When shortening back the branches, pruning should be done to a side shoot which grows in the desired direction.

Irrigation. This is useful, where available, for the purpose of producing

good growth and the maximum yield of large fruit. It is possible to advance the fruiting season in the spring by applying the first irrigation a few weeks before the rains arrive. Generally speaking, irrigation is only required for this plant when it is desirable to make good a deficiency of rain when there is a danger of the crop not becoming fully developed because of lack of rain. No irrigation is needed during the more or less dormant period from December to March.

Pests. The Garden Cherry may sometimes become attacked by scale insects, plant bugs, caterpillars, etc. These can be dealt with by the usual spray treatments. More serious trouble may be caused by eel-worms, particularly the root-knot nematode. If the presence of this pest is suspected, the land may be treated before planting with a recommended nematocide. Advice on these treatments should as a matter of course be sought from the field extension service.

Yields. Exaggerated statements have been made concerning possible yields of the Garden Cherry, but as interest in this crop is a relatively new development, accurate information on the subject is not yet available. Yields vary considerably between the different clones and according to the age of the tree. With reference to the latter, the following figures obtained from Homestead, Florida, are revealing:

Yield per plant at 3 years	19 lbs.
4 years	10 lbs.
5 years	21 lbs.
6 years	69 lbs.
7 years	131 lbs.

Records kept in Puerto Rico show that four-year-old trees of the clone 'B 17' have given from 3·6 to 5·4 tons of fresh fruit per acre.

The following table is prepared from records kept at Hope:

Table 1
Yield of Fruit in lbs. per Tree

Clone	*Date of Planting*	*1957 lbs./tree*	*1958 lbs./tree*	*Average of*
A 1	Feb. 1956	8	54	8 trees
B 17	Feb. 1956	12	62	7 trees

The Economics of the Crop

It is too early to give much factual information on this point. Local experience so far would suggest that the costs of preparation and maintenance for this first three years should not differ much from those for well tended citrus, growing under arable conditions. Estimates for crop yields have been compiled from data obtained in Florida (1, 2), from data obtained in Puerto Rico and from three years' records of the yields obtained from the plots at Hope. From these data a sigmoid growth curve has been prepared and projected into the future to give an indication as to what sort of yields may be expected here in Jamaica (Fig. 9).

The behaviour of the two imported clones in Jamaica indicates that they tend to come into bearing earlier here than they do in Florida or Puerto Rico. Should this prove to be the case it may mean that maximum yields will be reached at an earlier stage in Jamaica than is the case farther north. The following table compares our records (for three years only) of the average yield of fruit in lbs. per tree with yields reported from Florida and Puerto Rico.

Table 2

Comparison of Yields in lbs. per Tree over First Five Years as Recorded in Jamaica, Florida and Puerto Rico

Year	*Jamaica*	*Florida*	*Puerto Rico*
1	2.3–3.8	—	—
2	7–53	—	—
3	50	19	—
4	—	10	24–36
5	—	21	—

It would seem that under Florida conditions the yield curve commences to flatten out in the eighth year at about 170 lbs. per tree (51,000 lbs. per acre). In order to obtain a conservative estimate of production for Jamaica and in the absence of any local record of yield for trees over three years of age, we have assumed that our extended yield curve might flatten out in the sixth year at about 80 lbs. per tree (24,000 lbs. per acre).

Uses

The value of the Garden Cherry as a commercial commodity lies in its Vitamin C content. One ton of the freshly harvested fruit contains from 25 to 30 lbs. pure Vitamin C.

It can be eaten as a fresh fruit or an iced drink can be made from the freshly squeezed, strained and sweetened juice. Unfortunately the fresh juice after pasteurization and canning loses both its colour and its flavour. Frozen juice, however, retains its red colour and practically all its Vitamin C and probably in this condition offers the best commercial proposition. It is suggested that the canned juice might be used to enrich the Vitamin C content of other fruit juices with which it blends well.

Local analyses of the fresh fruit and various derived products carried

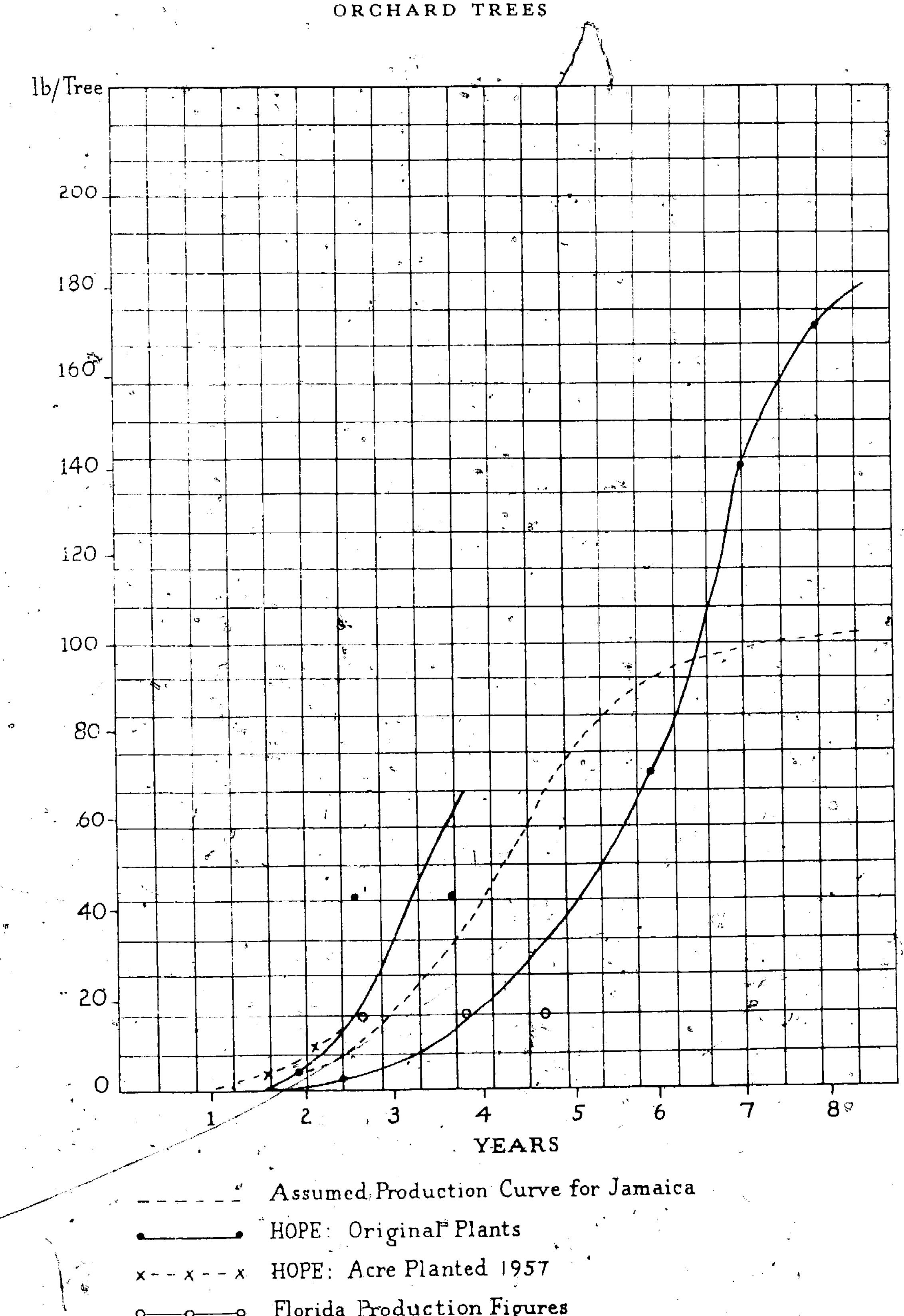


Fig. 9

out by the Government Chemist and by the Agricultural Chemist of the Ministry of Agriculture and Lands have given the following results:

Table 3

Vitamin C Content of Fresh Garden Cherry and of Various Derived Products

	Mgm. per 100 *ml. juice*		
	Minimum	*Mean*	*Maximum*
A 1—fresh fruit	1003	1476	2105
B 17—fresh fruit	927	1299	2184
Canned syrup	—	614·4	646
Jelly	—	676	—
Pasteurized juice with Brix raised from 8°–18°	—	819·3	—

The Garden Cherry has been, and still is, a garden fruit of only minor importance in Jamaica. There has, however, been some local interest in its possibilities as a commercial commodity of recent years. There is at least one business corporation in the United States of America with interests in Florida and Puerto Rico, which processes and markets the juice. The tree is relatively easy to grow and thrives well in most parts of Jamaica. It could, if our local fruit and beverage processors were to develop means of putting it on the market, provide a useful addition to our complement of commercial orchard crops.

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The Ackee

Although originally coming from West Africa, the Ackee does not appear to figure in the dietary of the people, it being left for appreciation in its adopted home, Jamaica, to attain a high degree of popularity and production.

The tree occurs throughout Jamaica in the low lying and intermediate elevation districts, but does not fruit well at the higher elevations.

Propagation is by seed, the trees normally coming into bearing three or four years from planting. The trees are not cultivated and continue developing until a considerable size is attained—thirty to forty feet high—at which stage the crop borne is large.

Fruiting. The fruit is large, bluntly triangular about three inches long and bright red when ripe. On ripening, the rind splits longitudinally into three sections connected at the stem and spreading out at the base, revealing three large shiny black seeds attached to the firm cream-coloured, kidney-shaped, fat-like substance (the aril) developed around the base of the seed. This constitutes the edible portion of the fruit, which when fried or boiled and flavoured with salt and pepper, is considered delicious. In Jamaica it is usually served in combination with boiled salted codfish, and when the taste for it has been acquired, is most highly relished. Care must be taken, however, to use only freshly gathered fruit fully ripe and open.

Between the lobes of the arils is a pink integument which must be removed when prepared for eating.

As the fat content of the aril is high (16% to 18%), the food value of this fruit is definite.

The immature seeds as found in the unopened fruit contain a saponin-like glucoside which is believed to affect the flesh, which if eaten may cause the so-called ackee poisoning.

The Starapple

The starapple, also known as the caimito is a very handsome tree growing to large proportions, the upper surface of the leaves being dark green and the under-sides bronze. It makes a very attractive shade tree as the bronze under-sides of the leaves are exposed to view in the lightest breeze. The fruit (green when ripe in one variety, and dark purple in another) is round, and about the size of a large apple.

When green the fruit, like the Naseberry, contains a milky viscous latex which disappears on ripening, leaving a sweet, pleasant jelly-like pulp and semi-transparent jelly sections enclosing the flat black seeds.

When cut across, the jelly substance covering the seeds shows a distinct star formation—hence the name given to the fruit.

Propagation is from seed, and the tree is worth cultivating both for ornament and for the fruit.

It thrives on practically all soils, at altitudes between 500 to 2,000 feet.

The Naseberry

The Naseberry or **Sapodilla** is a medium sized tree twenty to thirty feet high, with dark, green, glossy, leathery leaves.

It is a native of tropical America and because its sap is milky and viscous, it is known in Central America as *chicle*. It is tapped for its sap which is coagulated to form the basis of chewing gum. It thrives well in the lowlands ranging from sea-level up to an altitude of about 1,500 feet and is more common on the freer draining limestone soils. It is propagated from seed and under favourable conditions develops quickly, but is slow to come into bearing.

The fruit is round or heart-shaped, russet brown in colour, thin skinned and consisting when ripe of a mass of soft, luscious, slightly almond flavoured brown pulp in which two or three flat, shiny, black seeds are contained. Like the persimmon, it must be perfectly ripe to be eaten.

There is a larger fruited variety usually called **Sapote** with larger, pointed fruit of much coarser texture. With proper selection, propagation by grafting, and cultivation, the naseberry, basically an excellent fruit, is capable of being much improved.

The Sweetsop

The Sweetsop is a member of the *Anona* family and is sometimes referred to as 'Custard Apple'. The tree is small, and the heart-shaped fruit varies in size, depending on the locality where grown and the amount of cultivation received, from five or six ounces to a pound and over.

The rind is thick and of a peculiar appearance, the entire surface being divided into small knobby scales which break away separately when the fruit is ripe, exposing the creamy, sweet custard-like pulp enclosing small black seeds. The finest sweetsops are found in the lowlands of St. Elizabeth, but the trees thrive on nearly all lowland alluvial or light soils.

Propagation is by seed.

Custard Apple

A near relative of the sweetsop is the Custard Apple—sometimes called 'sugar apple' and 'bullock's heart apple'. This is also a small tree, thriving best in the warm lowlands or at moderate elevations on light soils. The tree is more bushy than the sweetsop, but does not attain a very large size. The fruit is heart-shaped, with a thin skin that attains a pinkish tinge when ripe. The pulp of the ripe fruit is sweet, of custard-like consistency, and is either eaten plain or used for making ices or fruit drinks.

The Cherimoya

The Cherimoya, although the finest of the *Anona* group, is least known in Jamaica, being found only in the high elevations of the Port Royal Mountains. It originated in Peru, but the date when it was introduced

into Jamaica is uncertain. The fruit, heart-shaped, with thin green skin, is known in the London market as 'Custard Apple', supplies coming from Madeira where it is extensively cultivated. The fruit possesses a delicious sub-acid flavour, resembling the sweetsop and custard apple as regards the creamy custard-like texture, but far surpassing them in excellence.

In Madeira it is propagated by grafting (although it may also be raised from seed), and the best varieties produced there are almost seedless.

The tree is best suited to hill districts with deep rich soil, and where the rainfall is not too great.

The Soursop

The Soursop is another member of the *Anona* family, the tree being quick growing and shrubby, attaining a height of between fifteen and twenty feet. The leaves resemble those of the laurel, but are somewhat smaller, with a glossy green colour and a pleasant sub-aromatic smell when crushed.

Propagation. It grows readily from seed, at all elevations up to 3,000 feet and develops quickly. Started in small baskets or bamboo 'joints', they are set out in their permanent positions when they are about eighteen inches high, and if the holes are well prepared and manured, growth is rapid.

The fruit is ovoid in shape, covered with short soft spines, dark green in colour, changing to a pale green when ripe, and weighs between three and six lbs.

The pulp of the ripe fruit is white and of a 'woolly' texture, juicy, and pleasantly sub-acid, the black seeds being embedded in the pulp sections. The flavour of the fruit is characteristic, but difficult to describe, resembling none of the other well known fruits. The juice is often used for flavouring ices and for iced drinks.

The Breadfruit

The Breadfruit is a native of the Pacific Islands and was introduced into the West Indies in the eighteenth century. Under favourable conditions it grows quickly, attaining when full grown a height of fifty to sixty feet. The leaves are large, glossy-green, deeply incised, with a heavy mid-rib. The fruit is round or ovoid, large ones weighing three or four lbs., and is borne in great abundance, with usually two crops a year.

The fruit forms a staple article of diet, being eaten either boiled (in soups) or roasted. The ripe fruit is not used in Jamaica although esteemed in the East Indies.

Propagation is by suckers springing from the roots. The plant thrives at all elevations up to 2,000 feet, but prefers rich, light soils at lower elevations, with good rainfall. Under favourable conditions, it fruits in three or four years.

The Jackfruit

The Jackfruit is nearly related to the breadfruit and while the fruit is readily eaten, it does not rank as high as the latter in the dietary of the people. The tree attains large proportions, with dense dark-green foliage, and the fruit is borne on the trunk and older branches.

The fruit attains considerable size, specimens weighing twenty-five to thirty lbs. and when ripe, has a strong musky odour. The edible pulp, covering the seeds, occurs in 'pockets' throughout the fruit, each measuring about two to two-and-a-half inches long. It is firm, creamy yellow in colour and slightly sweet. The seeds, about the size of large olives, when roasted are not unlike chestnuts.

Propagation is from the fresh seed, sown in baskets or bamboo pots. The seedlings do not stand transplanting well, and so the baskets should be planted direct into the prepared holes, after loosening the basketwork to allow easy spread for the roots.

Avocado Pears

The Avocado Pear, known in Jamaica simply as 'pears' is a native of tropical America and flourishes with over sixty inches rainfall per annum, at between 200 and 2,000 feet elevation. The shape of the fruit is generally pear-shaped and the edible part of the fruit, a thick layer of greenish-yellow pulp is contained between the skin and the large fleshy seed.

On ripening, the skin assumes a yellowish colour, although some varieties turn a dark red or purple.

The pear grows readily from seed, but when so grown does not fruit true to type and so if reproductions of an original specimen are needed the plants should be obtained by budding. Old trees may be top worked, preferably by sidegrafting.

The trees vary in habit of growth, some being tall with short lateral branches while others have spreading branches. The flowers are borne in compact panicles at the end of the twigs.

Fruiting. The fruiting of the avocado is very irregular and in setting out an orchard it is best not to set out all of the same variety but to intermix with trees of other varieties, blossoming at the same time, so as to secure good cross-pollination.

Varieties. Specially selected in-season and out-of-season varieties which are recommended for Jamaican conditions are (in season) Simmonds and (out-of-season—ripening between December and February) Collinson, Lula and Linda.

Budding. Budding is done in the same way as in citrus or other fruit trees. It can be done any time the stock plant has attained a suitable size and sap is flowing. The scion should be selected from the best tree of the

desired variety, should be well matured, preferably from twigs which are just ready to send out new growth and should contain plump and well-developed buds.

Buds give difficulty in growing out but may be encouraged to grow out by the removal of a ring of bark two inches above the bud three weeks after budding. Raffia also requires loosening and retying at three weeks if constriction is to be avoided.

When the scion is well advanced the top of the stock may be cut off about three or four inches above the bud, and after the bud has grown to a length of about twelve inches, the stock should be cut off clean just above the union and the cut surface immediately treated with tree paint or tar. When this cut surface has calloused over, the plants may be potted successfully in eight-inch wide ten-inch deep baskets, provided they are set under shade and watered persistently afterwards.

Planting. In choosing a planting site first consideration must be given to the drainage of the site. Plants will not survive on soils or sites which are not free draining. Drainage is of such importance that plants will even thrive on black dirt rock limestone soils which are more rock than soil but are very free draining.

The plants should be set out in the field at the beginning of the rainy season. Space twenty-five to thirty feet apart. Set the basket with the bottom loosened in the prepared and watered hole and level over with good surface soil, pressing it well down. Mulch slightly and keep well watered.

Maintenance. The new orchard should be well cultivated, fertilized, cover cropped and disc harrowed. When the trees have attained size avoid ploughing so as not to disturb the root system. Until the trees begin to bear, very little fertilizer will be necessary. When cropping begins a 5–8–3 mixture should suffice.

Pruning. Small unthrifty branches do not require removal for they usually die of their own accord and callousing occurs quickly at the point where they are shed.

Mulching. Where there is insufficient water, keep the soil moist with good mulch.

Harvesting. The trees begin to bear at between five and six years. The fruiting season generally begins in August and lasts till October. An average of 300 fruit to a mature tree is considered a fair yield.

The fruit is very perishable and should be handled with great care. In harvesting, care should be taken not to pick immature fruit, as these will ripen with a poor flavour. Maturity is indicated by a change in the colour of the skin. The bright gloss fades and is succeeded by a lighter green or red-streaked colour.

The Cashew

The Cashew is native to tropical America but has been naturalized in Africa, Ceylon, India and the tropical East. The well-developed tree attains a height of thirty to forty feet and is of spreading habit. The fruit consists of two parts, the fleshy pear-shaped 'apple', juicy and astringently acid, and attached to its extremity the kidney-shaped grey-brown seed containing the edible nut or kernel which when roasted constitutes the commercial cashew nut.

The tree is adapted to dry districts which are not too elevated.

Propagation is by seed, and as the seedlings tend to suffer a high rate of loss in transplanting it is recommended to set the seeds *in situ* in well prepared and manured holes, or in light bamboo baskets with somewhat loose bottoms in a nursery, and planting out the seedlings, basket and all.

Maintenance. Once established, the cashew needs little attention other than being kept free of weeds and an occasional loosening of the soil around the tree. Animals avoid eating the leaves and branches which contain an acrid milky juice.

Spacing. The mature trees should be about 45 feet apart, but as they take a good many years to attain maturity and with good care begin fruiting in the fourth year, the orchard can at first be set out with the plants about fifteen feet apart and be subsequently thinned out as the trees begin to attain size.

Fruiting—Processing. The nuts are prepared by roasting, thereby facilitating the removal of the nuts from the shells. The roasting operation has to be done with caution and by an experienced person, as the seeds contain a deal of inflammable oil which takes fire during the roasting process and may lead to the loss of the nuts through over-roasting. The experienced roaster judges the opportune moment for raking out the seeds and putting out the flame still spurting from them.

Flowering usually takes place in January and February, and the crop is usually over by the end of May, but there is a range of two to three weeks between widely separated districts.

The Granadilla

The Granadilla is the largest fruited of the passion flower family. It is a strong quick climber with large oval leaves and square stems bearing large oblong green or greenish-yellow fruit like a small water melon, containing in its hollow centre a mass of acid-sweet edible pulp mixed with the flat seeds. The pulp may be eaten with the seeds, or rubbed through a coarse-mesh strainer, when it forms a pleasant base for ice creams, fruit salads and cocktails and wine cups.

The near-ripe 'melon' makes a good preserve and when crystallized is not unlike melon.

Propagation. The flowers are generally pollinated by insects but hand pollination will ensure a good crop of fruit.

The Granadilla is propagated from either seed or cuttings and thrives best at an altitude ranging from 1,000 to 3,000 feet above sea.

The Golden Apple

This is a well known member of the Passiflora family, almost indistinguishable save for the orange-yellow colour of the ripe fruit from the purple fruited variety so largely cultivated in South Africa, Kenya and Australia.

The characteristics and cultivation of both varieties are similar. Readily grown from seed or cuttings, the vines are trained along a fence or trellis. The leaves are large, oval, and of a glossy green and the fruit, ovoid in shape, measures about three inches long and two inches in diameter.

Cultivation. The vine is relatively shallow rooted and therefore should not be deep cultivated. An adequate supply of moisture is necessary, secured by mulching if the general rainfall is insufficient. The vine will not tolerate direct sunlight on the stem and should be planted in shade at a site where it will be possible for the vine to climb up into strong light rather than open sunlight.

This necessity for adequate moisture is due to the dense foliage carried by the vines. At the same time excessive moisture should be guarded against as this encourages the Brown Spot disease to which the plant is susceptible.

The Otaheite Apple

The Otaheite Apple (Malay Apple) is a native of the Pacific Islands, having been introduced into Jamaica at about the same period as the breadfruit. Probably, as the name seems to suggest, from Otaheite.

Whether as an ornamental tree, or for its dazzling wealth of crimson blossoms, carpeting the ground as they fall under the tree, or for the innumerable clusters of wax-like pink and red fruit, the Otaheite is worth cultivating.

The tree is shapely, compact, usually cone-shaped, attaining a height of forty to fifty feet, with large oval, pendulous leaves.

The fruit is pear-shaped, waxy pink or red, with a slight rose flavour, and is borne in clusters around the smaller branches, coming into season in June or July.

Propagation is by seed, and the trees thrive best in the cooler elevations, from 1,000 to 3,000 feet, on practically all soils where the rainfall is good.

PART THREE

CHAPTER 45

Flower Gardening

Introduction

In the following pages of this chapter an effort has been made to set out and briefly describe the ordinary flowers that may be grown in any farmer's garden. No attempt is made to enter into long or learned details of gardening requirements, it being recognized that the members of a farmer's family do not have the time to devote to any specialized form of flower gardening. The object is more to bring to their attention the possibilities of adding a substantial touch of colour and beauty to brighten the homes of hardworking folk of moderate means.

Antirrhinum (Snapdragon)

Antirrhinums are very popular and commonly sold by the cut flower vendors. The long stems of the flowers and their many contrasting shades of colour make them sought after for brightening rooms.

Preparing the beds. The soil should be good, but not too rich. After a thorough preparation, a top dressing of lime should be worked in. Make sure that the beds are not wet. Snapdragons will not thrive in damp soil. They prefer it dry as they are light feeders.

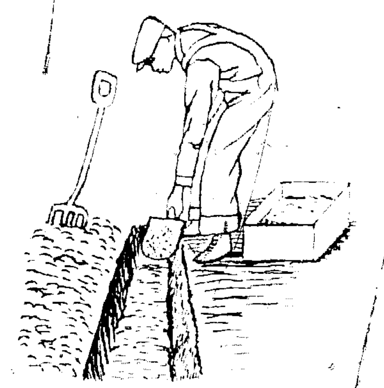
Propagation is by seed. The seeds are very small and should be mixed with fine sand or earth and lightly scattered in the seedbox, and a little finely divided earth spread over. Also, a few days before sowing the seed, the earth in the seed-box should be sterilized by a bath of boiling water.

Germination takes place in about seven days. The seedlings are very liable to 'damping off' and should be very sparingly watered.

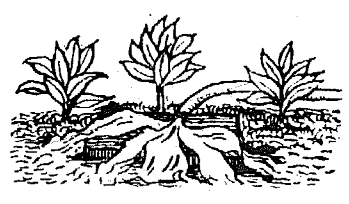
When big enough, the seedlings should be transferred into deep boxes and set about three inches apart. In this transplanting and the final transplanting into the beds the earth should be very firmly pressed around the roots.

Maintenance. Once established, the plants give little trouble. They do not like much watering. The crowns should be pinched when the plants

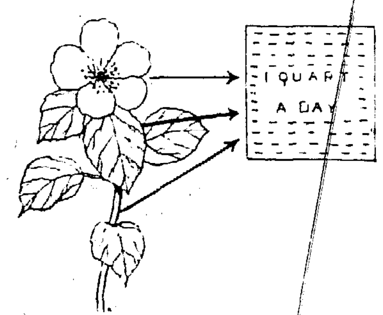
If the soil is rocky, you must break it up first with a pick



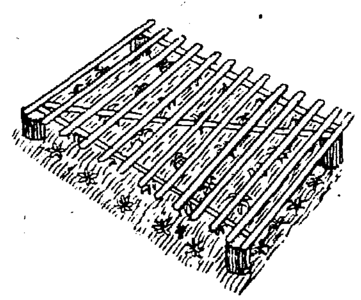
In special beds, layer compost through soil and mix



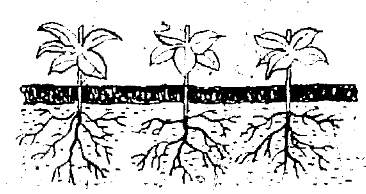
Flood watering a flower bed with hose laid over a board



Transpiration of moisture is a function of leaves aided by sun or artificial heat under glass



Seedlings should be shaded from the sun by slat covers raised above the frame or seed bed



The dust mulch is a blanket to prevent sun from absorbing soil moisture that feeds the roots

are half-grown, to promote spreading, and suckers from the leaf joints removed. The plants are subject to be stricken suddenly with a particular root disease, causing them to wilt and droop very rapidly. At the first symptom the plant should be pulled up, as there is no remedy and the disease spreads.

It is not recommended to plant antirrhinum for two successive seasons in the same bed.

Asters

Asters are widely cultivated for the cut flower market, the wide range of colours, ease of cultivation, profusion of blooms and their ability to remain fresh for many days after being out, all combining to make these annuals popular.

Propagation is from seed, these being sown in good potting soil and the seedlings transplanted to the pots or beds when two or three inches tall. In sowing, care should be taken not to cover the seeds too deeply. Two or three times the diameter of the seeds will be sufficient. The soil should not be too acid. If so, correct with some lime or powdered old lime mortar.

Begonias

Begonias thrive in Jamaica. There is a surprising variety of them, and they grow equally well on the plains and in the elevated regions, although, it must be admitted that they are at their best at elevations between 2,000 and 3,000 feet. A few indigenous species grow wild in the higher elevations.

Begonias may be divided into two classes, tuberous rooted and fibrous rooted.

Tuberous rooted Begonias are not widely grown in Jamaica, although in temperate climates they are commonly grown in beds and borders. In Jamaica, especially in the cooler regions, they can be very successfully grown in pots, where they make a lovely display when in flower. They are vari-coloured, and range from single and double, to crested and frilled.

Propagation is by bulb.

Fibrous rooted Begonias are commonly grown, and are found in various colours and habits of growth. The shades of colour vary from scarlet to pink, yellow, cream and white. Some are tall and jointed (the scarlet) bearing pendant clusters of bright red flowers, while others are bushy, sending up spikes covered with pale pink or yellowish blossoms.

Propagation is either from seed or by cuttings. The seeds are very minute and for planting should be mixed with fine sand and sprinkled over the seed-box and then covered very lightly with finely divided earth.

Cultivation. Begonias are easily cultivated. All they ask is good soil dressed with compost, a cool situation, and watering when it is dry.

Ornamental Foliage. The Begonia Rex is a wonderful example of an ornamental foliage plant. The colouring is rich and the veining and shape of the leaves most attractive. It is propagated from leaf cuttings. A mature leaf is taken, the mid-rib cut through at intervals, and the leaf then pegged down on to the seed-box. Rootlets will soon spring from the places where the rib has been cut through.

In planting, the sections of root bulb should be spaced about two feet apart to allow for expansion when full grown.

Calliopsis

This annual is grown from seed. The plants are coarse and the flowers borne on long stems, with yellow or orange rays. Almost any garden soil will do for these, the seedlings being set out about two feet apart, to allow room for development. The plant produces a wealth of flowers throughout its life.

Cannas

The Canna belongs to the banana family and is grown from the thick bulbous roots. By intensified cultivation the size and colours of blooms have been increased considerably, the colours ranging from yellow, salmon, ivory to rose, scarlet, crimson and mottled combinations. They are grown in masses, attaining a height of between three and four feet and the size of the blooms is increased by the application of good stable manure or fertilizer. A good supply of water is essential.

Carnations

Carnations do well either in pots or beds in the cooler areas, although with care they will also thrive and bloom freely at lower elevations.

Propagated either from seed or suckers, or by layering, the single blooms are borne on long stems, generally needing support by tying against small canes or rods. The blooms are fragrant with a characteristic clove scent, and have a wide range of colour.

Carnations require a good rich loam with high lime content (commonly supplied by using crumbled lime mortar). The seeds should be thinly sown where they are intended to grow, and the weaker seedlings thinned out.

If plants are to be grown from suckers, cuttings should be taken from young off-shoots, with a 'heel'. Place in shallow trays with a light mixture of earth and sand and keep moist but not wet. Carnations at no stage of growth can endure wet soil. When rooted, nip the tops to encourage spreading, and transplant early.

Cosmos

This annual is very similar to the Calliopsis in appearance, flowering, and habit of growth. The soil should not be too rich, else the flowering will not be profuse. The situation of the bed should be sunny. Double and semi-double varieties have now been evolved. The shades range from yellow, sulphur, rose, crimson, purple to white.

Chrysanthemum

Chrysanthemums are of many varieties, some grown as annuals (from seed), some (perennials) in pots and beds for cut blooms (from cuttings),

and others, usually free branching and bearing a profusion of small flowers, in beds where they remain permanently. The range of colour is very wide—yellow, white, pink, deep red, bronze, apricot, lavender.

The single flowered varieties have a daisy-like centre, usually with white petals, and are borne on long stiff stems. The best known variety of these is the so-called 'Shasta Daisy', a perennial, blooming all year round, commonly grown for the cut-flower market.

The standard double varieties bloom in September and October and when attention is paid to their cultivation, reward the gardener with a profusion of loveliness. It is best to propagate these from cuttings, in the spring, setting them out either direct into the pots or beds, or in boxes containing light rich soil, and transplanting as soon as well rooted. Cuttings strike readily, and care should be taken never to allow the plants at any stage of their life to suffer from either lack or excess of water. A slightly moist condition of the soil is ideal for 'mums'.

Some lime mixed with the soil is helpful, and all manure applied should be old and well rotted and then mixed with light earth, and the entire mass then thoroughly mixed and divided.

Special fertilizers to be mixed in water and applied direct to the roots are readily obtainable and should be regularly applied, as Chrysanthemums are gross feeders. If special show blooms are required or desired, the plants should be grown singly in pots, all side buds nipped and the single plant staked against a cane or rod. All side blooms should be nipped and only the crown bud and three or four buds at ends of side branches grown for this purpose allowed.

Shading of some kind against the midday and afternoon sun is requisite, also protection from heavy rains.

If a more branching plant, with less showy blooms is desired, the crown of the plant should be pinched back when halfway grown to allow for side development.

Celosia (Cockscomb)

This plant is an annual, its flower borne at the top like a crown, being in form and colour very similar to the comb of a cock. The blooms are large, flattened, ruffled, and with a plush-like bloom. Modern cultivation has considerably improved the celosia, and individual plants now attain a height of three to four feet, with strong side branches terminating in well developed flowers. Variations of colour also occur, a tip of gold or dark pink flowers being obtainable.

Celosias do best in a light, rich garden soil and are very easily grown (from seed) either direct in the beds or first in shallow boxes and transplanted when a few inches high.

Dahlias

Originally introduced into Europe from Mexico (where they still grow wild) in the eighteenth century by the Portuguese traveller Dahl, dahlias although propagatable from seed, are usually grown from their tubers.

Although classed as perennials, dahlias are more annuals, as the plants die down after blooming and fresh plants spring from the tubers to replace them.

In habit they are bushy and branching, and the flowers are of beautiful shape and colour, the former ranging from enormous double and semi-double flowers, to diminutive and extremely double 'pom-poms'. The range of colour is also wide, running from pure white to dark maroon, with miscellaneous coloured edgings and, among the 'pom-poms', a fascinating assortment of mottled colourings. In shape too, there are many variations, from single and semi-single forms, to quilled, incurving, to double and extra double.

Dahlias thrive best in a medium to light well drained soil with a good supply of compost or manure. It should be remembered that the tubers are large and the feeding roots numerous and far-spreading.

Planting. In taking the tubers from the clump care should be taken to leave a small portion of the old stem attached. The buds start at the neck. It is safer to wait till small sprouts have actually started growing from the tubers before removing them. Remove only the larger tubers, leaving the smaller for another season's development. Plant four to six inches deep, end up, leaving the top about an inch below the soil.

Delphinium

The Delphinium (Larkspur) occurs both as an annual and a perennial. Usually the annuals are called Larkspur while the perennial types, with more highly developed flower spikes, are called Delphiniums. The stalks are tall and branching. The flowers are mostly blue in different shades. The hybrids develop other shades of colour—lavender, yellow and white. The flowers look like little hoods with the characteristic spur at the base.

The plants will thrive at elevations over 2000 feet and propagation is from seed. They favour a rich, alkaline garden soil hence the beds must be liberally dressed with lime and a fertilizer rich in phosphate. The soil should be deeply forked and a good addition of compost or stable manure worked in. The plants should be spaced not less than 3 feet apart to allow for growth.

Fuchsias

Fuchsias are tender plants, requiring a good elevation, a cool climate and ample water supply. They are propagated from cuttings and should

be grown in shaded positions, in rich soil, rotted leaves being favoured. For ease of cultivation where cool shaded positions are not available for beds, growing in pots is recommended. By pinching back shoots a spreading habit is encouraged. Liquid manure can be given at regular intervals.

The varieties differ widely in form and colour, from simple single 'ear-drops' to full double; and white, red and purple are the predominating shades.

Geranium

Geraniums will grow at the lower elevations, but are at their best at 2000 to 3000 feet.

They adapt themselves to any good garden soil, preferring a sunny position. If potted they prefer a hard and somewhat dry soil.

Propagation is usually by cutting, about three inches long from which all leaves except those at the tip should be removed. These should be set in a very sandy loam, and given good shade and enough water. The roots will develop quickly and the plants should be transplanted when the roots are about half inch long.

The flowers are borne on stiff stems in large trusses, and the varieties range from single to extra-double, in scarlet, crimson, rose, pink, salmon, cream, blush and white.

Gerbera (African Daisy)

Gerberas have become very popular in Jamaica, especially in the cut-flower market, the long stems and long keeping quality of the blooms, no less than their intrinsic beauty, making them very suitable for indoor decoration.

The plant is a stemless perennial with heavy, low lying leaves, resembling dandelion leaves, from which the flowers spring on long stems. The colour of the flowers vary from pale yellow to dark red; orange, yellow and pink predominating. Single, semi-double and double flowers occur. Plants can be grown from seed, but cuttings of side-shoots grow more readily and bloom earlier.

A fairly rich soil ensures a larger sized bloom.

Gladiolus

The Gladiolus is propagated from the fleshy corms of the plant, sometimes called bulbs. The plant has sword-like leaves, and the flowers carried on the sides of the erect spikes, in profusion to the very tip of the spike. The range of colour of the flowers is astonishingly wide, and the purity of some of them a revelation. They range from light pink, deep pink, salmon, blotched pink, white, to violet, dark red, scarlet, crimson, rose peach, orange, and yellow.

A sandy loam is best suited for gladiolus culture, or any other light soil, but not a heavy or wet.

The corms should be about $1\frac{1}{2}$ inches and set about 1 inch deep in a furrow 4 to 6 inches deep which will gradually be moulded up against the stems. The deep planting helps to keep the plants erect. They should be spaced about 6 to 9 inches apart.

After flowering, when the plant has dried down, the corms should be taken up and stored in a dry place against the next planting, when they should be peeled and inspected and only the best selected for growing.

Heliotrope

The heliotrope (of Peruvian origin) is a low, bushy plant that should be in every garden where the elevation is good and the climate temperate.

The plant is of branching habit and bears clusters of small, very fragrant flowers at the end of the top branches, the colour varying from white to pale lavender, violet and purple, but mostly violet.

A good rich garden soil is needed, whether for beds or pots, and the plants started from seed, although cuttings may also be used, the soft ends preferably, set in moist garden soil.

When half-grown, liquid manure should be regularly given.

Hollyhock

The hollyhock is a semi-perennial producing very tall flower stalks along which, beginning at the mid-part, the flowers, single and double, are carried, until the tip is reached at the end of the flowering period.

The leaves are large, rough, and rounded, and the flowers vary in colour—red, rose, salmon, yellow and white being chiefly found.

Propagation is from seed, the first year being given to growth, and the second to blooming.

Any rich, well-drained soil, well manured will do, but the situation must be sunny.

Unless preserved for seed, the faded flowers should be stripped, to induce better blooms higher up the stalk.

New plantings should be made every year, as the plants do not flower until the second year.

Lupines

Lupines are moderately high shrubs three or four feet high, thriving in the cooler locations, bearing four to six spikes of showy blue, white, or pink flowers. There are both annual and perennial varieties. Lupines are of easy culture, grown principally from seed. They do not transplant well, so the seed should be set *in situ*. They will grow in any good garden soil, although some varieties prefer a loose sandy loam.

Marigold

The marigold belongs to the group of annuals, is usually of a bright yellow coloured flower, and highly scented. The cultivated blooms are either ruffled or very double.

Propagation is by seed and they will grow practically anywhere, with the least amount of cultivation. The latest varieties are intensely double, incurved like some of the show chrysanthemums, and deep orange in colour.

Some dwarf varieties for massing in beds or for borders are also grown.

Morning Glory (Ipomoea, Moonflower)

The Morning Glory is a vine plant, the simple blue variety growing commonly in neglected spots where the soil is light. The leaves are heart-shaped and the flowers of the cultivated varieties are of large size, usually blue, white, pink, and orange. Some are ruffled.

They like a warm, sunny situation, the flowers opening at sunset, and closing by noon.

The plants grow easily from seed, and growth is rapid. The seeds should be planted where the flowers are intended to grow, and a good supply of water is essential.

Myosotis (Forget-Me-Not)

The Myosotis is popular in all gardens. The usual colour of the flower is sky-blue, but pink and white also occur. The plant is a biennial, averaging about twelve inches in height and producing a profusion of tiny flowers borne in terminal clusters.

The plant needs a moist soil and may be grown from either seed or rootstocks.

A variety—the 'Tree Forget-Me-Not' is of branching habit, attains a height of about two feet, blossoms profusely and, massed in a bank or circle with raised centre, gives a dazzling show of intense blue.

Nasturtium

The Nasturtium is a tender annual of dwarf or climbing habit, thriving on almost any soil in the cooler elevations, although with closer attention they do fairly well in lower situations. The round leaves are borne on succulent stems and the flowers are single, double, or fringed, the colours ranging from pale gold to deep maroon. Some varieties are sweet scented and of semi-erect habit, being tied to stakes during the flowering season.

Propagation is from seed which can be sown where the plants are intended to grow. The dwarf trailing varieties make a good show when grown from hanging baskets or porch boxes.

Pansy

The Pansy is a variety of viola, sometimes called heart's ease, of slightly creeping habit, with long brittle stems. The flowers are large, short stemmed, and of various shades of colour, gold and purple mostly predominating. There are many beautiful varieties, some with curled or ruffled flowers.

Propagation is from seed, and any moderately rich garden soil will be sufficient, but the seed must be fresh and for the first fortnight the seed-bed must be kept moist. If the seed becomes dry after once sprouting, it dies.

Petunias

These are among the most cheerful, easily grown, hardy and encouraging flowers that can be had in the garden. They do not mind the sun or a bit of dry weather, or even a little neglect, but just go on flowering and giving pleasure to the eye.

Propagation is by seed. As the seeds are very small—about the size of tobacco seeds, the petunia being a cousin of the tobacco, they should be mixed with sand or fine earth before sowing in the seed box. Scatter thinly and cover lightly. Sterilize the earth in the seed box with boiling water a day or two before sowing, and after sowing watch for ants. The seeds germinate in about a week, and may be transplanted into beds when two or three inches high.

Flowering. The range of colours is wide, from white, pink, mauve, variegated, to the deepest purple and the form from single to ruffled, semi-double and double.

Phlox

The Phlox is a popular garden plant, grown for its showy blooms in various shades of white, pink, red, blue, violet, buff. The annual varieties are usually preferred.

All of the family are easy to grow, propagation being from seed. The perennials prefer a heavy soil, and good manure.

The flowers, about three-quarter inch across, are borne at the end of medium-short spikes, and are very decorative for indoor use.

Pinks (Dianthus)

The habits of Pinks and their cultivation are very similar to those of carnations (q.v.), except that pinks are more easily grown, chiefly from seed, and bloom much more profusely, the growth being more bushy. The flowers are mostly grown in clusters or heads, on shorter stems than carnations, and the range of colour is wide.

A variety of the family is the **Sweet William,** a perennial of short life, with flowers borne in clusters.

Roses

The Rose has been a cultivated garden flower from the earliest recorded times and during that immense period of time it has undergone many changes in variety, form, and habit. Some are low-growing, others tall, and yet others of climbing habit. Some are sweet scented, others 'tea' scented, but all possess the characteristic *rose* perfume possessed by no other flower.

For the limited purpose of this chapter, roses may be roughly divided into four classes:

Tea and Hybrid Tea,
Polyanthus,
Ramblers,
Climbing,

of which the Teas and Hybrid Teas, and their variants, often called 'Everblooming' are the most suitable for small gardens.

Soil. The success of the rose garden depends chiefly upon the proper preparation of the soil. It should be rich, well drained, and not very heavy. To ensure drainage, stones and gravel should be placed at the bottom of the bed and a heavy layer of manure laid on top of that. The upper portion, about two feet deep, should consist of the soil well mixed with good manure in which bone meal should figure prominently.

If the soil is very heavy and tending to be very acid, lime should be worked in. Some varieties of rose, however, prefer a slightly acid soil.

Planting. The hole should be wide enough to allow the roots of the plants to be well spread out. All bruised roots are trimmed off and the plant pruned. Hybrid perpetuals may be cut back to five or six branches. Hybrid Teas can be cut back more severely, leaving four buds on each of four or five branches.

Climbers must be cut severely back to create a heavy root development.

Watering should always be thorough. Sprinkling brings the feeding roots to the surface. Watering should be done in the early morning or late afternoon.

Practical Rose Pruning. Good pruning is not a difficult procedure. Some general rules are applicable to most conditions and localities.

All pruning should be done in Spring as soon as the buds have begun to swell. The pruning of climbing roses should be done just after they have bloomed. Ground-covering types require little or no pruning other than the removal of dead branches and this can be done at any time.

In all types of pruning use sharp shears that will make a clean cut. Crushed ends discourage healing and encourage fungus. Cut about a quarter-inch above a bud or eye, and make the cut slightly slanting and parallel to the slant of the bud immediately below. A touch of tree paint or tar on the cut will preserve the end from fungus or insect invasion.

In pruning hybrid tea roses the grower must be governed by the space allotted to each plant, the effect desired, and the locality in which the plants are grown. In any event severe pruning of hybrid tea roses to canes shorter than 8 inches from the ground is to be discouraged. The food of the plant is produced in the foliage and the amount of the foliage is dependent on the amount of wood remaining after pruning.

For the grower who has spaced his roses closely, say 18 to 30 inches medium pruning (12 to 18 inches) is recommended, and for 30 inches and upwards, high pruning (18 to 24 inches). The various heights of pruning also aid in determining the effect, size and number of blooms produced. The larger the plants are allowed to grow, the stronger and more productive they will be.

When pruning, first remove all dead or diseased wood, then all weak or crossed branches, then cut back to desired height.

Varieties that produce a few tall, heavy canes should be permitted to retain more height than varieties that break readily from the bud.

Climbing roses present a slightly different problem in pruning. First we must separate them into three different types, namely, ramblers or small flowered ones; large flowered climbers; and the everblooming or climbing hybrid teas. The ramblers are very vigorous growers and send up many shoots from the bud each year. Each cane which has produced blooms should be cut back as near to the ground as possible as soon as it has finished blooming. The young shoots which grow up in the spring and summer should be tied to a support of some type as they will produce bloom the following year.

Large flowered climbers are handled in a slightly different manner from the ramblers. Inasmuch as they do not produce as many canes from the bud as the rambler each year, a proportionately smaller number of canes should be removed. A good rule to follow in pruning large flowered climbers is to remove as many old canes each year as there are new ones produced. Always remove the oldest canes in so doing. They will be the canes with the darkest and roughest bark. In removing them, cut as closely to the ground as possible without injuring the plant. The new canes should be tied to a support.

Everblooming and climbing hybrid tea roses are the most restricted growers of all climbing roses and need little or no pruning other than the removal of injured or diseased wood and the removal of spent or withered blooms immediately after blooming. The blooms should be cut off just above the first leaf below the withered bloom.

Pruning is one of the easiest and the simplest of all rose maintenance problems and once the rose grower has found the procedure that suits his

or her particular needs, it is a routine matter to maintain a rose garden with a minimum of labour.

Salvia

The Salvia is a perennial belonging to the mint family. They are widely cultivated for their brilliant scarlet blooms, produced in spikes. There are variations of the standard scarlet colour.

The plants attain a height of about four feet and are of easy cultivation, being grown from seed. A good garden soil, not too high in nitrogen content, suits.

Sweet Peas

The Sweet Pea, one of the legume family, is an annual of climbing habit, thriving at the higher elevations (2000 feet and upward). Cultivation is somewhat exacting, a deep well-manured soil being necessary. A sunny location is helpful, as plants and blooms do not thrive in the shade, and lime should be freely added to the soil.

Propagation is from seed, and the vines must be provided with a low trellis on which to climb. They should not be transplanted, and the seed should not be sown more than half an inch deep. Allow six to nine inches between plants. The greater the space, the better the conditions for large long-stemmed flowers. An addition of phosphate fertilizer is also recommended when the plants begin to bloom. It should be remembered that the more the flowers are cut, the greater the following yield. Do not allow any to seed.

Shasta Daisy

(See under Chrysanthemum)

Verbena

Verbenas are mostly grown as annuals, fresh seed being planted from year to year.

The plant is of creeping habit and the blooms are borne in flat clusters. Cultivation is easy, almost any average garden soil and any altitude being accepted. The shades may vary from white, pink, red, to violet and purple.

Zinnia

Zinnias are generally annual, propagated from seed, easily cultivated in light, well-manured soil with liquid fertilizer supplied when blooming begins. The flowers, borne on long stiff stems, vary greatly in size and colour. The colours are brilliant and the flowers range in size from midgets to four and five inches. Although they will grow in poor soil, much better results are obtained when good manure or fertilizer is used.

PART FOUR

CHAPTER 46

Dairy Cattle and Dairying

Dairying is a branch of farming especially adapted to countries with limited land room as Jamaica. Indeed, the most successful dairy farming in the world is to be found in countries with limited land room, e.g. Denmark and Holland. These countries enjoy the highest average milk production per cow in the world and the main reason for this is the small size of individual farms and the inevitably small size of dairy herds, an average of ten cows per herd. Because of the economical performance of the small herd there is now a tendency on the part of such countries as United States of America, Canada, New Zealand and United Kingdom, long noted for large dairy farms, to reduce the size of the dairy herd. Here in Jamaica such a short-sighted policy of running large dairy herds, and invariably they are always low producers, is no longer to be found. When it was discovered that the returns per acre from beef, sugar cane, bananas, etc., were higher than the returns per acre from ranch type dairy farming, farmers either reduced their dairy herds or switched completely to another enterprise. Today the average dairy farm in Jamaica consists of 15 milkers, with an average annual yield of 1,595 quarts per cow.* While still a far cry from annual yield per cow in such countries as the U.S.A. and New Zealand, it looms large under our conditions and testifies to the progress made by deliberate herd reduction when it is realized that in 1952 the average production per milking cow per annum was 752 quarts.†

The Best Type of Dairy Cow

What constitutes the best type of dairy cow in one region may not necessarily be the same in another. The average temperate zone text-book carries a number of factors to be considered in the selection of dairy cattle. These include relative differences between breeds in hardiness and milk and butter fat yield, feed supply, topography of farm, economy of

* Data supplied by the Division of Animal Husbandry, Jamaica, not including small settlers with dual purpose cattle.
† From the Beasley Report, 1952.

production of milk and butter fat, breeding qualities of cows, vigour of calves, beef value of discarded cows and adaptability of calves for veal. Indeed, they are applicable to dairy farming in Jamaica and the tropics in general but only after the solution of an all important problem, that of arriving at new types or breeds which are able to endure the ravages of our climate. The more well-known breeds of dairy cattle, Jersey, Guernsey, Brown Swiss, Holstein, etc., were established in the temperate zone, and as a consequence they are more at home in their natural environment. The higher temperatures and rainfall of the tropics have been observed over the years to have very deleterious effects on them. Reduced milk production, reproductive inefficiency, lack of growth and development are the chief failures observed. We now know that these breeds lack adaptation, often inadequately described as heat tolerance, although they possess the characteristic of high milk production. On the other hand, there are breeds of cattle well adapted to tropical regions but lacking in the ability to produce much milk, e.g., the breeds native to India and Africa.

Much has been accomplished since the turn of the century especially in Jamaica in fixing a type of cattle which combines the desirable characteristics of the temperate zone dairy breeds and the Indian breeds. This is seen in the Jamaica Hope, a breed which has resulted from crossing the well-known Jersey with the lesser known Sahiwal or Montgomery of India. The Jamaica Hope has been found to be suitably adapted to Jamaican conditions and indeed has proved to be the ideal cow for dairy farmers of all categories. The most outstanding characteristic of this newly evolved breed is its high productive capacity. A production as high as 18,000 lbs. of milk in 305 days has already been obtained from a Jamaica Hope cow. Herd average at the Government Cattle Breeding Centre at Bodles is at present 8,000 lbs. per cow in 305 days. Along with high productive capacity there is hardiness combined. In the development of this breed, milk production was chosen as the index of selection, it was not hardiness. To have selected purely on the basis of hardiness would have resulted in animals with low productive capacity. Indian cattle are among the hardiest of cattle known but they give little milk. It would seem logical to conclude that an animal is hardy or adapted when it is seen to produce a vast amount of milk under our conditions. On this assumption then was selection undertaken in the development of the Jamaica Hope. It is safe to say that the most important factor that determines a good Jamaica Hope cow is its ability to produce a large amount of milk and butter fat under our conditions in proportion to the amount of feed consumed. Coupled with this are other characteristics as regular production, a genetic makeup as will ensure transmission of desirable characteristics to progeny and persistency or a long and useful life in the herd.

Practical Considerations in Starting a Herd

Now that the most important problem has been solved, that of establishing a tropically adapted dairy breed, the choice of breed is no longer tenable but the selection of individual cows and bulls is a most important problem for the prospective dairyman. Certainly he wants as quickly as possible a herd which will be kept at a profit for a long time. It is generally recommended that the best procedure for a beginner to adopt is to buy registered cows from farms where production and pedigree records are kept. This, at the present time, is not realistic, for in Jamaica pedigrees are available for no more than 5% of the cattle population in the Island and production records for no more than 11%. This situation should not remain unchanged for long for the current island-wide up-grading or appraisal scheme aims to provide registration for all dairy cattle in the Island. Closely tied in with this movement is the Dairy Herd Improvement Scheme with its objective of instituting a system of recording on all dairy farms. High hopes are being entertained that in a short while production records will be available for the great majority of dairy cows in the Island.

Very often cows offered for sale represent unwanted animals, the difficult breeders, those of poor type and bad temperament. Only when a dairyman is going out of business would he dispose of his good cows and this happens but seldom. More often than not a dairyman merely switches to beef by top crossing with beef bulls under which circumstances no animals are sold.

In lieu of production records is the inevitable statement that she is a 12 or 16 quarts cow, meaning to imply an average but which is really the peak in a day. This is a most unreliable way to assess a cow. Some cows lack persistency, i.e. they milk well for a few weeks and taper off rapidly, milking for no more than a few months. It should be borne in mind that the overall production for a 10 month lactation is what is important—not a peak production for a day.

In the absence of production records, type is the chief method of selection employed. This method is based on the recognition of certain external characteristics which are considered directly related to the development of milking capacity. The characteristics which constitute desirable type include size, constitution, barrel capacity, mammary development, dairy temperament and quality.

Size is important in a dairy cow, other things being equal, the larger the cow the better. However, coarse boned cows lacking quality and refinement are not desired. Regardless of the breed, there is a tendency for small cows to lack substance and capacity.

Care Before Calving

The importance of a strong constitution is emphasized when it is realized that a high-producing cow works very hard in converting feed into milk. It is estimated that it takes four hundred pounds of blood pumped through the udder of a cow for every pound of milk produced. A strong constitution is indicated by width and depth between forelegs, and a large heart girth with well-sprung fore ribs. This allows ample room for the heart and lungs which constitute the power house of the animal. A cow may have excellent dairy confirmation, great capacity for feed, and an excellent mammary development, and yet not be able to produce for long owing to lack of the necessary constitution.

A well developed digestive system is indicated by a large barrel, shown by the length, depth and width of the body. The ribs should be long, far apart and well sprung. The loin should be wide and level, and the flanks deep and full. It takes feed to make milk, and that feed is often roughage in the shape of grass, cane, guinea corn, and other green feeds. The large capacity indicates ability to handle vast amounts of coarse fibrous feeds, which are usually the cheaper feeds, and to extract the nutrients to be used in the manufacture of milk. The mammary development, consisting of the udder, milk veins, and milk wells, is the most important part of the cow and should receive careful examination when a cow is being selected. The udder should be large, well-balanced and attached high in the rear and carried well forward in the front with no tendency of breaking away at the points of attachment. There should be little or no division of the quarters. The floor of the udder should be as level as possible, the udder should be soft and pliable, shrinking noticeably after milking. The milk veins are generally indicative of productive ability, and the longer and more tortuous they are the better. The milk wells are the openings in the stomach wall where the milk veins enter the body and should be large enough so that a finger may go in easily. The milk veins, it may be explained, carry the blood away from the udder back to the heart. Ability to produce milk is essential in a dairy cow and denotes the tendency of the cow to convert feed into milk rather than into beef. It is indicated in many ways but especially by a natural leanness and angularity throughout. A good dairy cow possesses a typical disposition or dairy temperament. She is a quiet, docile and motherly cow, one that is able to produce large quantities of milk for her calf and yet perfectly willing to give the milk to the milker instead of the calf.

Quality is shown by a loose, mellow and fairly thin skin, and by smooth clean bones. The cow should be free from coarseness about the shoulders withers and hip bones. Other features to look for include that fine, clean cut head with wide muzzle and open nostrils, prominent bright active

eyes as these reflect the state of health. The pelvic region should be roomy to enable good reproductive performance. Anyone purchasing a milking cow should be satisfied that all teats are functioning and that there is no evidence of mastitis. Finally, the cow should be treated for tuberculosis and contagious abortion.

The dairy cow is bred to produce milk and will often do so to the detriment of her physical condition. It is therefore important that she should receive rest or dry periods between calvings. Formerly, it was a long process to dry off a cow giving a fair quantity of milk. The modern way which has proven quite effective is to stop milking the cow entirely. Pressure within the udder soon develops to 25% of blood pressure, and at this point milk formation ceases. It may be advisable if the udder becomes very distended to ease the pressure by milking out a small amount for three or four days afterwards but if the cow is giving very little milk, there will be no need to do any further milking. During the drying-off period grain feed should be cut down for a week.

The period of rest preceding calving should be about six to eight weeks. Firstly, it is necessary to rest the milk secreting organs. Secondly, instead of using feed for two purposes—manufacturing milk and the development of the foetus—it is better to channel it in the latter direction only. Of utmost importance is the fact that it is necessary to build up a reserve of nutrients for the next lactation. This reserve is usually seen in the increased body flesh and loss of angularity at freshening time. It is therefore easy to understand why a cow is most lean and angular when she is at the highest point in her production.

When a cow has been dried-off, and is in poor condition, she should receive the same ration she was receiving while milking, to assist her to put on flesh. A little extra feed during this period will be more than repaid by the stronger calf and the larger yield of milk after calving. If the cow is in good condition at the time of calving, calving troubles will be less likely to occur. It is advisable to feed the type of ration which will maintain a laxative condition. Some skilled herdsmen give a dose of Epsom salts about two days before calving. A cow that is heavy in calf should not be subjected to dipping, she should be sprayed or dusted instead. Care should also be taken to see that she is not driven carelessly through narrow gates or openings. Grazing and tethering on steep hillsides should be avoided. A week or so before calving the cow should be placed in a small pasture or pen, so that she can be kept under constant observation and become accustomed to her surroundings. Approach of calving is indicated by distension of udder and teats, a depression on either side of the base of the tail, restlessness and finally, immediately before giving birth, the appearance of a large bladder or 'water bag'.

If the calf does not appear within an hour of the protrusion of the 'water bag', then experienced assistance should be obtained. The cow should never be interfered with during calving, unless there is evidence of trouble. She should be kept as quiet as possible.

Care of new-born Calf

As soon as a calf is born, its mother will usually commence to lick it; this aids respiration and blood circulation, as well as drying of the coat. If the cow fails to lick the calf, then it should be dried off with a bag or wisps of clean straw. The navel should be disinfected immediately after birth to prevent the entry of germs into the calf's system. (Friar's Balsam, Dettol and tincture of iodine are commonly used for this purpose.) The procedure consists of placing the cords into a bottle containing the disinfectant, pressing the bottle against the belly and quickly inverting so that the entire exposed navel region is wet. Occasionally a portion of the foetal membrane in which the calf was suspended before birth remains over the nostrils of the calf after birth, preventing respiration; in such a case the membrane should be wiped off immediately. It may also be necessary to squeeze the nostrils and wipe out the mouth in order to assist breathing.

After a normal birth, a calf is usually quite vigorous and strong and will attempt to stand and will commence nursing within half an hour. A weak calf will require assistance to rise, and in such cases it is necessary to aid it in nursing by holding it up to the dam's udder. It is essential that the calf receive the first milk or 'Colostrum' from its mother. The colostrum is laxative and in addition has other properties which help to give the calf a good start in life. The calf should be left with the cow for two or three days, depending on the condition of the cow's udder; with this plan the calf receives the colostrum, and it is in a position to feed whenever it requires food. Also, the feeding activities of the calf have a beneficial effect on the dam's udder. If for any reason it is not possible for the calf to receive the colostrum, a substitute should be prepared by mixing the white of six fresh eggs with fresh milk about one-tenth of its body weight for the first feeding. For subsequent feedings one egg less may be used each time. If the bowels do not move within a few hours of birth, one ounce of castor oil may be given.

Care of Cow after Calving

After calving, a cow will feel exhausted, and she should be provided with plenty of clean water for drinking and fresh green cut grass. Calving brings about an emptiness which if filled makes for quietness on the part of the cow. If the calving was normal, then it is not necessary to provide any medicine or drench. Shortly after calving, the membranes composing the afterbirth should be passed by the cow. If it has not been passed within 24 hours, then it will be necessary for experienced assistance to be obtained.

When a retained afterbirth does occur the cow should be isolated from other cows and treated as if the case was infectious. This is a safety precaution against the spread of diseases of an infectious nature as contagious abortion.

Teaching a Calf to Drink

After a calf has been removed from its mother, two or three days after birth, it may be taught to drink from a bucket. Instinct causes a calf to extend its nose upwards to receive nourishment from the udder, and this instinct must be overcome. The best method is that of backing a calf into a corner, standing astride of it, dipping fingers into a pail of milk and letting the calf suck the fingers. Gradually lower the calf's head into the pail until the milk may be drawn up between them as the calf sucks. After sucking for some time, the calf will become used to the procedure, and the fingers may be withdrawn gradually. Some calves will learn to drink at the first attempt, while others may take a long time to learn. A very stubborn calf should be starved for about twelve hours, after which it will be so hungry that it will probably adopt the new procedure quickly. Patience is required and no attempt should be made to force drinking or to pour milk down the calf's throat. For the less skilful husbandman, special calf feeders with teat attachments are obtainable from dairy supply stores.

Calf Care from Birth to Weaning

It is advisable to feed a calf three times a day at eight-hour intervals for the first month after birth. The calf should not be overfed, as excess milk may cause indigestion. One pound of milk per day for every ten pounds of body weight is adequate to keep calves growing nicely from the first month. The milk should be accurately measured, and should be fed at the same time each day. Milk should be fed at body temperature or as near to 100° to 101° F. as possible, it should on no account be fed cold at one feeding and warm at another. Cleanliness is very important, as nearly all disorders or diseases are traceable to lack of cleanliness.

The feeding pail should be washed and sterilized after each feeding, and be placed out in the sun. The calf should be kept in a clean dry pen. Individual pens 4 feet by 6 feet are best for calves for the first 4 to 6 weeks. Young calves should not be reared on concrete floors, as there is a danger of chilling. A concrete floor should be covered with duck board, in which case no bedding is necessary as the duck board may be removed for cleaning. This method eliminates danger of calves eating bedding, often the cause of disgestive disorders among young calves. Individual pens also prevent calves from sucking each other, which a wise dairyman guards against. The formation of hair balls in the stomachs of calves, leading to digestive upsets, is due to calves sucking one another.

A calf should be brushed each day; this helps to stimulate the skin and to remove dirt and loose hair.

At the age of two or three weeks a calf should begin to eat grain; this should be encouraged by dropping a small quantity of grain and meal into the bucket after the calf has finished drinking, or by rubbing some meal on the nose after drinking. A start should be made with a handful, to be gradually increased as the calf grows older and larger. It is important that fresh grain should be fed at each meal, and that no wasted grain be left over in a bucket or trough to the next meal; otherwise, digestive troubles are sure to follow.

At five or six weeks of age a calf should commence to graze or to eat some chopped grass; the latter should always be fresh and young.

It is advisable to keep a calf on milk for four or five months, if the milk is available; any change that is to be made in feeding should be introduced gradually, so as not to upset the digestive system. If skim milk is available, this should be substituted for whole milk at four or five weeks of age, when the calf commences to eat grain. The main difference between whole and skim milk is the butterfat content, and the grain compensates somewhat for the loss of fat. The change-over from whole to skim milk should take about seven days. This is accomplished by putting in a small amount of skim milk at first and gradually increasing the amount day by day until at the end of a week all the whole milk has been replaced.

A suggested feeding schedule follows:

Suggested Feeding Schedule—Whole Milk and Skim

1. From birth to 3 days	With dam.
2. From 4–10 days	Feed 3 times daily—1·5–2 lbs. whole milk each time of feeding. Milk to be of blood heat. Allow clean water to drink.
3. From 10–21 days	Feed 3 times daily—3½ lbs. each time of feeding. Add a handful of calf meal. Place meal at bottom of bucket. Allow clean water.
4. From 21–31 days	Feed 3 times daily—as above, giving at each feed 3 pints of milk. Grain as above.
5. From 1–2 months	Feed milk twice daily—2 quarts morning and 2 quarts evening. Put about ½ lb. of calf meal mixture in trough at mid-day and some fresh, young and clean grass in feed racks. Allow clean water to drink.
6. From 2–3 months	Feed fresh milk in decreasing amount so that calf receives 2½ to 3 quarts milk at each feed, half to three-quarters of which should be skim milk. Allow ¾–1 lb. grain. Allow clean water.

7. From 3–6 months	Feed fresh skim milk between 3 and 3½ quarts and grain about 1½ lbs. daily. Allow clean water.

Whole milk is best for a calf, skim milk is second best; but with the high price for whole milk now there has been widespread use of milk substitutes. A good milk substitute can now be obtained from any reliable feed company. Home-mixed milk substitutes are not to be recommended because they do not usually contain ingredients which can be easily digested by any young calf. Milk substitutes should be fed as warm gruels being mixed with either milk or water. As a general rule 1 lb. of dry milk substitute should be mixed with 9–10 lbs. water. A feeding schedule which has been used and found successful is shown below.

Feeding Schedule for the Use of Milk Substitutes

Age	*Lbs. Milk Daily*	*Lbs. Gruel Daily*	*Grain*
1–3 days	With dam		
3–14 days	10		
14–21 days	9	1	
21–30 days	9	3	Free access
30–45 days	6	6	Free access
45–60 days		12	Free access
60–90 days		14	Free access
90–120 days		14	Free access

Powdered skim milk now has a distinct place in calf feeding as a great deal is being imported into underdeveloped countries from countries with surplus dairy produce such as U.S.A. and New Zealand. It is just as good as liquid skim milk and has the desirable characteristic of being able to keep indefinitely. It should be dissolved in warm water and fed without delay.

Fresh, clean water should be available to a calf at all times; in addition to milk, a calf will normally drink three or four quarts of water daily.

At seven or eight months of age, a calf may be weaned from milk or milk substitutes. The cost of feed up to this stage represents by far the most expensive item in the rearing of dairy calves, but adequate feeding must be provided. After weaning, the main consideration will be to keep the calf growing. Weaning should cover a period ~~of two weeks~~, milk being reduced and grain feed increased to about 1½ to 2 lbs. per day at 6 months of age. This daily ration with good pasturage should continue until 12 months of age, when the heifer should be able to get along on pasture alone. After this, no more grain need be fed until freshening time. Calves should always have an abundant supply of at least calcium and phosphorus. To ensure this, it is necessary to have before them at all times a mineral mixture consisting of:

Local phosphate —3 tablespoonsful
Ground limestone—5 tablespoonsful
Bone meal —4 tablespoonsful

Calf rearing is an expensive proposition. Indeed, it is possible that the value of whole milk, milk substitutes and grain feed for rearing a calf to the time when she is bred is in excess of her value at that time. Obviously, not all calves should be reared. Only those which can be expected to grow into satisfactory replacements for herd development should be reared. It is a much sounder business rearing only calves needed for herd replacement, thereby selling more milk to the Condensery, than rearing all calves and selling but little milk. Yet, it is important to bear in mind that it is penny wise and pound foolish to sell too much milk and underfeed the cows of tomorrow.

Care of Heifer from Weaning to Freshening

It is wrong to assume that a calf may be turned out after weaning to fend for itself, with no further attention. The digestive system of a newly-weaned calf is unable to cope with adequate quantities of roughage in the shape of grass for normal growth, and it is necessary that feeding of grain be continued after turning out to pasture, up to the age of twelve months.

The growing heifer should not be allowed to get too fat or there will be difficulty in getting her in calf, and in addition, the udder will develop fat rather than milk-secreting tissue. For these reasons it is advisable that heifers be kept solely on pastures from twelve months of age until say two months before calving, when they may be given a pound or two of concentrate depending on freshening condition. Chopped canes, Napier grasses, St. Vincent plum and silage can be fed at times, but should only be as a supplement to pasture when feed is low. The use of these feeds involves stall-feeding but because this is a costly operation, it is not to be recommended.

A good supply of fresh water is also necessary and should be where the calves can get it at all times. Rock salt or better still a balanced mineral-lick in the pasture is also very necessary as it keeps the animals in proper condition. It is a good and inexpensive form of insurance against sickness.

A well-grown heifer may often be bred six to nine months earlier than a neglected, poorly-fed heifer, and early production of milk will compensate for expenditure on feed and care. The age of breeding depends upon a number of factors as breed and type of husbandry to which the heifer was exposed. The latter determines underdevelopment or normal development. The weight at which Jamaica Hope heifers are ready to be bred has been found to be 600 lbs. Usually this weight is reached at sixteen to eighteen months. The mistake is often made of breeding heifers according

to age, and not according to growth and condition. An under-sized heifer will never make a good cow, because milk production is such a heavy drain that the lack of growth before breeding cannot be compensated for after production has commenced.

A record should be kept of the service date so that the heifer may be kept under observation from the nineteenth day after service. If the heifer does not hold to the service, she will return on heat 19 to 21 days later. Indications of heat or oestrum are restlessness, being ridden by other cows, slight redness and swelling of the vulva, and in early heat usually a clear mucus discharge. It is very often easier to determine when heifers are on heat than older cows. A heavy milking cow sometimes has short periods which are not noticed; this type of animal must be closely watched or she may go for months before being bred.

Two or three months after breeding, it is fairly easy to determine whether a heifer has settled in calf; the udder begins to develop, the animal becomes quieter, and puts on flesh. In older animals on the contrary, it is often difficult to determine pregnancy by physical appearance until the fifth or sixth month. When it is of importance to determine whether a heifer or a cow is in calf, and physical appearance is not definite, then it is advisable for a veterinarian to make an examination of the uterus.

When a heifer has settled in calf, she will not need any special feeding other than good pasture or fodder for the first six months. At the end of this period she should be brought into the milking herd to become used to the cow shed, and to receive a grain ration. An amount of 1½ to 2 lbs. per day at this time will make a great deal of difference to the heifer; as pregnancy progresses the ration should be increased until the heifer is receiving not more than four pounds daily at ten days before calving. At this time the grain feed should be changed to a laxative ration containing bran. Rice bran which can be had easily is suitable.

The heifer should be groomed and handled daily in order to accustom her to the surroundings. The udder should be massaged to help development and to accustom the heifer to the milking process which will commence after calving.

Grooming, Spraying and Dehorning. Daily grooming will help to maintain cows and calves in good health. Brushing stimulates circulation of the blood, brings out the natural oil of the skin and is also an important sanitation measure for removing of dirt and loose hair which might otherwise fall into the milk pail. All parts of the body, including the legs and feet, should be brushed and brushing should proceed in the direction of the hair growth. Animals should not be washed frequently as the natural oil of the skin will be dissipated and the coat will become dry and staring.

When regular grooming is practised, the problem of tick control becomes easier as brushing removes any ticks. Dipping or spraying should be organized with great care for too strong a mixture may do great damage, while on the other hand too weak a mixture will be useless. Care should be used to prevent sticks used for stirring a mixture being left lying around, as animals have a tendency to lick or chew sticks. The same caution should be observed in connection with containers in which dips or sprays were mixed. Spraying should be carried out in a place to which animals do not have normal access, as they will often return if possible to the place of spraying to lick the dirt, and many animals have died from this cause. Animals which must travel some distance to a dip should be rested before dipping and it is advisable to let animals drink water before dipping takes place. Cows which are heavy in calf, and young calves, should not be dipped; spraying should be substituted for dipping in these cases.

Horns are of no use to dairy cows, and often are a great nuisance when several animals are kept in a limited space; in many herds injuries to the udder from horning are the most frequent cause of mastitis. Dehorning makes for a more uniform appearance in a herd of cows. There are several methods and materials used in dehorning. The best time to dehorn is when the calf is three or four days old and one of several different kinds of dehorning paste or sticks of caustic potash may be used. Horns grow from the skin, and the dehorning material destroys the skin at the point of horn growth, preventing development. When the calf is three or four days old, the rudimentary horn may be felt, and the hair should be clipped from an area about an inch in diameter around this spot, vaseline or some form of grease should be spread around the outer edge of the clipped area, to prevent the dehorning material from running over the head of the animal, otherwise extensive burning or blindness may be caused. The calf is next placed on its side, with the head held firmly on the ground, and dehorning material is rubbed on the young horn until the hair has been removed. Rubbing should cease before bleeding takes place. The process should then be repeated on the other side of the calf's head. When both horns have been treated, the calf should be placed in a stanchion or be securely tied to prevent rubbing of the treated spots and to prevent the calf scratching the spots with its hind feet. The calf should not be turned out, particularly in rainy weather when the caustic material may run to the eyes, until the treated spots have dried. If the work has been properly done, no horns will develop; if it has been carelessly done, the animal may be disfigured for life.

Vaccinating

That prevention is better than cure is especially true in relation to livestock; many common livestock diseases may be prevented if vaccinations are carried out at the proper time. The diseases of cattle for which there are preventive vaccines are Blackleg, Contagious Abortion (Bang's

disease) and Anthrax. Calves should be vaccinated against Blackleg at three months of age and against Contagious Abortion when the calf is four to eight months old. Animals in areas where Anthrax is known to occur should be vaccinated against this disease annually.

Milking

Milking a cow by hand is an art which few people have mastered successfully. A good, clean, fast dry-hand milker should be rated as a skilled workman.

A cow should be milked at the same time every day, and it is also advisable that the same person should milk the same cow every day. A cow's udder consists of four separate glands, the four quarters of the udder. On an average, the rear quarters produce 60% of the milk, and the fore quarters 40%. Each quarter is entirely separate from the other three.

The udder should be wiped and massaged with a warm chlorine disinfectant solution one minute before milking commences. This action stimulates the cow to let down her milk, and it is also a sanitary measure in that chlorine is a potent germ destroyer. The wiping and massaging sets up nerve impulses which cause a gland at the base of the cow's brain to release a chemical substance, a hormone, into the blood stream. The hormone travels to the udder which forces milk into the teat and gland cisterns, whence it may be removed by the action of milking. The process is known as the 'letting down' of milk. Similar stimulation may be effected by giving the cow feed, by other activity in the cow shed associated with milking, and by the muzzling of a calf. The effect of the hormone lasts for seven to nine minutes and obviously milking should be done very quickly in order to get the best results.

Clean milk may only be produced by clean methods and strict attention to general sanitation. The milker should see that his finger nails are cut short, clean overalls should be worn, and the milking buckets should be washed and sterilized in boiling water after each milking. During milking unusual noise or other distraction will upset the cows and may cause them to hold up the milk. Even the changing of milkers very often results in reduced production for a few milkings. Accordingly, it is wise that milkers be assigned definite cows for daily milking, rather than be allowed to milk any cow from day to day.

In hand milking the milker should use his full hand, with a squeeze, a release action, and a slight pull towards the bucket. Digging the fingers or the thumb into the teat should be avoided as this may cause injury to the lining of the teat. Dry-hand milking only should be practised, as wet-hand milking is a dirty habit. Milking by stripping is also a poor practice; in addition to prolonging the process of milking, it may cause injury to the teat, and when a cow has become accustomed to this faulty method, she may not send down her milk readily when the proper method is introduced.

High-producing cows should be milked three times per day. Experiments have shown that this procedure instead of twice daily milking increased production by 20%. Cows milked four times per day will give 5% more than when milked three times. Additional feed will be required by the cow to supply the nutrients necessary for manufacturing the extra quantity of milk.

Milk and Breeding Records. No satisfactory progress may be made in the management of a dairy herd or even in an individual cow unless an efficient system of recording the feeding, breeding, production and other factors is maintained. Milk records show whether a cow is profitable or not. The only way to determine accurately the production of a cow is to weigh the milk regularly during the lactation period and to keep a record of the weights. With this procedure, it is possible to feed the cow concentrates according to her production and it is also possible to detect when a cow is off condition as the first symptom of illness is a drop in production of milk. Many animals have been saved by the milk record showing that production was not up to the the usual standard.

The breeding efficiency of a cow may be determined only by the keeping of records. A cow should calve every twelve to fourteen months if she is to be profitable. A breeding record should show the date of service, name of sire, date of calving and sex of calf. No more than three months should elapse between calving and breeding. The record of service enables a cow to be dried off in time to give her a rest before calving at or about seven months after she was bred. Records also help in keeping a check on age and family relationship among the animals of the herd. If records are maintained there can be no question as to age, identity of sire and dam, and milk production when a sale is to be made.

In addition to records of breeding and milking, other important records are those related to quantities of feed, dates of vaccination and dates of dipping and spraying and deworming. Practical dairymen keep a day-to-day diary in which are entered all daily services, calvings, illness, pastures fed and all other happenings on the farm. Entries into permanent records are then made periodically from the daily diary.

The Care of Farm Dairy Utensils

That milk should remain sweet for a reasonable period of time is of considerable importance. The farmer who fails to take the necessary care is bound to lose money. If he is to escape such losses he must find out where his methods are at fault and take steps to correct them, so that the keeping quality of his milk may be improved.

As is well known, spoilage of milk is due to the action of bacteria. Milk of satisfactory keeping quality must therefore contain few bacteria. This means keeping down the numbers of bacteria getting into the milk.

In order to prevent bacteria from getting into the milk, the milk producer must know where they come from. Primary consideration should be given to the most important sources, the degree of attention given to the minor ones varying with the requirements of the market.

Careful experiments have shown that poorly cared for utensils or dirt from the cow's body account for more added bacteria than all other sources combined. Therefore, neither of these sources can be neglected. Of the two the utensils are the more important, hence success in producing milk containing few bacteria will depend mainly upon the care taken in their cleaning and sterilization.

It is not only the carelessly washed pail or can that adds large numbers of bacteria to milk, although these are naturally the worst offenders. Even cans and pails that have been washed and steamed or scalded, and appear perfectly clean, may add millions of bacteria to the milk at the next milking if traces of moisture remain in them. There are always a few bacteria remaining after the steaming or scalding and these may grow very quickly in the film of moisture inside. Within a few hours at ordinary temperature, hundreds have become millions and at the next milking the milk picks up a heavy seeding of bacteria.

Washing Dairy Utensils. Only the best grade of utensils, if possible of seamless construction and made of some non-rusting metal should be used, or failing this, heavily tinned steelware. Galvanized, enamelware or wooden pails should never be used. Utensils with rusty spots, cracked seams or rough surfaces are hard to keep clean. Should any cracks or open seams develop, they should be filled with solder immediately, otherwise they offer protection for many bacteria which seed the milk at the next milking. 'Milk-stone' which forms from the milk solids and the minerals in water and cleaning solution, provides excellent protection for the bacteria, and its formation should be guarded against. If it appears, it should be taken off at once with a specially compounded 'milk-stone remover' or acid detergent. Steel wool should never be used. It leaves a scratched surface, and hastens rusting.

After milking, a film of milk covers the inside surface of utensils. This should be removed without delay, for if allowed to dry on it is hard to remove. Best results follow the use of a warm rinse; very hot water should not be used as it scalds the film of milk on to the metal. The remaining traces of milk should next be removed with a stiff bristle brush and a hot (125° F.) solution of a good dairy cleaning compound. Such a product is specifically designed for the job of removing milk residue and minimizing the formation of milk-stone; it will soon pay for itself over cheaper products. A wash cloth should not be used; it is hard to keep in a sanitary condition and may harbour billions of bacteria; and it tends to smear the milk film and bacteria over the surface rather than remove them. Soap is also unsuitable because it forms a greasy film and curd-like particles that are hard to rinse off.

While a good alkaline dairy cleaning compound is effective in removing the remaining traces of milk, failure to use it regularly as directed may lead to the formation of a film of milk-stone. If allowed to build up, a laborious treatment with a special milk-stone remover is required to take it off. One means of preventing the formation of such a deposit is to alternate the use of the new acid type cleaning solution with the regular alkaline type. The acid cleaner is less effective against fat and proteins, but does dissolve the mineral deposit. Frequency of treatment with the acid cleaner will depend upon the rate at which the film forms. In extreme cases it may be necessary to use the acid cleaner every other day, while in others once a week or less may suffice. However, the simplest way to avoid milk-stone is to brush with a good alkaline dairy cleaning compound according to directions after every milking.

After pre-rinsing and brushing, utensils should be given a clear rinse, preferably with a large quantity of really hot water. This leaves the surface clean and hot, and ready for the next step. After being shaken to remove as much moisture as possible, the utensils are placed upside down on a suitable draining rack to drain and dry.

Treating to kill bacteria. If the utensils always dried rapidly there would be little to worry about, for bacteria cannot grow in the absence of moisture. However, some moisture nearly always remains in the form of a film. As previously mentioned, at favourable temperature the surviving bacteria will multiply so rapidly in this moisture that enormous numbers may be present by the next milking. Consequently it is advisable to rinse all dairy utensils with sanitizing solution immediately after milking. An active hypochlorite compound is generally favoured for this purpose and if the surfaces are clean and free from milk-stone, this step should leave very few bacteria to contaminate the milk. Although the method outlined above is the one generally recommended, there are several others available. Heat, either in the form of steam, hot water or hot air, is a most effective agent, provided it is so used that the metal surfaces are heated sufficiently to kill bacteria. So-called 'scalding' of utensils with a kettleful of hot water is rarely effective since the volume of hot water is not sufficient to heat the surfaces sufficiently to destroy bacteria. Moist air sterilizing cabinets where the freshly washed utensils are subjected to temperature of 180°–200° F. in an electrically heated cabinet, have the added advantage of leaving the utensils perfectly dry and protected from dust, insects, etc. However, hot water and hot air require more equipment than is found on most farms,

and are less convenient and more expensive than chemical solutions. Finally, the newer quaternary ammonium compounds which are offered under a variety of names are being used to some extent in place of hypochlorites as a sanitizing rinse. Although their use has not received as full approval as has the hypochlorites, they too appear to be effective disinfectants on clean surfaces.

Care of Milking Machines. The milking machine with its yards of rubber tubing offers wonderful opportunities for bacteria to develop and contaminate the milk. Unless properly looked after, the milking machine may easily add more bacteria to milk than all other sources combined. It is better as well as easier, to keep the machine clean at all times than to clean a dirty machine.

A number of methods of caring for milking machines have been described but many are laborious and time-consuming. The milking machine is intended to be a labour saving device; if the time saved in milking is to be spent in looking after the machine, there is little appeal. Consequently, many milking-machine users save time by taking short cuts, and in so doing often get into trouble from high bacteria counts, off-flavours, etc. The aim is to find the simplest possible method of maintaining the milker in good sanitary condition as judged by both physical cleanliness and freedom from excessive bacteria.

A method has been developed which depends upon the ability of a weak (0·5%) lye solution to remove traces of fat and protein from the rubber parts, and to prevent the growth of bacteria thereon between milkings. It has also the advantage that hot water is not needed in the daily care of the teat cup assembly, leaving more to be used on the pail, pail head and other metal parts. The following is a description of the method:

1. Immediately after milking the last cow suck a pail full of clean water preferably at 100° F. through the teat cup system into the milker bucket. Raise and lower the teat cups so that air and water surge alternately through the tubes. This gives an air-brush effect and removes more of the milk residue. Use a fresh pailful for each unit. Brush the outer surfaces to remove milk.

2. Disconnect the long milk tube and hang the teat cup assembly on a solution rack. Such a rack may be built from a few pieces of lumber along the lines indicated. Be sure the rack is perfectly level. Completely fill the assembly with lye solution and leave until the next milking.

3. Wash the pail and pail head, including check valve and rubber gasket, in the same manner as the other utensils. Rinse in hot water, 180° F. or hotter, shake, and place upside down on the draining rack.

4. Before the next milking drain out the lye solution, assemble the unit and suck a pailful of hypochlorite or quaternary ammonium solution through the teat cups. This may be the same solution used to rinse the other

utensils. If prepared from hot water, it may be saved and used to wash the cow's udder and prepare her for milking.

5. Once a week dissemble each unit completely for careful inspection. Brush all parts in a hot solution of dairy cleaning compound. Boil the liners and milk tubes in 2% lye solution (8 pounded teaspoonful per gallon) for 10 to 15 minutes, rinse thoroughly, and store in a cool, dark place. Substitute a second set of liners. (By boiling them in lye and alternating their use, their length of life is greatly increased.) Replace rubber parts at once when they show signs of cracking or checking, otherwise high counts may be expected.

As previously mentioned this method has proved highly satisfactory on a number of farms. With some water supplies, however, a film of mineral salts may build up on the rubber parts. This may be avoided with hot cleaning solution following the cold water rinse. Another method is to substitute a suitable acid type cleaning compound in place of the lye solution whenever this type of deposit is observed. After the acid cleaner has dissolved and deposited, the lye solution may again be used until the deposit once more becomes evident. The importance of perventing the formation of milk-stone cannot be over-emphasized. It takes far less time and effort to prevent its formation than to remove it once it has formed. Milk-stone provides food and protection for bacteria, hence it is frequently the source of high bacteria counts and particularly of heat-resistant types which survive pasteurization and make it difficult for milk dealers to meet bacteria count limits. Because of its porous nature, rubber is extremely difficult to keep clean and free from bacteria. As it ages, fine cracks develop on the surface, increasing the difficulty in cleaning. Bacteria find excellent opportunities for multiplication in these pores and crevices, where they are largely protected from the action of cleaning and sanitizing solutions. The most effective means of keeping rubber parts clean and destroying the bacteria present is a weekly boiling in 2% lye solution. Boiling in lye solution does not harden rubber but actually improves its condition. All rubber parts should be carefully inspected at least weekly and any showing signs of checking or cracking should be replaced at once. Rubber parts will last longer if protected from butterfat, heat and strong light.

Air hoses and vacuum pipe lines should be cleaned out at regular intervals and especially when milk is accidently drawn up into the line. Starting at the stall cock nearest to the pump, suck a pailful of hot 2% lye solution through every other one, taking care not to overfill the moisture trap on the vacuum line. Drain the tank, then follow with a pailful of clean hot water. Open all stall cocks and allow to drain and dry out.

Check valves should be carefully washed after every milking. If neglected they may be responsible for serious contamination of the milk. Storage between milkings in lye solution is recommended.

Care of Cream Separators. Cream separators require careful attention. If left unwashed, the bacteria present may multiply to enormous numbers and these will contaminate the cream at the next separating. This is one of the chief reasons for poor quality cream. For best results, the separator must be thoroughly washed and sanitized after use. Less than 5 minutes are required to complete the task if these directions are followed:

1. As soon as the milk has drained from the supply tank, rinse the tank with a cupful of warm water.
2. Next pour a pint of warm water or skim-milk directly over the float to clear the cream from the machine.
3. Pour a pailful of hot (130° F.) solution of a dairy cleaning compound into a supply tank. Allow this to flow through the separator while the bowl is still turning. Recover the solution in a pail or dishpan. During this time clean the supply tank and spouts by brushing with a soft brush.
4. Dismantle the machine and place cleaned spouts, float and inlet in the supply tank.
5. Open the bowl and place disks on the disk rack. Spread and brush these and the bowl with the cleaning solution, if necessary, then place in the supply tank.
6. Pour several gallons of really hot (180° F.) water over the parts; drain off this water, shake and hang the disks on a hook and leave the other parts in the supply tanks, where they will dry off from their own heat.

A separator cared for in this manner will not only turn out a better quality of cream, it will also last much longer and will skim cleaner than one not properly washed.

Where for any reason the full programme described above cannot be carried out, the machine should be rinsed and then the hot cleaning solution flushed through. The bowl should be drained and held in a cool place until next milking, then when the separator is assembled, and the bowl up to speed, a pailful of hypochlorite solution, prepared according to the manufacturer's directions and preferably hot, should be poured into the supply tank and allowed to run through. While this will greatly reduce bacterial contamination of the cream, it is not so effective as the regular method described above.

Use of Minerals in the Maintenance of Dairy Cattle

The role of minerals in the feeding of livestock was little understood up to the latter part of the nineteenth century. Although it was commonly felt that salt, phosphorus and lime (calcium) were necessary for the health of animals, the amount of these elements required by the milking cow and other types of livestock were to baffle farmers for a long time. A great deal of information in this area is now available, having come about as part of the body of knowledge which has been built up in the field of nutrition since the turn of the present century.

Feed companies are now making extensive use of mineral supplements in compounding rations and it is timely, for it is now clear that fodder grown on badly eroded soils as are found in Jamaica is greatly deficient in essential minerals.

What causes certain animals in certain parts of Jamaica to suffer a 'nervous' condition in which they spin around and fall is not known, although the evidence suggests a mineral relationship. What causes a progressive wasting away or stiffness of joints in cows especially in the central part of Jamaica is not clearly known. The latter has been labelled 'Manchester Wasting Disease'. It is known to have a mineral relationship since it occurs only on the bauxitic soils in Jamaica. Indeed there are many other puzzling ailments which are believed to be due to insufficient and/or imbalance of minerals. It indicates that much more needs to be known, but nutritionists the world over are hard at work in the field and laboratory. In the field they are busy correlating troubles of animals reared under certain soil conditions. In the laboratory they are compounding rations and by appropriate means leaving out a particular element this time and at another time, another element, and then observing the effects. In so doing the role of each element in the body is determined on the basis of the abnormality created.

Let us now see some of what has been learnt about minerals over the years.

What is meant by Minerals? When a plant or animal is burnt, the residue or ash is what is referred to as minerals. On analysis of the ash, the following minerals are found: calcium, phosphorus, sodium, chlorine, potassium, manganese, magnesium, sulphur, iron, iodine, cobalt, copper and zinc. Of the above minerals, calcium, phosphorus, sodium and chlorine are liable to be short in the diet. Fortunately, calcium and phosphorus are found in bone meal, calcium in limestone and sodium and chlorine in common salt. Occasionally, there is a deficiency of iron and iodine, but in general most of these elements will be found in sufficient quantities in the average type of fodder used in livestock production.

Effects on Dairy Cattle. The minerals control life's processes, and a deficiency results in a lack of thrift, poor health, emaciation and disease. Blood lacking in sufficient minerals lacks tone and the ability to resist harmful organisms entering the blood stream. Thus early-maturing animals not supplemented with minerals fall easy prey to pneumonia and other diseases. Young animals need a great deal of minerals and in the right proportion because the growth of all new tissue involves all minerals and in proper balance. Calcium and phosphorus build bone and aid in circulation. Phosphorus is found in the nerve centres. Calcium aids in the

clotting of blood. If chlorine is not present to work with calcium, potassium and sodium, the heart cannot beat. If copper is not present the cow cannot make use of iron from its feed. Cobalt is very essential in the manufacture of red blood cells and in giving appetite.

Not only is it necessary for calcium and phosphorus to be present in the cow's system and to be available, but it is necessary that they be in the right proportion. An imbalance, especially seen in heavy producing cows at the time of calving, results in milk fever. In this condition calcium in the blood stream is in short supply because much of this is drawn off to be put in milk. This leaves phosphorus relatively high, thus the cow is forced to draw calcium from the bones and at the same time work hard in excreting phosphorus to maintain the critical balance. A cow with milk fever is greatly weakened from the loss of calcium from its bones, hence the invariable reclining position. When the readily absorbed calcium gluconate is injected and the cow recovers it means that the deficiency of calcium is removed and the balance between the two elements restored.

Experimental work has shown that by feeding common salt to dairy stock growth and production will increase. Better results from dairy and beef cattle have been obtained on farms with pastures on brackish lands. Cows have shown definite hunger for salt. There is a great deal of evidence to indicate that heifers grown out where a deficiency of salt existed conceive much later than those grown under normal conditions. The question of growth and development is the greatest drawback to economical livestock production. And when it is realized that many cases of infertility in dairy cattle can be traced to retarded development and an advanced age of first calving, it behoves the dairyman to satisfy all the requirements for early maturity.

Phosphorus aids in the consumption of more roughage and thus helps to increase the feeding capacity of the cow.

When cows are resting between lactations, they should build back the reserve amount of minerals in their system, especially calcium and phosphorus. With the quality of our grasses, if the period is not long, this is not possible. For heavy production, a cow should not be dried longer than sixty days as stromatic cells commence to be laid down in the udder and reduce its efficiency. Thus it is essential to feed minerals to cows at this stage, as the cow when in heavy production will be unable to absorb sufficient minerals to supply the milk and thus must draw from her reserve, or else reduce her supply, or her system must suffer. Calves produced from cows not well supplied with minerals will tend to be small and weak, and a good start in life is absolutely essential for the future usefulness of the animal.

There are innumerable general disorders in addition to the many well-known diseases traceable to mineral deficiencies and imbalance. These general disorders come about in a widespread generalized way, that is to say that the animal's body is like an intricate machine. Pull one cog and the entire machine does not function satisfactorily. Thus it can be seen that a deficiency of a single mineral can open the way for many secondary disorders to develop.

Causes of deficiency. The chief cause of deficiency lies in the heavy demands made by animals especially under intensive management where higher and higher yields are desired. When a 1,000 lb. steer is sold off the farm, 39·5–42 lbs. of minerals are removed. Thus if 100 head are sold annually, 4,000 lbs. of minerals are removed or its equivalent or enough to fertilize 20 acres of grass or corn.

Every 100 lbs. of milk carries with it 1 lb. of minerals. Thus on a farm which sells 400 quarts daily, 10 lbs. are removed, or about 3,600 lbs. of minerals annually. When the cows are brought into the stable and pens, the droppings and urine leaking away, remove a considerable amount of minerals from the pastures.

Quantity, Composition and Manurial Values of Different Classes of Livestock*

	Horses	*Dairy cows*	*Steers*
Lbs. per ton	35–45	70–80	40–50
Nitrogen	11·8	9·7	13·8
Phosphoric Acid	5·6	5·4	5·6
Potash	14·6	9·4	10·6
Values per ton	\$2.57	\$2.00	\$2.57

Thirty cows will produce 1 ton per day. Now if 20% of this is lost by being stabled, then in 5 days thirty dairy cows will produce 1 ton of manure. Thus, with every 30 cows 1 lb. of phosphoric acid and 2 lbs. of potash are lost daily, which would be over 1,000 lbs. annually lost from the farm.

Lime is being removed by the animals and by leaching out of the soil along with the other minerals that enter in the soil solution. When we consider that the greater part of our pastures are uncultivated (whereby minerals from the lower strata are made available) and nothing is being returned, we will realise how, day by day, the soil is being depleted, and thus the major reason for fodder becoming less and of a poorer quality.

Correcting Mineral Deficiency

By Pasture Improvement and Management. Much attention has been focused on pasture improvement in recent years and the result is an increase in quality and quantity of fodder. This has been greatly facilitated by soil surveys which have made it possible for most of the island of Jamaica

* *Manures and Fertilizers Bulletin 364*, Ontario Agr. College, Ont. Dept. of Agriculture.

to be soil mapped and the capability of the land determined. Such marked mineral deficiencies as have been seen in certain areas serve to bring home most forcibly the need for restoring the fertility of the land. The application of fertilizers to pastures has now become routine in many sections. Having regard to the variations with respect to the mineral contents of soils in general, no single recommendation can here be given for all pastures. However, any Extension Officer can, by reference to the Government Division of Crops and Soils, advise on the application to be made. Hand in hand with the application of fertilizers for correcting mineral deficiencies should be the mowing of pastures. Pastures should be mowed just after heavy rains in November. That dense stemmy growth should be cut back, irrigated where possible, and then the application of fertilizers made. The application is made to give a spurt to the grass at this season of low growth. There will be therefore a uniform growth largely because essential mineral elements have been furnished by the fertilizers applied.

Another way in which mineral deficiencies can be corrected by pasture improvement consists of adopting a programme which makes it possible for different types of grasses to be grown. Certain mineral elements may be abundant in some grasses but found to a lesser extent in other grasses. A type of supplementing takes place in which mineral deficiencies are prevented, when a rotation can be worked out with such established pasture grasses as Guinea, Coastal Bermuda, Pangola, Wynne and Para.

Since it is well known that legumes are rich in calcium it is to be expected that good pastures should carry some types of legumes. In temperate zone countries it is the clover, Alfalfa, Vetches and other legumes that make for the superior performance of these pastures. Besides serving as a direct source of fodder the legumes also provide the environment for the growth of grasses in association, thereby furnishing adequate feed and concomitantly an adequate supply of mineral matter.

In general, pasture improvement means carrying out such practices as will ensure the maximum amount of feed all year round. Most mineral deficiencies, let alone deficiencies of vitamins, proteins and other food constituents, are seen in animals, simply because they are not able to find enough food. A cow producing about eight quarts of milk per day requires about 18 lbs. of dry matter in the feed. It is estimated that our pastures in Jamaica contain not over 20 lbs. of dry matter to the acre, therefore a cow producing daily the amount of 8 quarts of milk would require just about 100 lbs. of dry grass per day, but how many cows really get as much as 50 lbs.? Indeed many of the animal health problems that we encounter would not have been if our animals were better fed.

Feeding Mineral Supplements

Common Salts. Teach a few cows to lick the salt, and these will in turn teach the rest. Rock salt may be used. A small stand should be made, about 2 feet above the ground, and cover so that rain water will not dissolve the salt. The shed above the salt should be high enough that it does not prevent the cows licking the salt, and the stand must be convenient to young stock. It may be fed to the young cows while in the stanchions, or mixed with the grain feed at the rate of 2 lbs. per 100 lbs. feed.

Bone Meal. This provides phosphorus besides calcium. Phosphorus is the chief mineral lacking in our feeds. There is good evidence to believe that the poor reproductive performance of very many of our cows is traceable to phosphorus deficiency. The daily requirements of phosphorus by dairy cows and heifers range between 16 and 20 grams per day but very little of this is supplied by our pastures. Tests have shown conclusively that our pastures contain no more than 0·1% of phosphorus. It is obvious then that nearly all of the required amount must be given in the form of supplementary phosphorus, and in this regard bone meal comes in quite handy.

Feeding Salt and Bone Meal

A salt-bone meal mixture is to be recommended for supplementary feeding of calcium, phosphorus and salt. The proportions of the two ingredients are of great importance if the mixture is to be self fed. The one which determines the quantity that will be eaten voluntarily is the salt. Therefore if the salt forms too large a portion, then very little of the other ingredient which is designed to furnish phosphorus and calcium will be consumed.

An average dairy cow requires about 1–2½ lbs. of salt per month and as stated before about 18 grams of phosphorus per day. To supply these it is recommended that a mixture containing 1 part salt and 2 parts of bone meal be made available at all times.

In the past it has been customary to recommend all kinds of mineral mixtures, most of them rather cumbersome to behold, and tending to furnish more calcium than was desirable. Under average conditions calcium is never critically deficient, and especially where concentrate mixtures containing adequate amounts of ground limestone are fed, no more calcium need be fed.

The modern trend favours the feeding of mineral licks containing certain trace elements now known to be useful, notwithstanding the small amounts in which they occur. These licks can be conveniently obtained at nearly all feed stores. This procedure of feeding mineral commercial licks is to be recommended over that of feeding home-mixed supplements, because the former are usually better balanced than home-made licks.

Handling Cattle

The successful handling of animals is almost as important as breeding and feeding, and is certainly an integral part of management. Without good management the owners of livestock can never hope to derive that profit which is one of the primary purposes of domesticated animals.

Zebu cattle are very nervous and should always be handled gently. The use of thong whips should be avoided, and especially noise. This has been the chief cause for the difficulty experienced with Zebu cattle. When gently handled they are likely to be the most friendly members of the cattle family.

The efficient livestock owner will always see that his cattle are capable of being handled and inspected without being at the other side of the fence, and in so doing his first thought will always be—treat them gently. Animals that are harshly treated will never produce the same returns as those that are gently and properly handled. This applies especially to the dairy cow that is very susceptible to ill-treatment. A milking cow that is ill treated immediately becomes nervous and her first reaction is to withhold her milk. To a lesser extent the beef animal that is nervous and constantly galloping about is not as likely to produce as high a proportion of live-weight gain in relation to the food consumed as one that is quiet and contented.

The training of all dairy animals should be done when they are young, at which stage kind treatment and proper handling is more readily impressed on their minds. In other words, 'catch 'em young but don't treat 'em rough!'

The first stage therefore in the training of calves should be at about one week old; that is, as soon as they are 'on their legs' and can run about the calf house without the staggering gait that generally accompanies the new born. At this stage they should be trained to a proper halter and not

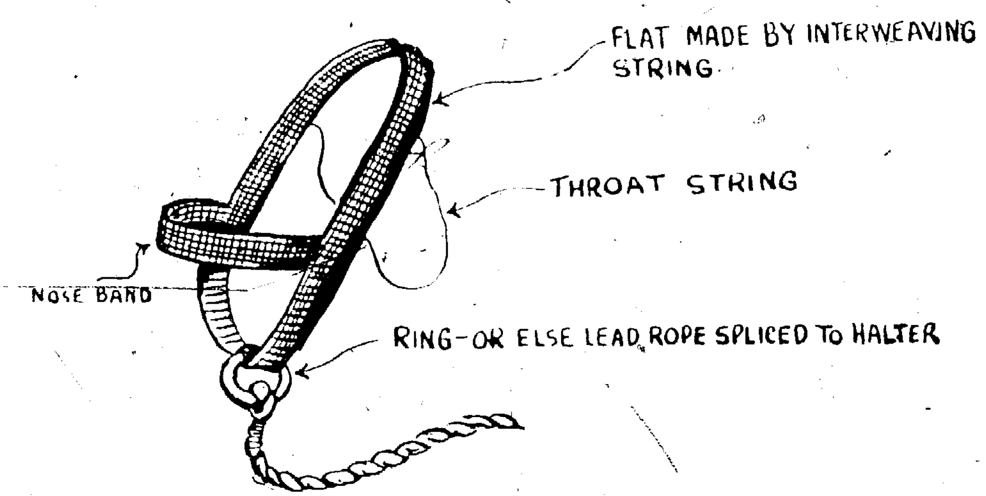


Fig. 1. Halter woven from string-web type

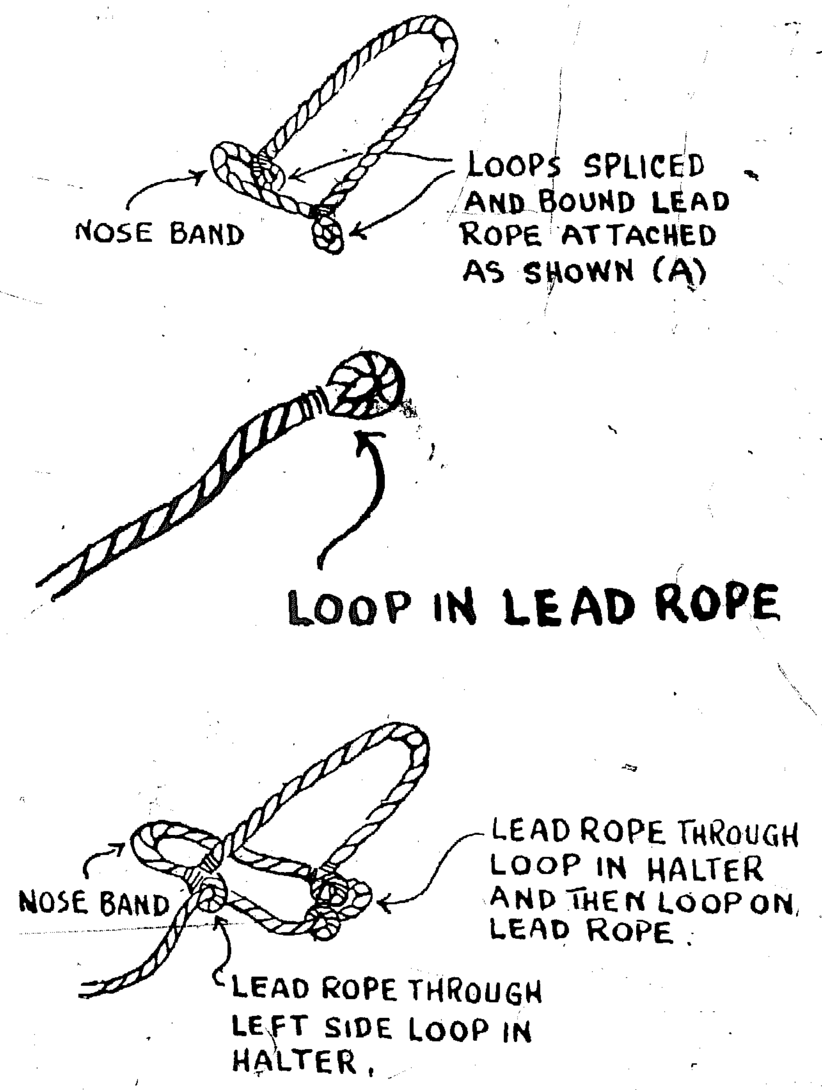


Fig. 2. Halter made from rope-rope type

just a rope around the neck. It will save a great deal of time and energy if it is done at this stage. Simple web rope halters can be made as shown in the accompanying sketches.

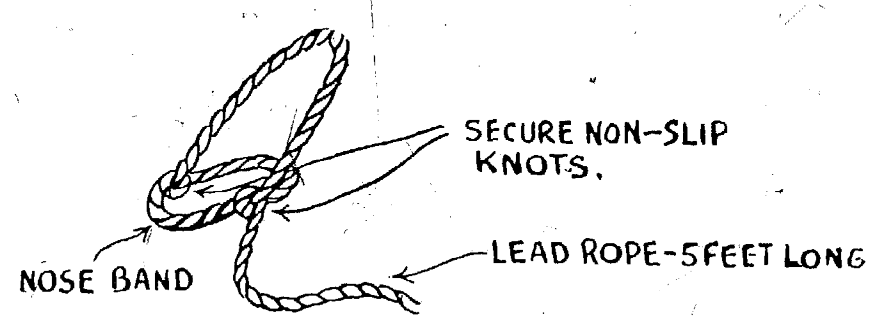


Fig. 3. Simple halter made from single length of rope

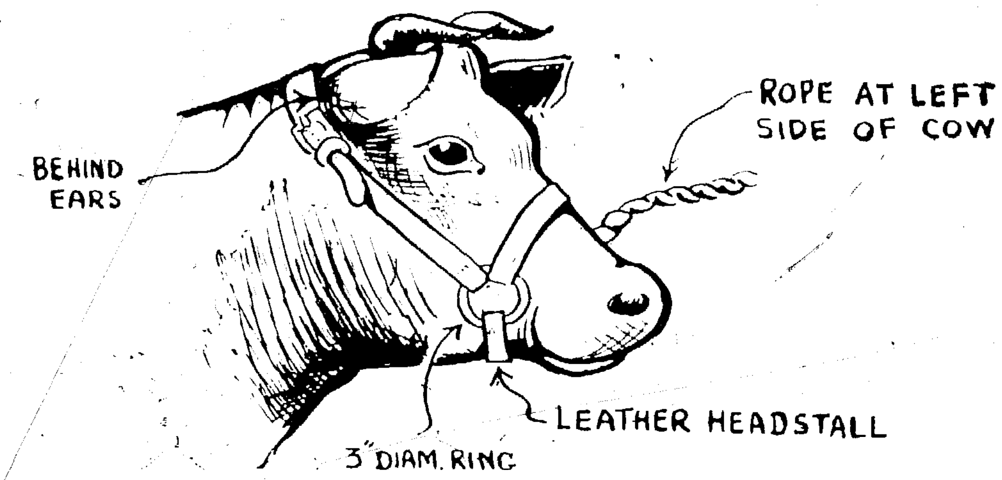


Fig. 4. Adjustable leather headstall for use with lead rope shown in Figs. 1 and 2

When training an animal to lead, care should be taken to see that the halter is of the type shown in Fig. 1 or Fig. 3 where the rope is of the non-slip variety otherwise when the animal resists and pulls back, the tightening action of a slip noose will cause discomfort and skin the under jaw. That shown in Fig. 2 is the simplest and easiest to make but should only be used on animals that are trained to lead. All the types shown can be made to any size but it is best to have three sizes, for calves, young stock and cows. If calves are trained to lead at an early age, say two or three times per week, they will never forget and can be turned out to pasture at six to nine months of age with the knowledge that when they come in to the dairy as cows they will not have forgotten. After a month or six weeks leading as calves, once or twice a week will be sufficient to keep them familiar with the routine.

A more elaborate and permanent type of halter can be made from leather and is shown in Fig. 4 with a simple variation for trained animals as shown in Fig. 5. These are of course adjustable, but it is best to have two

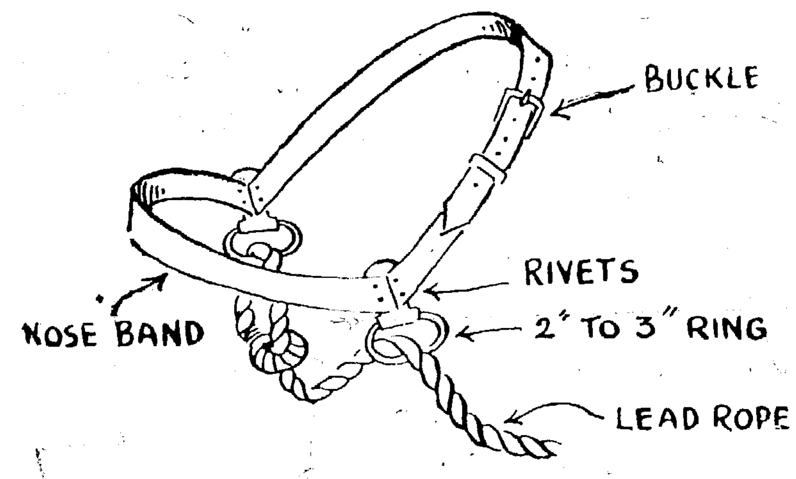


Fig. 5. Simple adjustable leather headstall for use with trained animals

sizes—one for young calves and heifers up to 15 months old, and another for older heifers and cows.

The common method of leading a cow with a rope or chain tied round the horns or neck is neither safe nor humane; and with an additional 15 or 20 feet of rope trailing behind makes it even more dangerous, as a man or boy is more often than not tripped up if the cow runs away or takes fright at something. In addition she is liable either to choke or break her neck if the rope becomes entangled. The secret is in having the right kind of halter, and training them as calves.

The proper method of showing animals is important when presenting the animal to a buyer. Animals shown in poor condition or standing badly create a poor impression and may mean a lower price. A bull standing right creates a good impression and also attracts the eyes of the buyer.

Showing Cattle

The fitting and preparing of cattle for Agricultural Shows and Fairs is an art which requires long experience and practice to reach perfection. Only by experience of showing, selecting and observing the technique employed by the more experienced showman can one hope to lead in the winner of a close class.

The first important step is the selection of the animal to be shown; this has to be done months before and is a task requiring good judgment and an eye for type. A study of the prize list should be made so as to select the best animal for the right class. It is no use selecting a dual purpose animal for a dairy class or a young heifer for a mature cow class. The animal selected should be a good representative of the breed, and should approach the maximum age for this class as older animals will have more growth and development. In selecting cows in milk it is advisable to have them calve a month or six weeks before the Show as this gives them time to fill out and they are then usually at their best production. No amount of work or feed will make an under-developed inferior animal into a show winner. The purpose of fitting an animal for show is to develop and train it that it will show to the best advantage.

Equipment. The equipment required for preparing an animal will include the following: a stiff and soft grooming brush, a curry comb, a mane comb for the tail, soap, cloth, wash bucket and a leather or rope halter. A blanket is a useful item of equipment to assist in keeping the animal clean, providing protection against flies, inducing sweating which mellows the hide and hastens the shedding of loose hair.

Feeding. An animal should not be too fat, but should carry just enough flesh to present a smooth sleek appearance. It is advisable to feed the animal being prepared for show on a special fattening ration to bring it up to condition and the ration should contain a proportion of an oil meal

preferably linseed meal, to put a bloom on the coat. A small amount of molasses each day will help in this respect. It does not pay to force the animal too fast as several days off feed may undo weeks of conditioning. Crushed corn and coconut meal is a useful feed in putting on flesh.

Clipping. It is not advisable to clip the animal all over, but those parts of the body which tend to give the animal a shaggy appearance. The head, neck, udder and tail should be clipped to give the animal a clean cut appearance. The hair from inside the ears and around the base of the horns should be carefully trimmed.

The tail should be clipped from the switch to the setting, and any long hair at the top should be trimmed off. The udder and belly of cows in milk should be clipped as this shows the veining to greater advantage.

Washing. Too much washing is not necessary as it removes the natural oil from the skin and leaves it harsh and dry. The animal being fitted, when first brought in, should receive a thorough washing to remove scurf and dirt from the hide, a good brand of toilet soap being used. Broken-coloured animals or animals carrying a large amount of white on legs or flanks often show stains which require a bleaching agent to remove them. These stains can be removed by the application of hydrogen peroxide or formaldehyde. Weak blue water is also effective in whitening stains. One teaspoonful liquid blue to four or five gallons of water is satisfactory.

Grooming. Animals should be brushed thoroughly each day with a good stiff brush; this stimulates the blood circulation and brings out the natural oil in the skin. Every part of the body should be groomed, care being taken to brush the hair the natural way. After grooming with the stiff brush repeat with a soft brush to take off the hair and the dust. Daily application of olive oil applied with a soft cloth and massaged well into the hide will impart a gloss and lustre to the hair. The curry comb should be used mainly for cleaning the brush but it is also for use on the flanks and legs to take off dirt or manure. It should not be used on the animal except for this purpose. It should be remembered that grooming is just as important as feeding in getting an animal in condition. A good grooming is worth an extra quart of feed.

Horns. The horns should be first scraped with a piece of broken glass or filed with a coarse rasp to remove the rings and scratches, starting from the base and working up to the tip; care should be taken not to scrape the horn down to the quick, or bleeding might occur. If the horns are too long an inch or more may be sawn down and scraped down to new points. After removing all the rough spots, use narrow strips of emery or sand paper see-saw fashion round the horns to obtained a smooth surface. The horns should then be rubbed with olive oil or linseed oil and then polished with a soft cloth. After the horns have been scraped and polished they should be wrapped in bandages to prevent them becoming scratched and scarred

The manicuring of the horns takes some considerable time and the animal may become restless, so it is best not to work more than half an hour or so at a time daily on the horns.

Hoofs. The hoofs should receive attention and be properly trimmed so that the animal will stand level. The toe, if long, should be cut back to the natural shape. The sole should be level and the heel lowered; the weight of the animal should rest on the walls of the hoofs, not on the pad. Care should be taken not to cut so close as to draw blood or you may find your animal lame on the day of the Show. The hoofs, if black, may be cleaned and shined with boot polish; amber hoofs should be cleaned with neat's foot, linseed or olive oil in the same way as the horns.

The Switch. A clean, bushy, well-combed switch adds greatly to the appearance of the animal. The switch should be washed every day to keep it a good colour; in the case of a white switch, hydrogen peroxide can be used for bleaching or removing stains and to obtain a good colour. The night before the Show the switch should be plaited into two or three strands and tied to prevent unravelling; the whole switch should be wrapped in cloth to keep it clean. Just before going into the ring the switch should be let out and well combed and brushed.

Showing. Just a few more words about the showing of cattle at Agricultural Shows. It goes without saying that it is much easier for the judges and competitors if there is a uniform method of showing cattle. At most shows animals are shown with long ropes or chains around the horns or around the neck and some with no rope at all. Thus if a cow or heifer is unruly, the lives of spectators are often endangered. The correct method is to train the animal when to lead with a proper halter as described. But

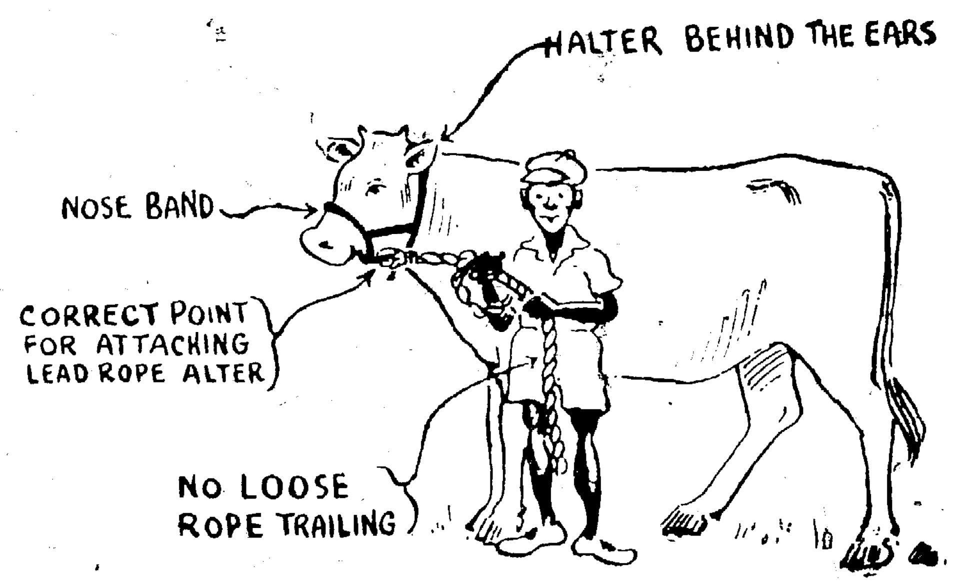


Fig. 6

there is more to it than that. All animals should be led at the left side, that is the halter rope in the attendant's right hand and with the animal on his right side. His right hand should hold the rope about one foot from the point of attachment to the halter and his left hand should hold the loose rope to prevent it entangling in his feet. For safety's sake he can tie a knot in the end. In this way his right shoulder will be close to the left shoulder of the cow as shown in Fig. 6 and if she jumps he has a better chance of keeping her straight. Some stubborn animals may need someone to walk behind.

Each exhibitor should know how to handle his animal and be sure that it is quiet and well trained. It should be arranged to stand square on all four feet, the two front feet together and one hind foot a little behind the other. The head should be kept well up and not allowed to drag on the ground. If the animal is really quiet the attendant can stand in front and take hold of the halter at each side of the jaw bone with both hands and keep the head up. If the steward asks him to move to another place he must do so and arrange his animal in the same position. When the judges have finished, the prize winners should attach the cards to the halter on the right side of the animal and parade round the ring in the order they have been judged.

Handling Bulls

Animal breeders all over the world are becoming more and more alive to the fact that progeny testing is the only safe guide to the value of a bull as a herd sire. This applies equally well to both beef and dairy types but especially with regard to dairy cattle. It has been the practice of farmers until comparatively recent times to buy a young bull, use him for about two or three years, and then sell him to the butcher as being unsafe to keep. In this way many potentially valuable bulls have been lost to their respective breeds. It takes about five to five-and-a-half years to prove a beef-bull and effective sire of high class progeny, or the reverse. The corresponding period for a dairy bull is $5\frac{1}{2}$ to $6\frac{1}{2}$ years. If a bull after this period is proved to be of value as a transmitter of those inherited qualities by which first class animals are judged then it is obvious that such a bull ought to be kept so long as he is capable of begetting calves. Unfortunately as a bull gets older his temper becomes more uncertain and in the interest of safety such bulls are often slaughtered. Although progeny testing of sires in the same way as ley farming is being boomed as a new discovery it is in fact only a rediscovery. Records show that the early breeders of livestock such as Bakewell, Bates, Collings, Booth, Cruickshank, Jonas Webb and many other based their breeding work on progeny testing. Many of them in order to test a greater number of their young sires loaned them to neighbouring farmers at a nominal annual fee and when an outstanding sire was found he was brought back into the herd of his breeder.

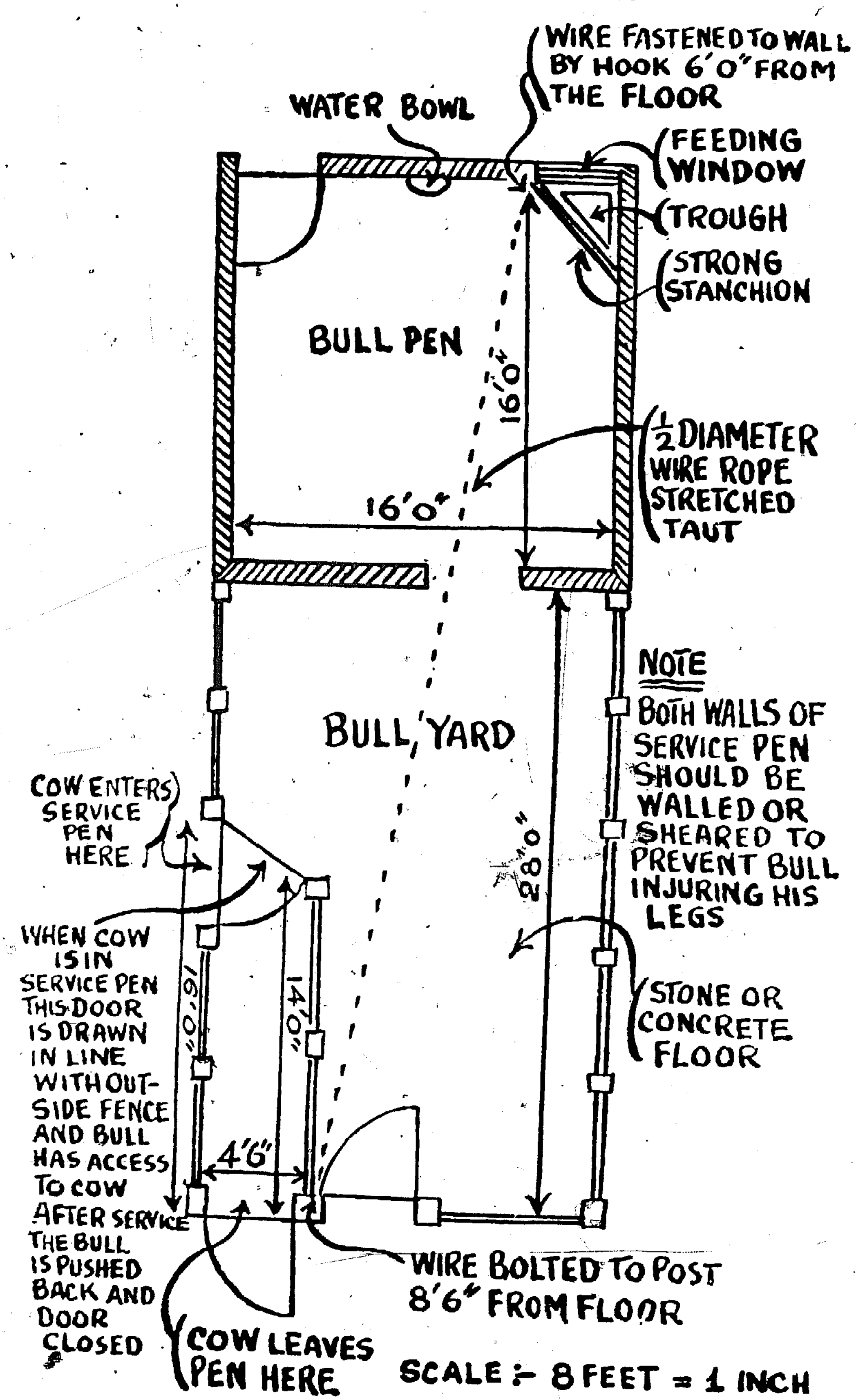


Fig. 7. Bull Pen for fractious bulls

A bull pen for an animal which is confined should be so located as to enable him to see everything which goes on around the farmstead. An animal kept in a confined place and isolated will always lose his temper first. Providing he is known to be reasonably quiet it is a mistake to keep a bull tied up in a cow shed or loose box and in this case a paddock securely fenced, about half an acre to one acre in extent with a suitable bull shed located at a point next to the roadway is always best. Quite often it may be convenient and advisable to put one or two in-calf cows in the pen with him in order to give him company. If a suitable area for a bull paddock is not available he can be kept in an ordinary loose box and tethered out each day for exercise, but when tethering the chains should always be attached round the horns and the lead down the forehead and through the ring in the nose. Such a chain should be light but strong and attached to an iron pin three feet long driven in the ground. The top should be made with a revolving piece. Another useful device is to tether the bull to an old heavy cart wheel which can revolve on the hub yet is too heavy to drag away.

It must always be remembered that bulls are very strong and they must be kept in a substantial building where they are never able to realize their strength. If once a bull finds he can break fences and doors he may try his strength on other objects and persons with serious results. The shed should therefore be constructed of strong materials and should preferably have an area of 150 to 200 square feet. Provision should also be made for feeding from outside the pen and a water supply be provided. A hinged opening in the wall above the manger is suitable, but the ~~better method is to have an~~ ordinary wooden stanchion built across one corner, of specially stout materials. Within this and in the corner is placed the feed trough so that when the bull comes to feed the neck-yoke can be fastened from the outside. It is also desirable that the bull's rings be caught and fastened to the lead rope or staff, or both, from the outside, so that when the attendant enters the pen the bull is secure and can be released from the neck-yolk with safety prior to leading out. The fastening of the bull to his feed trough should be a daily practice to accustom him to discipline and also to enable the attendant to clean out the box and groom the bull in safety. With a bull that will not let anyone catch hold of its ring, it will if a short chain is hung round the horns through the ring, and hanging about 18 to 30 inches.

If the stock bull is kept in an exercise yard as opposed to a grass paddock the yard should have a concrete or hard stone foundation to keep his feet in good order. Such a yard should be preferably about 400 square feet and if concreted the surface should be left rough to prevent slipping. Fig. 7 shows a bull pen and exercise yard that is specially suitable for saucy and intractable bulls. On farms where more than one bull is kept it is advisable

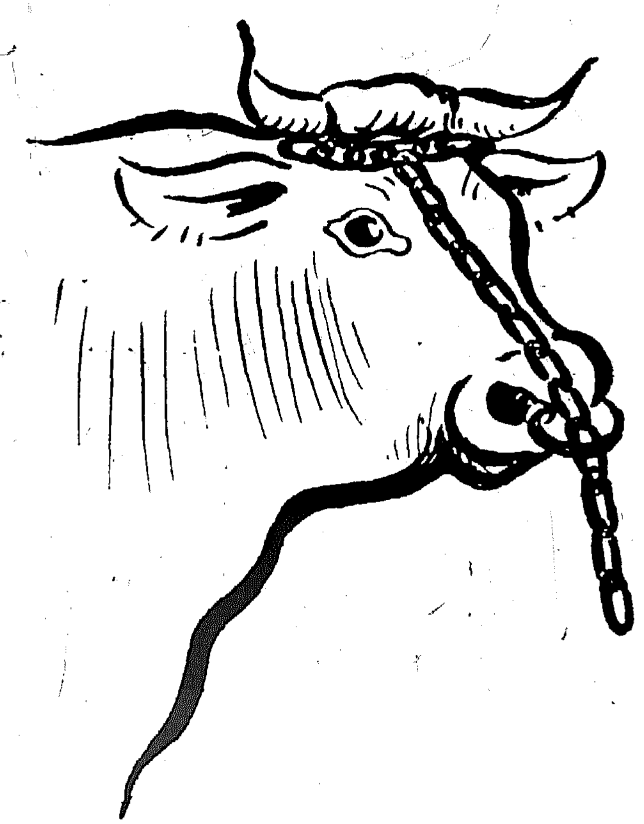


Fig. 8

to have at least one bull pen made to this design. As will be seen a pen of this type provides for an overhead wire rope. A seven-foot length of chain is then looped by means of a 2 to 3 inch iron ring.

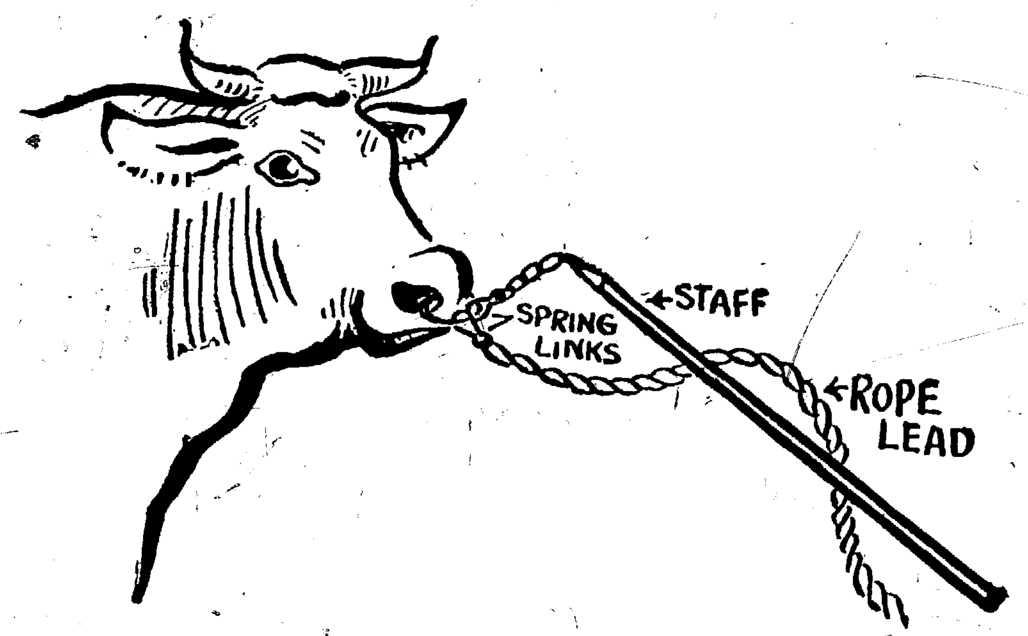


Fig. 9

By this means the bull has complete freedom within the range of his pen but is at the same time curtailed in his activities, and knowing that he is fast, seldom gets abusive. Along with this pen is a service pen which obviates the necessity of a man entering the area where the bull is when a cow is on heat.

When a bull is known to be reasonably quiet there are many ways of handling him when serving cows, but by far the best way is by means of a bull staff. In this way one man can retain complete control. If an animal is inclined to be fractious a second man can always be detailed with another staff, but it is always best to have in addition a 10 foot rope with a spring clasp attached to the ring and held by the man with the staff. Loose rope should be safely gathered up in the hands. A sketch of a bull staff is shown in Fig. 9.

With particularly awkward bulls it may often be necessary to mask them, and there are several types of masks which are advertised in farming papers and can be obtained from the makers.

CHAPTER 47

Beef Cattle Production

Introduction

In Jamaica today, it is the general feeling that beef cattle farming is an enterprise which should only be practised by big farmers. This is because from as far back as we can recall, most of our beef was produced on the big sugar estates and the properties of the big landed proprietors. Beef cattle production under these conditions has always meant several acres of commons to the head of animal. Obviously, farmers not possessing vast acreages would think of any other enterprise but beef.

Fortunately, our approach to farming today is of a more intensive nature. With the realization that the more we subdivide our pasture the greater is the carrying capacity, we have begun to see the fattening phase of beef production as a highly feasible and profitable proposition for the small farmer. On small acreages at the Grove Place Animal Production Research Station it has been possible to carry more than two steers, yielding a total liveweight gain of 1,000 lbs. per annum, on an acre of fertilized Pangola.* By any standard, this is a highly profitable venture, and small farmers would do well to improve their pastures and cash in on the high returns which can be made. Not only will they be making a good livelihood, but the national interest will be served because beef in the Island today is in short supply and indeed supply will continue to lag considerably behind demand for many more years. However, it should be borne in mind that the amount of land required for keeping the capital herd is so great, and the overall cost for maintaining it is so high that the breeding phase of necessity will always be the job of the big farmer.

The beef that is produced in Jamaica today is derived from three main sources, namely, (*a*) culls from dairy herds; (*b*) commercial beef animals; (*c*) pure breeds of local and imported cattle.

Culls from Dairy Herds. Culls from dairy herds include aged and unthrifty milkers, bull calves and cow calves unsuitable for breeding. A very common practice in Jamaica is the rearing of dairy calves and bull calves to several months of age, sometimes several years, but it is to be emphasized that this is an unwise procedure. The results of research have indicated that at a given weight or age animals of the larger breeds (beef)

* See Feeding Beef Cattle, page 660.

gain more rapidly on less feed than animals of the smaller breeds (dairy). When a pound, shilling and pence value is put on the amount of milk fed to dairy bull calves which are eventually to be castrated and fattened as steers, it becomes evident that it is uneconomic to rear them. Instead, unwanted bull calves should be vealed as early as possible after birth. This recommendation would seem at variance with accepted practices in other countries as the United Kingdom where a great deal of beef is obtained from dairy Fresian steers and their crossbreds. Fresians are large boned animals carrying far more fleshing than the relatively smaller Jamaica Hope breed of dairy cattle. In the United Kingdom today many housewives prefer this type of beef because it is beef with a minimum amount of fat and because it is cheaper than beef obtained from true type beef animals. Of course no breed is static and breeders are always moulding their breeds as trends dictate. Thus we find that as the trend is for a great deal of beef to be produced from this source, there is a positive effort to increase the size of our dairy animals.

For some time now, Fresian blood has been introduced into the Jamaica Hope breed for the purpose of increasing its milk and beef potential; therefore it will not be long before we find Jamaica Hopes significantly increased in size. Until this is realized, the only logical thing to do is to veal unwanted calves and channel the milk which would be used in feeding them into the liquid milk market.

Commercial Beef Animals

Until recent years the line of demarcation between milk and beef production on most cattle farms was a slim one. Penkeepers did not, as a rule, specialize in either beef or milk breeds. They were not nearly as interested in maximum returns as they were in the convenience of having animals to furnish them with milk and meat in accordance with the self sufficiency so typical of early agriculture. The pattern consisted of producing milk which would be retailed in the neighbourhood, a fair quantity going to the penkeepers' homes for homemade butter, etc., and making available a steer or cow for beef each week. The cattle kept on these farms were, for the most part, nondescript, because little care was taken in selecting bulls. A bull of an Indian breed would be used at one time, only to be followed by one of the Red Poll breed.

Commercial beef production of this type had a long history in Jamaica. It was not until a Condensery was established in 1939 that any measurable degree of specialization was observed. Dairy bulls chiefly of the Jersey breed were used on many herds which now began to specialize in milk. On others, especially in St. Ann and neighbouring parishes, there was consistent use of bulls of the dual purpose Red Poll breed. Milk was therefore produced, which was sold to the Condensery and at the same time

Fig. 1. The old type of mixed cattle farm

these herds continued to supply the beef shops of the country. Still another source of commercial beef in the Island during these years was the cross-bred progeny of purebred beef sires kept by a few farmers who specialized in pedigreed beef herds chiefly of the Angus breed.

The pattern of beef cattle production has changed since recent years. Nondescript herds are not nearly as numerous as they were two decades ago. Three breeds of beef cattle are now being developed in the Island, namely Jamaica Brahman, Jamaica Black and Jamaica Red Poll, and herds are now being developed in accordance with the choice of the particular farmer. Commercial beef is now derived mainly from the culls of these breeds and also from animals not accepted in the Herd Books and which are multiplied and reared where facilities permit. In addition, a fair amount of crossbreeding is done. Two types of crossbreeding are being practised, namely (1) the Jamaican beef breeds crossed among themselves, and (2) imported purebreds as Charollaise, Aberdeen Angus, Red Poll and American Brahman cattle crossed with Jamaica Brahman cattle.

The results of beef cattle fattening experiments conducted by the Ministry of Agriculture and Lands and certain private farms have shown that crossbred steers are superior to purebred steers of the Jamaican breeds in rate of gain. These results have also shown that good profits can be made from fattening such stock on fertilized Pangola pastures which are satisfactorily managed. Since these findings are in the possession of the leading beef producers of the Island, it would seem reasonable to believe that crossbreeding for commercial beef production has a great future in the Island.

Purebreds of Local and Imported Breeds

A fairly substantial amount of beef on the market is derived directly from the three beef breeds being developed in Jamaica. This has only been since the last five years, although the development of these breeds dates back to 1948. With a comparatively small population to begin with at first, the emphasis was on multiplying the available animals, thus selection of seed stock had of necessity to be very wide, but today breeding has become highly selective. Many of the animals now being denied registration in the Jamaican Herd Books and which are consequently placed in the commercial herds are considered far superior to the type accepted ten years ago.

Most of the high quality beef in the beef shops is derived from steers of the Jamaican breeds. These steers are either carried as a supplementary fattening enterprise on breeding farms or sold at weaning time to certain big farms engaged in purchasing thin cattle and fattening them on grass, and in some instances on grain.

Some of the beef on the local markets is also derived from at least one imported breed, i.e. the tropically adapted Santa Gertrudis breed which was developed in Texas, U.S.A. At present there is only one herd of Santa Gertrudis cattle in the Island. The beef obtained from these breeds is of a high quality, thus all, or nearly all of this beef finds its way to the city markets where premium prices are obtained.

Beef Cattle Husbandry

Beef cattle husbandry denotes the combination of the art and science of breeding and feeding, with the care and management of the animals used in producing beef. For success in this enterprise, a sound knowledge in these areas is highly necessary. A knowledge of the principles of breeding will enable a farmer to make the wisest choice of animals to be reared. The rate of gain and the amount and quality of beef produced by an animal are hereditary factors, i.e. transmitted from parent to offspring. If these potentials are not present in the animals with which we work, then no matter how much feed is provided, the desirable characteristics will not be expressed, and from a practical standpoint the venture is bound to prove uneconomical. It is essential to know the simple principles of feeding. Too often we see animals being fed over-ripe grass which provides but little nutrients. Many cows in Jamaica suffer both a hollow and a hidden hunger, hollow from the standpoint of inadequate feed, hidden from the standpoint of too much bulk and too little nutrients. It should be realized that no matter how well bred an animal may be, it needs the raw materials with which to manufacture beef, because we cannot create something out of nothing. It is also true to say that no matter how well bred an animal may be it cannot produce satisfactorily if it is not given the right care and management.

Some farmers do only fattening; some keep only a breeding herd but do no fattening. Obviously a fattening enterprise suggests the need for a greater knowledge of feeding than of breeding, and vice versa. Whatever the speciality it will be found useful to know about all the phases of operation.

Systems of Production. We often find the following systems of beef production:

1. Cow and Calf System. Under this system, beef breeding herds are kept, calves are allowed to run with their dams and as a rule the cows are not milked. Calves not wanted for replacement are sold at weaning time.

2. Cow and Calf Rearing Combined with Feeding Operations. In this all surplus young cattle are fattened on the farms where they are produced.

3. The Fattening of Cattle. Under this system young cattle are obtained and fattened on grass. Grazing and feeding small amounts of grain under a modified feed lot system where grain is cheap is being tried out in Jamaica. As a rule, the price of concentrates is high, thus it is unlikely that this system will ever become popular.

Fig. 2. Fertilized Pangola carrying 24 heads on 10 acres. Note water drums in foreground and rough shelter in background.

4. The Production of Baby Beeves. The term Baby Beeves applies to finished cattle from 12 to 18 months of age. Baby beef production in its truest form involves the use of grain, the feeding of which is commenced from as early as 4 to 6 weeks of age. Grain is not generally used in Jamaica where on grass alone it is possible to produce baby beeves averaging over 900 lbs. in weight.

5. Broiler Veal. This has not yet reached Jamaica but since it is widespread in England, Holland and other countries of intensive livestock production, it is not unlikely that it could one day be practised here. Broiler veal consists of rearing calves under confinement for approximately 12 to 16 weeks where they finish at an average weight of about 400 lbs. The Dutch system which practises extreme confinement prefers only standing room for vealers, actually 8 sq. feet per broiler, thus they never lie down for the period. The British system favours housing calves in pens which allow 128 sq. feet per calf. Also, under the Dutch system milk substitutes designed to create anaemia are fed because a white meat is preferred by housewives. Humane Societies are objecting to this system, thus it is difficult to predict the fate of broiler veal production.

6. The Production of Purebreds. This is a highly specialized type of production. Essentially, it involves production of pedigreed seed stock. Certain farmers in Jamaica, because of their long history of rearing pedigreed stock, have built up for themselves a high reputation, thus their main income comes from the sale of purebred bulls to local farmers engaged in commercial beef production, as well as to foreign purchasers. More farmers today are attracted to purebred breeding than are those to commercial beef production.

Registered purebred cattle in Jamaica amount to 8% of the total cattle population. This is high in comparison with the United States and England, where purebreds amount to no more than 3 to 5% of the cattle population in those countries. What is the reason for so much emphasis on purebred breeding in Jamaica? The reason is that the establishment of pure breeds in Jamaica is a recent innovation. We are now at the compromising stage—a stage passed through by all the outstanding cattle producing countries of the world, i.e. a stage in which animals conforming to certain laid down standards of excellence are accepted and entered in the respective Herd Books of the breeds being developed. This may be for ten or fifteen years, as the members of the Breed Societies may decide. After this period the Herd Books are closed to the entry of new blood, and only the descendants of the animals found in the Books are considered pure and as such eligible for registration.

Development of Jamaican Breeds of Beef Cattle

Definition of Breed Terms. Understanding the terms generally used in discussing breeds and breeding will make for easy comprehension of what has taken place in the development of our breeds.

1. Breed Society. A Breed Society is an association which is formed for the purpose of keeping the records of the ancestry of individuals within a breed and promoting the particular breed. Every Breed Society carries a Herd Book. The Society determines the standard of perfection or what the ideal animal should be like and this is stated in an official score card. A primary function of the Society is to determine the specific requirements of eligibility for registration. There are three beef Breed Societies in Jamaica, namely Jamaica Brahman, Jamaica Black and Jamaica Red Poll and one for dairy cattle, the Jamaica Hope Cattle Breeders Society.

2. Herd Book. A Herd Book is the official record used to record the animals of the breed. Entries are made in normal sequence. It is to this Book we turn when official pedigrees and Registration Certificates are required. The Herd Book is usually kept by the Secretary of the Society. In Jamaica, where the Ministry of Agriculture and Lands has been giving direction to the development of the Jamaican breeds, the Herd Books of the four Breed Societies are kept by the Ministry.

3. Purebred. A purebred animal is one both of whose parents are duly recorded in the Breed Society's register of Herd Book.

4. Registered Animal. A registered animal is one whose parents are duly recorded in the Herd Books of the breed to which they belong. In addition, the animal itself must be recorded therein and its registration certificate issued.

5. Registration Certificate. A Registration Certificate is a written record of the ancestry of an animal which is issued by the Breed Society and usually contains considerable pertinent information concerning the animal. Usually the Certificate contains the date of birth of the animal, the name of the breeder, the sire and the dam and their respective registration numbers.

6. Pedigree. The word pedigree is often used synonymously with registration certificate. Indeed it is true to say that the pedigree is also a written record of the ancestry of an animal, but the pedigree does not necessarily have to refer to a registration certificate. We can therefore have a pedigree of an unregistered animal.

7. Breed. A breed is a group of animals which have a common origin. Animals comprising a breed should possess characteristics which are readily distinguishable. Eventually, with good selection, these characteristics should become so fixed that they are distinctly passed on to successive generations. Obviously the term breed is quite relative.

Origin of the Breeds

All domestic cattle belong to the family Bovidae which has two sub-groups, namely *Bos taurus* and *Bos indicus*. The *Bos taurus* group includes all domestic cattle common to the temperate zones, e.g. the Aberdeen Angus, Red Poll, etc. The *Bos indicus* includes those humped cattle common to the tropical countries and usually called Zebu or Brahman cattle. Over the years both types of cattle have been brought to Jamaica. The Brahmans have been found to be very much at home in our tropical weather, but the temperature zone cattle have been found to be poorly adapted.

Ever since this observation, the great objective has been to combine into a single type the high beef yielding qualities of certain temperate zone cattle and the heat tolerance or tropical adaptation of the Zebu. Breeding work of this nature dates back to the turn of the century and fortunately as a result of intensive efforts during the last two decades, three beef breeds have been established. They are peculiar to Jamaica, hence the names Jamaica Brahman, Jamaica Black and Jamaica Red Poll.

Jamaica Brahman. The Jamaica Brahman is the result of selection from crosses of several Brahman breeds of cattle which were introduced from as far back as early nineteenth century. There are thirty or more

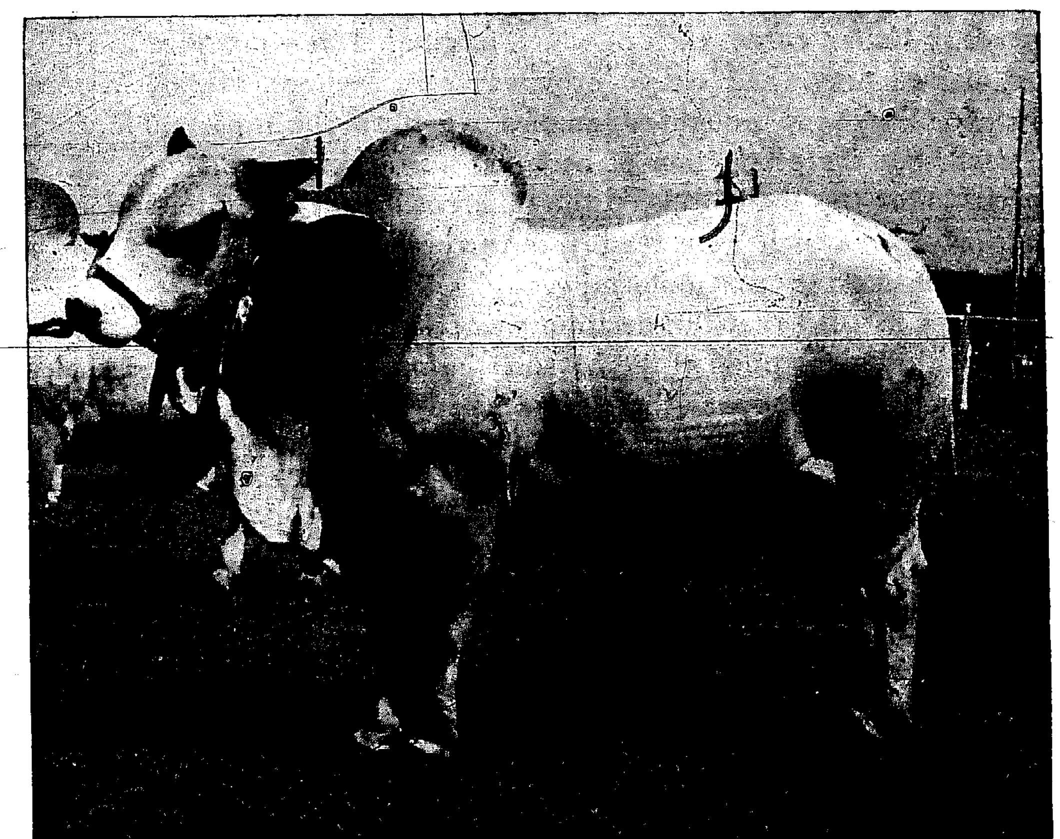


Fig. 3. Jamaica Brahman bull (Denbigh Show, 1958)

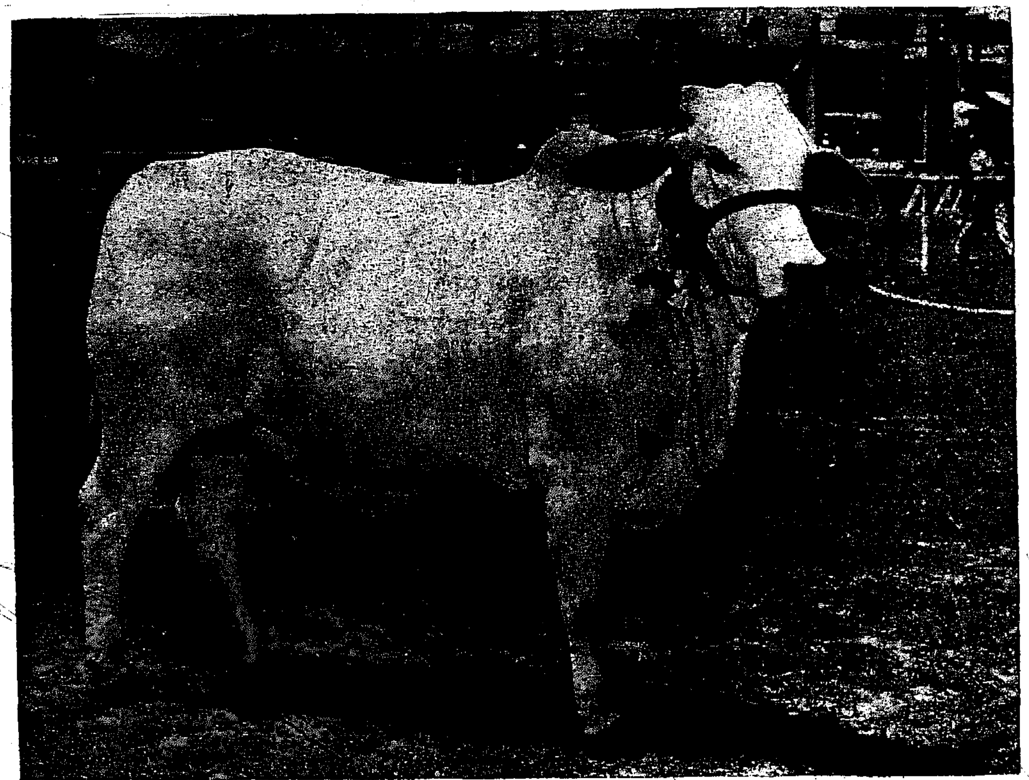


Fig. 4. Jamaica Brahman cow (Denbigh Show, 1958)

breeds of Indian cattle, each of which originated in a province in India and named after their native province, e.g., Nellore, Hissar, Mysore, Guzerat. They were brought to Jamaica to perform the important function of draft, but the production of beef was also given some emphasis. No special effort was made to keep the different breeds separate, and apart from Mysores which were readily distinguishable, they blended into a single type showing great uniformity.

It was in 1948 that the decision was taken to develop all the Zebu stock, with the exception of the Mysores, into a beef breed. The Jamaica Brahman Herd Book was therefore opened in 1949 and a registration scheme started. The Jamaica Brahman Breed Society* (embracing all members of the Jamaica Livestock Association interested in breeding Brahman cattle for beef) was subsequently formed. The Society initiated a system of appraisals by means of which selected animals are entered in a provisional herd register and inspected once a year for at least two more years. At the final appraisal, all animals selected are transferred from the provisional to the permanent Herd Book. The Herd Book was closed in 1955, but in the face of pressing demand for further entries, the Society decided to reopen it. The Jamaica Brahman Herd Book now shows a total of 6,827† entries distributed among 22† farmers.

* Two Government Agricultural Officers have always been included on its executive.
† As of 30 June, 1960.

Conformation. A high degree of uniformity in conformation can be observed in the Jamaica Brahman. Intensive selection has made them a comparatively lot set, deep bodied and muscular type. The drooping rump, uneven top line, excess hide in dewlap and sheath and even the wild disposition long known to be characteristic of Brahman are rapidly being eliminated. Mature cows weigh 1,200 lbs.; bulls 1,800 lbs. Jamaica Brahmans are very attractive in appearance. They are among the most economical producers of beef under our conditions. As such their future as a beef breed is assured.

Jamaica Black. The Jamaica Black is the result of selection from among animals carrying varying percentages of Aberdeen Angus, Brahman and local 'Creole' blood. The Aberdeen Angus breed is one of the many outstanding breeds developed in Scotland. Cattle of this breed were brought to Jamaica during the first decade of the century, and were, if not deliberately, then accidently, crossed with Brahman. Brahman cattle were popular on sugar cane estates, being used as draft animals. Local 'Creole' cattle refers to the descendants of old Spanish cattle brought here during the Spanish occupation. 'Creole' cattle would be expected to be fortified with Brahman blood through random breeding which took place many years ago.

Indeed, much of the breeding done in the early years was random, but this has had the effect of bringing about combinations of animal types, some of which were desirable and some undesirable. Thus, in the absence of present day knowledge of genetics, the early breeders discarded the undesirables and multiplied the desirables—a type of mass or phenotypic selection.

Mass selection is based on individual appearance of animals on the assumption that form and function are strongly related. This type of selection is not used to any great extent today because its effects are only limited to a generation or two. Fortunately, more efficient breeding devices are now available, and use is now being made of them in bringing about further development in the Jamaica Black breed.

It was in 1952 that plans for the establishment of the breed were formally put into effect. In that year, the Jamaica Black Breed Society was formed and a system of appraisals launched. In effect, the system provides for foundation cattle to be selected and entered in a provisional registry to be kept for a period of ten years from inception. The selected animals are subject to three consecutive appraisals. At the end of the ten year period, the provisional registry will be closed, final appraisals will be held, and all males and females elected will be entered in the permanent Herd Book.

The animals registered in the Jamaica Black Herd Book can be divided into three types, namely X, tending towards the purebred Aberdeen

Fig. 5. Jamaica Black (Frome Show, 1956)

Angus; type Z, tending towards the Zebu or Brahman type; and type Y, an intermediate between the two extremes. Until recently, all three types were accepted at appraisals and registered in the categories accordingly, but now agreement has been reached that a single type will be developed, i.e. type Y. Nevertheless, it will be many more years before the X and Z types disappear. The Jamaica Black Herd Book now shows a total of 3,063* entries distributed among 18* farmers.

Conformation. The ideal Jamaica Black is a clean skin early maturing animal, black in colour, and hornless. Disqualifications include horns, off colour, white on the underline except on the udder, small udder and hairiness. Bulls at maturity weight 1,200 lbs., and cows 1,000. A compact, broad, deep and heavily muscled animal is aimed at. They should not be as low set as the Aberdeen Angus. The Jamaica Black are being exported to South American countries and are giving a good account of themselves under feed lot as well as under pasture conditions.

The Jamaica Red Poll Breed. The Jamaica Red Poll breed is derived from Red Poll cattle and Zebu or Brahman cattle, the latter coming chiefly through 'Creole' cattle. Red Polls, which are native to England, were introduced here around 1900. As was the case with Jamaica Black cattle, mass selection was the device used in the early development of the Jamaica Red Poll breed. There were over 5,000 female

* As of 30 June, 1960.

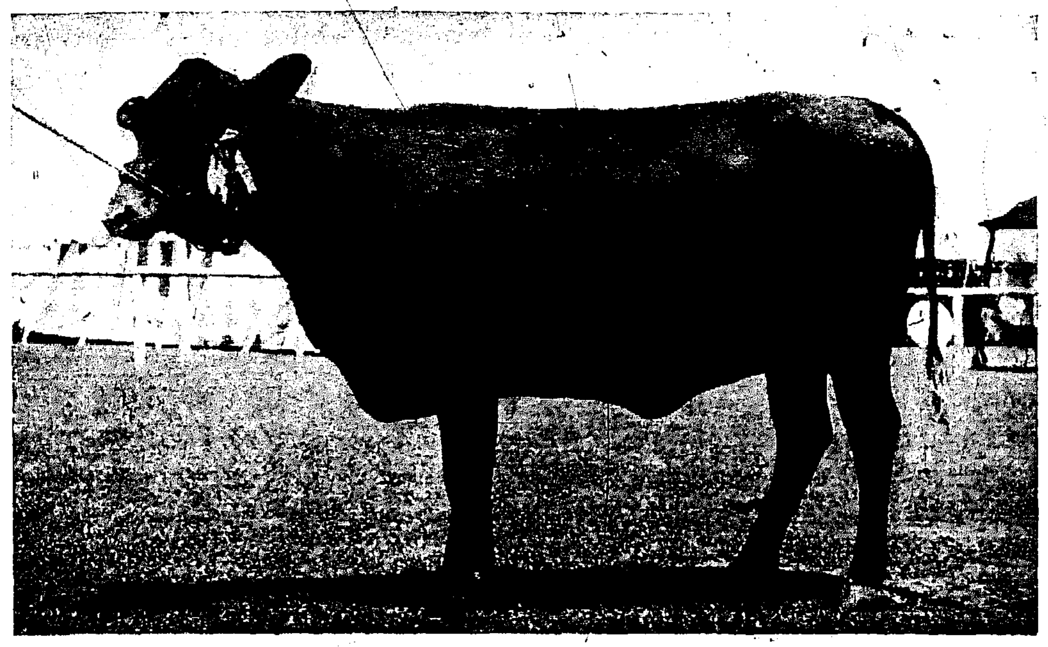


Fig. 6. Bryan Castle's 'Nellie'; winner of Barclay's Bank Cup for Champion Jamaica Red Female, 1959

cattle of Red Poll origin in Jamaica in 1952. From these, foundation animals were selected and entered in the provisional Jamaica Red Poll Herd Book. Three consecutive appraisals were required for acceptance. Eight years after the first appraisal, in December, 1960, the provisional registry was closed, all animals were appraised, and those selected were entered in the permanent registry. An upgrading Register will be opened in 1962. The Jamaica Red Poll Herd Book shows a total entry of 7,154* distributed among 53 farmers.*

Conformation. Of the three breeds the Jamaica Red Poll shows the highest degree of uniformity in all important characteristics and it is a credit to the breeders that such a high standard has been reached. Jamaica Red Polls are polled and red in colour, varying from very light to very dark red. They are moderately short of leg, deep in body, moderately thick, with a smooth, even covering of flesh. The true Red Poll is a dual purpose type, but intense selection for beef has made the Jamaica Red Poll a full fledged beef breed.

They are outstanding for their clean-cut appearance, freedom from excessive hide and early maturity. Bulls weigh about 1,500 to 1,800 lbs. and cows about 1,200 lbs. More Jamaica Red Polls are exported each year than the total of the other Jamaica breeds exported.

Other Breeds of Beef Cattle. The ideal beef animal is an animal which shows a low set, compact, thickly and evenly fleshed condition, with good lines and with all parts smoothly blended together. The breeds

* As of 30 June, 1960.

which are largely responsible for this concept are the Aberdeen Angus of Scotland (black), Beef Shorthorn (red, roan and white) and Hereford (red with white face), both of which originated in England. These are the most popular beef breeds in temperate zone countries, but they do not stand up well to the hot and humid conditions of the tropics. Scotland has also produced two more important beef breeds, namely the Galloway (black, dun and black-belted), and the Scottish Highland, a breed with an extremely hairy coat. The Charollaise, a white or light creamy coloured breed which was developed in France, is growing in popularity.

The Santa Gertrudis, cherry-red in colour, is the leading tropically adapted breed of the United States. It was developed on the King ranch in Texas from a cross between Beef Shorthorn cows and beef type Brahman bulls. It is the first distinctly American breed of cattle to be recognized. Other beef breeds of American origin include Charbray (Charollaise × Brahman), Brangus (Brahman × Aberdeen Angus), Braford (Brahman × Hereford), Beefmaster (Brahman × Shorthorn × Hereford) and American Brahman, the counterpart of the Jamaica Brahman. All these are tropically adapted breeds. Although they are comparatively young breeds, demand for them is growing, and this is largely because of the great bid to exploit the vast acreages of tropical grasslands.

Selection of Stock. Mention has been made of the available breeds of beef cattle. It was shown that some breeds are more adapted to tropical conditions than are others. Under our conditions, the choice must therefore be made from the tropically adapted breeds and indeed the particular breed selected would seem a matter of personal preferences. Selection of the individual animals within the breed is more important than the selection of the breed itself. However, it would be wise to select a breed well represented in the herds of the successful beef producers in the area. Much can be gained by co-operating with the breeders in the community. An experienced Jamaica Red Poll cattleman will testify to the superiority of his breed over the Jamaica Black or over the Jamaica Brahman as the case may be. It is wise to hear all the arguments and to make the most careful evaluation. In the final analysis, unbiased assistance with regard to the relative merits, current prices and the blood lines of respective breeds can always be obtained from the Government Animal Husbandry Advisory Officers.

The system of beef cattle production proposed will largely determine the considerations to be made in the selection of stock. The criteria to be used in selecting cattle to be fattened are not what would be considered for a breeding enterprise. Selection on the basis of good general appearance is a necessity regardless of the purpose for which the animals are to be used, but where a breeding herd is to be established, a great deal more must be considered.

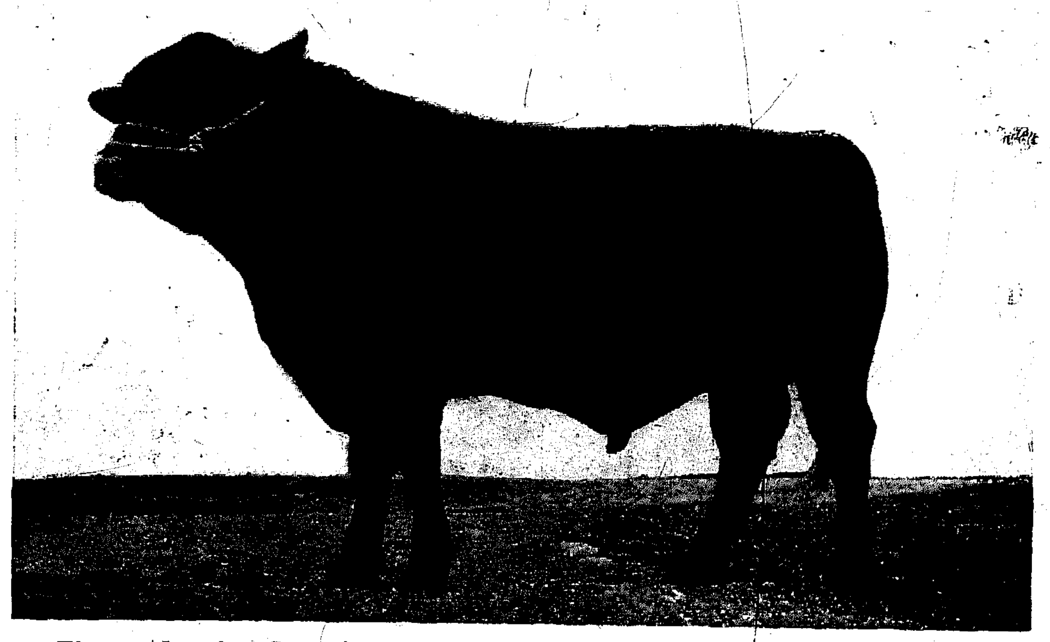


Fig. 7. Alumina Jamaica's 'Charm Boy', winner of Supreme Champion Beef Bull award 1959, Jamaica Livestock Association Cup and Aljanis Cup for Champion Jamaica Red Bull, 1958 and 1959

The Establishment of a Breeding Herd

The Bull. It is frequently said that the bull is half the herd, but indeed it eventually becomes the entire herd. Many farmers prefer to build a beef breeding herd from nondescript cows and a superior bull. It is under these conditions that the bull becomes the entire herd. This, being a very economical method, is to be recommended to farmers who are at first interested in commercial beef production and may eventually grade up to registered purebreds.

One important point to consider in choosing a bull is his record of performance. What sort of progeny has he if he is old enough? Do they show a high weight-for-age? In addition, the bull should have a good pedigree. A good pedigree will indicate good family lines.

Breeders frequently become over-enthusiastic about family blood lines irrespective of how distant they may be, but in judging a pedigree, special note should only be taken of the first three generations, for they contribute $\frac{7}{8}$ of the inheritance. In conformation, the bull should be deep bodied, wide, smooth and thickly fleshed, with sound feet and legs. He should show the characteristics which are typical of the breed. Above all, make sure he is fertile, disease free and from a herd with good health history.

The Cows. Starting with purebred cows has its advantages as well as its disadvantages. Purebred cows are usually expensive but there is the advantage that a herd of a high standard is at once available. On the other

Fig. 8. Beginnings of good beef herds

hand a beginner would be wise to do his groping with relatively inexpensive cattle. An upgrading programme would therefore be followed and by the time the herd is near purebred, valuable experience would have been gained. Many good beef herds in Jamaica today have had their beginnings with nondescript cattle. In some instances dairy herds were bred to become beef herds. In nearly all these cases the breeding system followed consisted of mating firstly to Brahman bulls in order to obtain progeny with good framework, then mating these half bred progeny to Jamaica Red Poll and/or Jamaica Black Bulls, depending on the breed desired ultimately. This system is to be strongly recommended. When foundation cows are from dairy stock and the Jamaica Black is the desired goal, it is not necessary to use Jamaica Red Poll bulls in between. There would be enough milk in the breeding stock for early weaning and for the rearing of good calves. Obviously, a desirable feature of Jamaica Red Poll cattle is their higher than average milk producing ability for beef cattle. The general recommendations for bulls, i.e. health, gaining ability after weaning and a high weight-for-age, more or less hold good for cows.

Feeding Beef Cattle. Approximately $\frac{3}{4}$ million acres or roughly $\frac{2}{5}$ of the total acreage of land in farms in Jamaica are available as pasturage for live-

stock and the cattle population amounts to 299,900.* On the other hand, experiments at Grove Place Animal Production Research Station are showing that Pangola pastures top dressed annually with 2 cwts Sulphate of Ammonia and 1 cwt Muriate of Potash to the acre can carry for an entire year, an average of 2·5 steers per acre† which actually means an average gain of 1000 lbs liveweight to the acre. This being so, it is only logical that the subject of beef cattle feeding be tackled from the standpoint of what should be done in the way of pasture development and management.

There can be no doubt that supplementary feeding, e.g., silage and grain, will eventually come, and this will be brought on by factors consequential to industrial development and population increase, but until that day is in sight let us begin to exploit the vast potentials we have in grass. The cornerstone of successful beef cattle production is grass. This is so even in countries where grain can be grown cheaper than it can be grown in Jamaica. Cattle are naturally able to handle vast amounts of roughage. A cattle farmer, dairy or beef, who stints on grass and tries to make up for this with concentrates, is carrying out a most short-sighted policy.

On the basis of available information, it is far more economical to feed fertilizers, i.e. by applying to pastures instead of feeding concentrates. Think of the saving in labour when cattle are entirely on grass. They do their own reaping and in doing this they make for maximum fertility of the land. How true is that old Flemish proverb—'No grass, no cattle; no cattle, no manure; no manure, no crops.' It behoves the beef farmer to have highly productive pastures all year round, and to realize this a knowledge of grassland management is highly essential.

Pastures should be Established before Cattle are Obtained. Very often farmers purchase cattle and then proceed to establish pastures, but this procedure is to be discouraged. It should be the other way around. If new pastures are to be established, it is highly necessary that a complete job of soil preparation be done. Whereas with a good job of preparation Pangola pastures can be ready for first feeding in two months, depending on the soil type, moisture and other factors, it may take a year or two for Pangola on unprepared soils to furnish a reasonable amount of feed.

No definite rule can be laid down on how soon to turn cattle on a newly established pasture. This is largely a matter of discretion. It should be sufficient to say that it is best to wait until the plants have taken a firm hold.

Varieties to Use. Pangola (*Digitaria decumbens*), Guinea grass

* Data from Survey of Agriculture; 1958. Division of Economics and Statistics, Ministry of Agriculture and Lands, Jamaica.

† Five-year Steer Fattening Experiment on 40 acres at Grove Place Animal Production Research Station.

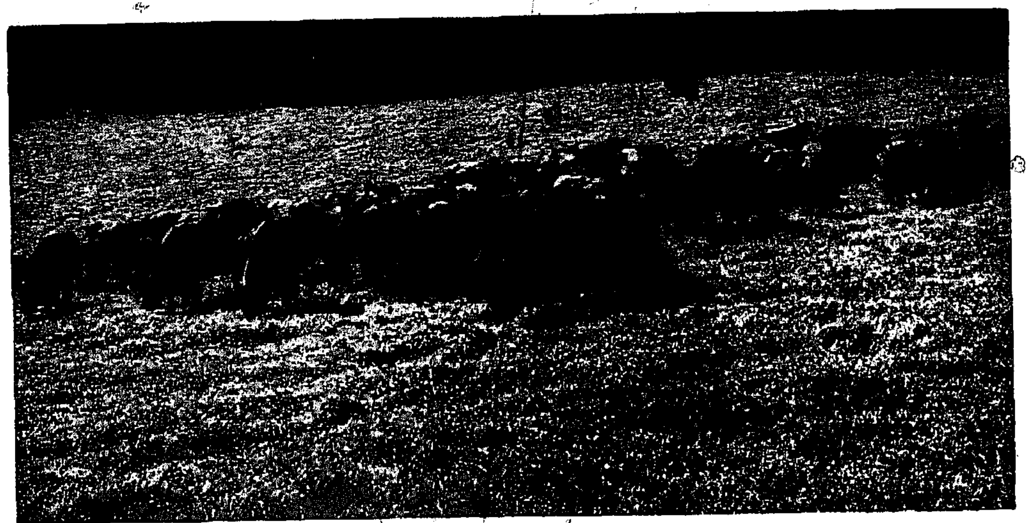


Fig. 9. Pangola grass pasture

(*Panicum maximum*), Coastal Bermuda (*Cynodon dactylon*) are highly productive grasses. **Pangola** is a grass which thrives well over a wide range of rainfall and soil conditions. It is a most palatable grass for livestock, highly drought resistant, and notable for its aggressiveness and competition with weeds. In addition, it responds well to the application of fertilizer. Where new pastures are to be established, one would be wise to use Pangola grass.

Guinea grass, the 'bread and butter' grass of Jamaica, does well on a wide variety of well drained soils. It is fairly drought resistant but is never at home under water-logged conditions. In many areas of Jamaica it seems to occur naturally. Where this is the case, and new pastures are to be established, it would be unwise to reject Guinea grass for Pangola or for any other. Indeed, Guinea grass will long continue to be the standard forage grass in Jamaica and in much of the tropics. Very often all that is necessary in an area with a fair density of Guinea grass is reploughing. Without additional plants, a good stand will soon follow.

Coastal Bermuda is a tropical grass which is adapted to a wide range of soils from sands to heavy clay, but grows best on moist, well drained, medium to heavy soils. It is almost as productive as Pangola. Coastal Bermuda shows a great deal of promise in Jamaica. It is the grass to be used on sandy soils located near the sea coast. Two grasses which are used to some extent in Jamaica are Para grass (*Brachiaria mutica*) which does well in water-logged soils and Wynne grass (*Melinis mutiliflora*) found at high elevations, and is capable of providing a good vegetative cover on dry steep slopes. These grasses are not as highly productive as the first three named, but they can make production possible from areas which are unsuitable for other grasses.

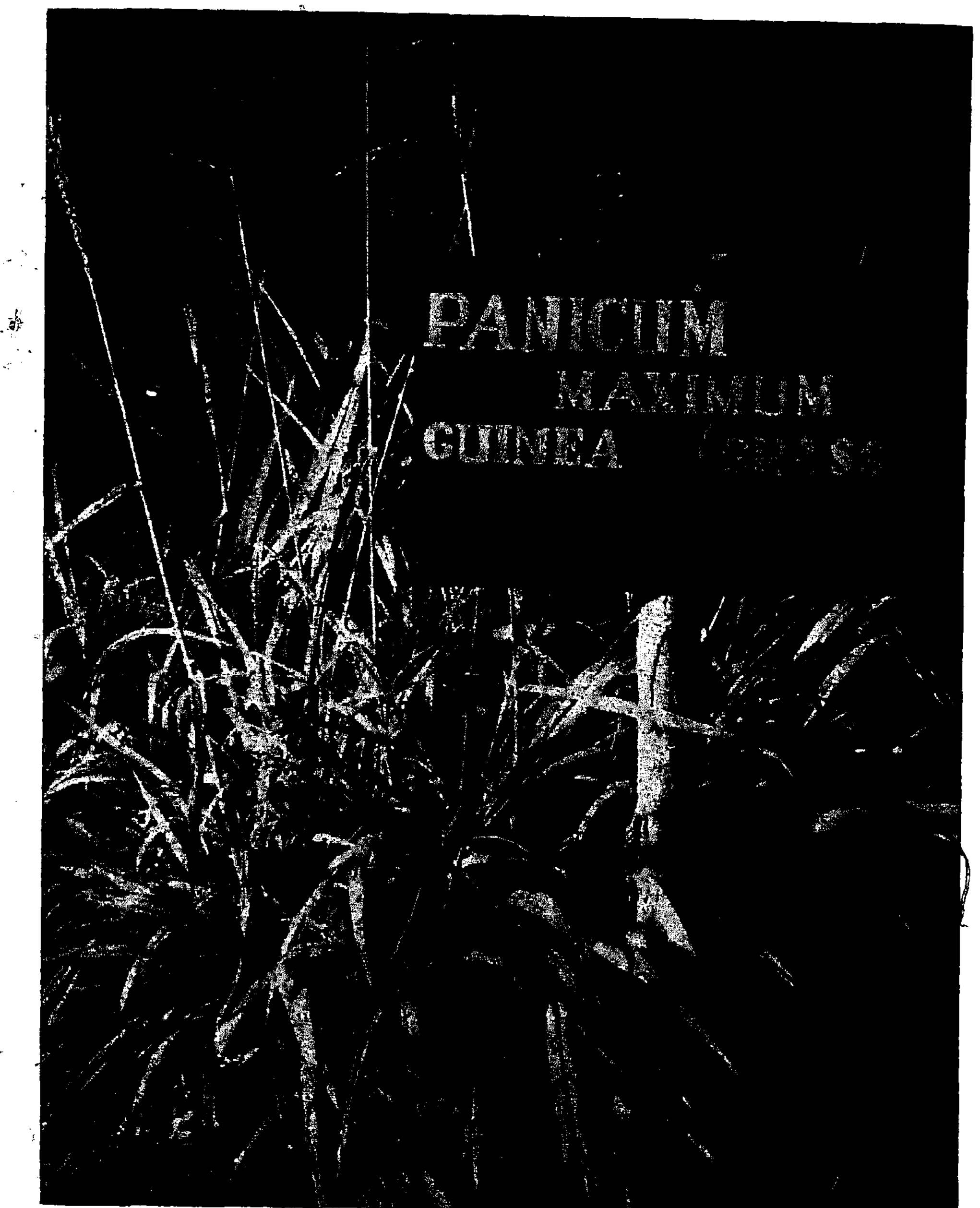


Fig. 10. Guinea Grass Pasture

The Size of the Herd in Relation to the Available Pastures. Even in the leading pastoral countries of the world farmers are either overstocked or understocked at any single time. The weather has much to do with this because in Spring there is an abundance of grass, while in the fall and winter months not much grass is available. In Jamaica, it is during the latter months that the Island experiences a severe drought, and growth is considerably reduced. It is foolhardy to use the flush season as an index of carrying capacity on the farm, because in the dry season the herd will be underfed. On the other hand, an all year carrying capacity which is based on capacity in the dry season has its disadvantages also, in that there will be more grass in the spring than the herd will be able to consume. When this is so, it is not possible to keep up with the cycle of feeding the pastures when the grass is most nutritious, and the whole grassland management programme will be upset.

Perhaps the general recommendation which can be made is that farmers could regulate their stocking during the year by sales and the purchase of stock. Remember the condition of the cattle is the best guide as to whether or not the farm is overstocked. To some farmers it might be convenient to close some pastures during the spring and make silage and hay from them for tiding them over the dry season. The biggest difficulty with this lies in reaping the grass, because it may be virtually impossible for implements to work in the pastures during the spring rains. Before any attempt is made at conservation, i.e. turning surplus grass into hay or silage, it is advisable that a careful examination be made into the economics of the venture.

Rotational Grazing and Pasture Size. For many years, continuous grazing was the order of the day, and even today there are a few beef farmers who still afford this luxury of farming under extensive ranch conditions. Where cattle are left to graze continually on wide open pastures, the result is selective grazing which is most undesirable. Here we find that parts of the pasture are left ungrazed and grow coarse and tall. The coarse grass may be eaten eventually when nothing else is available, but its nutritive value will be very low. By the same token, other parts of the pasture will be grazed over and over again with the result that the plants so affected will be weakened and in a little while are bound to die.

Rotational grazing has long been recognized as a means of making the most effective use of pastures. In a system of rotational grazing, pastures are divided into a number of paddocks. Each paddock is grazed at a high rate of stocking, viz. 6 to 10 cow equivalents per acre, for periods of from 3 to 6 days at intervals of from 3 to 5 weeks. In this system, the grass is grazed only once during each grazing period, and with the long rest from grazing and trampling a high level of production and good quality feed is possible. An example should make this clear: Using an area where it is possible to carry a beast or its equivalent* to the acre, let us suppose that the herd consists of 40 cows or cow equivalents. Each paddock should be 5 acres in extent, the entire herd should remain in each for 4 days and each should be rested for 28 days. Investigations to date reveal that this is an ideal feeding cycle for both Pangola and Guinea grass.

* Cow Equivalence:

1 cow = the following: 2 yearling cattle, 4 calves, 7 sheep, 14 lambs, 3 sows, 5 hogs weighing 200 lbs. each, 10 shoats weighing 100 lbs. each, or 100 hens or roughly livestock weighing 1,000 lbs. liveweight.

Other Management Factors. In good pasture management, consideration is given to the maintenance of drainage. Deep, wide drains are unsuitable for pastures. It is best to plan the system of drainage before subdivision is done as in so doing fencing may be done more appropriately and hazardous stretches may be fenced away.

If irrigation is to be done, then suitable provision should be made in laying down pastures whether for flood or overhead irrigation. In routine irrigation, it will be necessary to follow feeding a pasture with irrigation, not otherwise.

Mowing is an important management practice which should be done at least once a year, i.e. in the fall. In Pangola pastures and even more so with Guinea grass, one can always notice clumps of stemmy growth at the end of summer. The relatively reduced growth from these clumps make for a low productivity of the grass, but cutting back with a bush cutter or other means will enable a more vigorous growth to take place. Mowing can be done at other times of the year as conditions in the pasture and economics warrant.

A pasture management programme is not considered sound if it does not include the periodic application of fertilizers. All pastures, regardless of location, should receive sulphate of ammonia or other source of nitrogen. Even where no dung is lost for pasture, the herd puts back no more than 80% of the elements taken from it. But even apart from fertilizing to put back what was taken from the soil, it is possible with fertilizer to increase significantly the carrying capacity of a pasture. The amount of fertilizer applied should not be guessed. The Agricultural Chemistry Division of the Ministry of Agriculture and Lands should be asked to make a soil analysis and application made on the basis of the recommendation.

A few points on general management have been touched upon in this treatment of feeding beef cattle but it should be borne in mind that pasture management itself is a vast subject. Attention should, therefore, be turned elsewhere when there is need for more specialized information. The objective of this discourse has been to indicate that with proper pasture management in Jamaica and in similar areas, it is possible to rear and fatten beef cattle on grass alone.

Care and Management of Beef Cattle. The care and management of beef cattle is really the heart of husbandry. In order to care and manage beef cattle satisfactorily, one must have a thorough knowledge of breeding and feeding, thus the definition of beef cattle husbandry could well be limited to care and management. It is through the medium of care and management that the scientific principles of genetics and nutrition are put to work. In the long run it is care and management that determine whether or not an enterprise is profitable. When it comes to a breeding herd, profitability depends largely on the annual calf crop. Because of this, beef cattle, namely hand mating and pasture mating.

Hand Mating. With this method, the bull is not allowed to run with the herd, instead, when cows are to be bred, they are put to him. One advantage of this method is that the bull can serve more cows than when he is allowed to run with the herd. Usually a single service is given in hand mating. This system suits purebred breeding, where it is essential to keep very accurate breeding records. Hand mating allows for accurate checks to be made at all times as to whether or not a bull is settling the cows mated to him. A mating bull on hand service can effectively serve 60 to 70 cows a year.

Pasture Breeding. With this method, the bull is allowed to run with the herd either throughout the year or during definite breeding seasons, depending on the practice of the farm. This method of breeding requires less labour, and there is the added advantage that cows will be bred in time providing the bull is fertile, for heat periods will hardly be missed. The number of cows that a bull can settle when on pasture breeding depends on the size of the pastures. A bull should be expected to settle

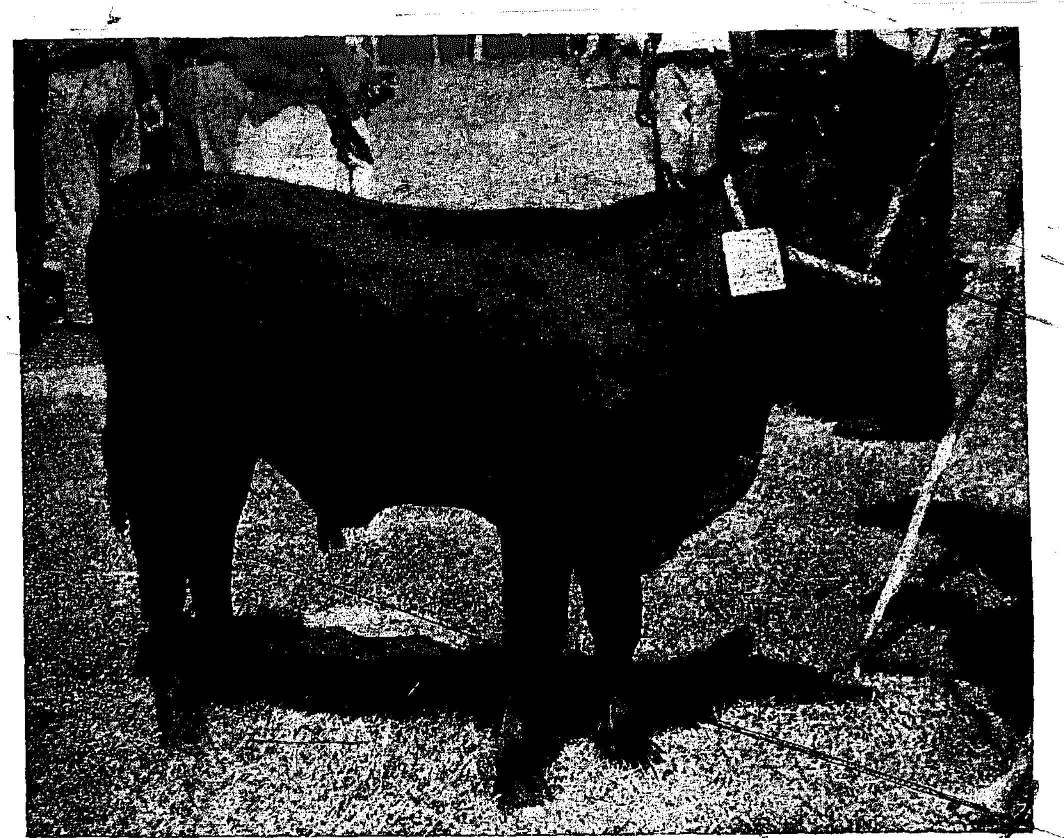


Fig. 11. Champion Yearling Jamaica Black from Harmony Hall Estate

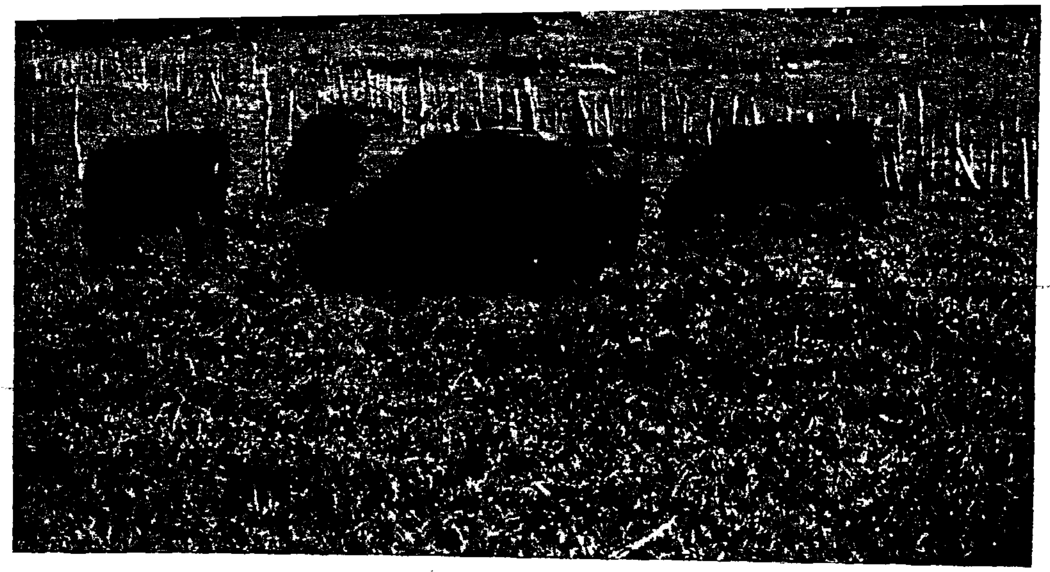


Fig. 12. Fattening on grass

more cows when pastures are small than when they are large. As a guide, one should plan for about 25 to 30 cows per bull.

Age and Service of Bull. The herd bull should be maintained in a thrifty condition all the time, if he is to perform well. One should avoid breeding from an overfat bull. Apart from the fact that his condition may prevent him from jumping with ease, it should be borne in mind that the bull is more often fat because he is sterile, than the other way around. It is not advisable to begin to use a bull before he is 15 months old, and even then, only light service, preferably controlled hand service, should be allowed. Plenty of exercise is essential. Bulls on pasture service will get all the exercise they need, but care should be taken to provide enough for the bull being hand-mated.

Age to Breed Heifers. The time when heifers should be bred will vary with their growth and development. Heifers that are bred too early, especially on farms which practise poor husbandry, always prove unthrifty. On the farms which practise good husbandry, Jamaica Black and Jamaica Red heifers are being bred at 19 months of age, and Jamaica Brahman heifers two or three months older. On the average, heifers reach puberty at about 12 months of age, but they should be withheld from the bull until they reach the desired age for breeding. It should be the aim of every farmer to lower the existing age of first conception. It is possible to do this with good feeding and husbandry.

Heat Periods. The time during which the heifer or cow will take the bull (heat) lasts for around 18 to 19 hours and this occurs every 20 to 21 days. Where hand mating is practised, great vigilance should be exercised

Table 1.—*Gestation table for cows (283 days)*

Day of month bred	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Explanation: Find date cow was bred in first column and month bred in top line. The date in column below opposite date bred will be the time at which the cow is due to calve											
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	11	11	9	9	8	11	10	11	11	11	11	10
2	12	12	10	10	9	12	11	12	12	12	12	11
3	13	13	11	11	10	13	12	13	13	13	13	12
4	14	14	12	12	11	14	13	14	14	14	14	13
5	15	15	13	13	12	15	14	15	15	15	15	14
6	16	16	14	14	13	16	15	16	16	16	16	15
7	17	17	15	15	14	17	16	17	17	17	17	16
8	18	18	16	16	15	18	17	18	18	18	18	17
9	19	19	17	17	16	19	18	19	19	19	19	18
10	20	20	18	18	17	20	19	20	20	20	20	19
11	21	21	19	19	18	21	20	21	21	21	21	20
12	22	22	20	20	19	22	21	22	22	22	22	21
13	23	23	21	21	20	23	22	23	23	23	23	22
14	24	24	22	22	21	24	23	24	24	24	24	23
15	25	25	23	23	22	25	24	25	25	25	25	24
16	26	26	24	24	23	26	25	26	26	26	26	25
17	27	27	25	25	24	27	26	27	27	27	27	26
18	28	28	26	26	25	28	27	28	28	28	28	27
19	29	29	27	27	26	29	28	29	29	29	29	28
20	30	30	28	28	27	30	29	30	30	30	30	29
21	31	Dec. 1	29	29	28	31	30	31	July 1	31	31	30
22	Nov. 1	2	30	30	Mar. 1	Apr. 1	May 1	June 1	2	Aug. 1	Sept. 1	Oct. 1
23	2	3	31	31	2	2	2	2	2	2	2	2
24	3	4	Jan. 1	Feb. 1	3	3	3	3	4	3	3	3
25	4	5	2	2	4	4	4	4	5	4	4	4
26	5	6	3	3	5	5	5	5	6	5	5	5
27	6	7	4	4	6	6	6	6	7	6	6	6
28	7	8	5	5	7	7	7	7	8	7	7	7
29	8	—	6	6	8	8	8	8	9	8	8	8
30	9	—	7	7	9	9	9	9	10	9	9	9
31	10	—	8	—	10	—	10	10	—	10	—	10

in recognizing this heat period. The characteristic symptoms of a cow or heifer on heat are (1) nervousness; (2) attempts to jump other cows which in turn attempt to jump her; (3) swelling or inflamed appearance of the vulva; (4) frequent urination; (5) mucus discharge.

In the case of hand mating, it is best that mating be done toward the end of heat, for release of the egg does not take place until about 10 or 11 hours after the end of the heat period. On the average, beef cows come on heat about 60 days after calving. They should be bred then, or as soon after as possible, in order to aim at obtaining a calf per year.

Gestation Period. The gestation period or the period of pregnancy in cows lasts for approximately 9½ months or 283 days (see table).

Signs and Tests of Pregnancy. When a cow is served and she fails to come on heat, it is a fair indication that she has been bred, but it should be borne in mind that sometimes non-pregnant cows fail to return to heat, and also that some pregnant cows come on heat a few times even after conception has taken place. A pregnant cow puts on weight and becomes docile as pregnancy progresses. An experienced person can ascertain pregnancy from as early as the second month after its inception by feeling with the hand through the rectum.

From around the fifth month, pregnancy can be determined by feeling the foetus externally in the abdominal region. This consists of pressing the

fist against the abdomen, in the lower right-hand flank region and making an inward thrust. In the case of pregnancy the foetus can be felt and it can be seen to fall back in place when the hand is withdrawn. From mid-pregnancy onwards the foetus can always be seen to make movements, especially when the cow is drinking water.

Care of Cow During Gestation and at Parturition. Apart from making sure that cows are always on good pasture, no special care is necessary during gestation. Pregnant cows should be allowed to run with the general herd, but near the time of parturition they should be separated and placed in a small pasture near the compound.

It is best to have such a pasture which can serve for maternity and other emergency purposes. In it should be an inexpensive maternity shed which need not be used until times of bad weather. Where it is not possible to segregate cows which are due to calve, as a regular routine pastures should be checked twice per day and even more often during the height of the calving season.

Calving. The first sign of early and approaching calving is a distended udder. There will also be seen a marked shrinkage or falling away of the muscular parts in the region of the tail head, together with the swelling of the vulva. The immediate indications that calving is to occur are extreme nervousness, uneasiness, straining and distress groans. Soon a water bag appears and hangs from the vulva. It increases in size until it ruptures. A second water bag appears, which also ruptures, and there follows a great straining by the cow. The calf soon appears, front feet first, followed by the nose resting on them. Then the shoulders. Calving is now almost complete, for it is only seconds before the calf is fully dislodged.

Most cows will calve easily without assistance. Nevertheless, it would be wise to be on hand at calving time just in case difficulties arise. If presentation is normal, within an hour or two after the onset of pains, the calf should be born. On the other hand, if the calf is making little progress and labour is irregular or greatly lengthened, it is time for assistance to be given, and it should be sought from the Livestock Officer, Veterinary Officer, or other capable and experienced individuals.

The placenta or after-birth is usually expelled within 12 hours after calving. If it is retained longer than 24 hours, then competent assistance should be sought. The cow should not be allowed to eat the placenta. It should be burnt or buried.

The Calf from Birth to Weaning. Apart from treating the navel of the new born calf with ordinary iodine of 10% strength, or any other suitable disinfectant, nothing needs to be done to the normal new born calf. The cow is usually able to take care of the rest. Most calves are up on their feet in half an hour after they are dropped, and are ready to suck. Any weak or undersized calf, providing it is worth rearing, should be

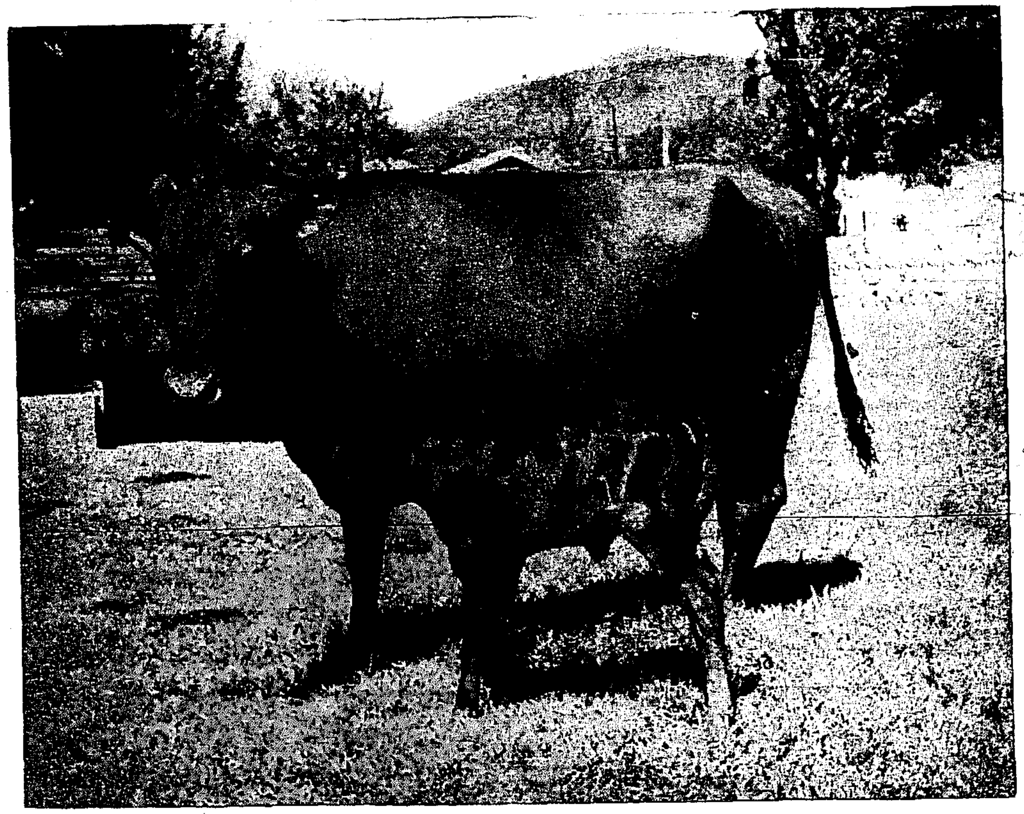


Fig. 13. Good pastures enable the cow to produce the calf's ration

helped to suck the first milk as soon as possible, since there is no more effective way of overcoming its handicap.

Feeding of the calf from birth to weaning is a simple matter. With the breeds of cattle now in use, it is rarely that one finds a cow which does not have the ability to provide enough milk for nourishing the calf. The greatest need then is for good pastures to enable the cow to produce the calf's ration. It is not considered economical to do any supplementary feeding of grain to calves before they are weaned, mainly because the protein and other needs are met by milk and pasture, and also because the rate of feed conversion is relatively low at this stage.

Calves should be weaned at six to eight months of age. It is at this age or before, if possible, that all calves should be separated. It was formerly recommended that calves being weaned be put back with their dams to nurse at increasingly less intervals over a period of two weeks as this would prevent the incidence of spoiled udders. It is now known, however, that sudden separation is better because by this a pressure is built up in the udder, thus stopping further secretion.

Dehorning and Castrating. It is most advisable to dehorn calves, as the herd will in time be spared a considerable amount of injury. Dehorning is a simple operation if done early. It should be done about two or three

weeks of age. A caustic stick or paste should be applied on the horn buttons, care being taken to prevent it getting beyond the buttons. Nowadays electric dehorners are in use.

All male calves not wanted for rearing as bulls should be castrated. The operation, a simple one, is usually accomplished with the use of the burdizzo. This should be done before three or four months of age.

General Considerations. Many people go in for beef cattle production because of the general feeling that it calls for easy husbandry. Very often they take this too literally, and in so doing neglect many of the simple but important details of management. But in beef cattle production, as in any other phase of agriculture, it is how much attention is paid to these details that determines profit or loss. Some of these details may be mentioned.

Calf Crop. It was shown that it is possible to obtain liveweight gains of 1,000 lbs. or more per acre, i.e. fattening 2·5 steers to the acre. But how many cows did it take to produce these steers? In other words, how many cows must be maintained for the number of steers to be fattened? When due consideration is given to the capital herd, as indeed it should, the liveweight gains per acre must be whittled down and the extent to which this is done is determined largely by the annual calf crop. If the calf crop is 50% it means that it is taking 5 cows to produce 2·5 weaner calves, which eventually gain 1,000 lbs. liveweight. The carrying capacity of the pastures for the breeding cows may only allow one cow to the acre. In this case liveweight gains per acre would now be under 200 lbs.

Many big herds in Jamaica are realizing annual calf crops of 90 to 95% which is good. With good operational efficiency on smaller herds, the maximum can be obtained, but it will take highly fertile bulls, and they should be properly rotated. It will take also an intensive programme of culling. All shy breeders, old and diseased cows, should be culled. The most productive age of a cow is from 4 to 8 years of age. Older cows, unless they are outstanding and giving a calf each year, should be replaced with young and thrifty heifers.

Disease. A formula which can be given for disease is $D = C \times \frac{V}{R}$ where C = concentration or number of disease-causing organisms, V = virulence or how powerful they are, and R = resistance of the animal. Obviously, the bigger the value of the denominator R, the more ineffective will be the nominator. How can R be increased? Largely by good management, and this means seeing to it that animals are properly fed and well cared for. The incidence of disease on well run beef farms is insignificant. It is on farms that are poorly managed, where animals are on a low plane of nutrition, that there are frequent outbreaks of disease.

Every precaution should be taken to prevent the possible introduction of infections from other herds. All livestock introductions should be isolated for 2 to 4 weeks before being placed with resident animals. Such diseases as Blackleg, Brucellosis and Anthrax should never be found on farms since they can be so easily prevented through the use of vaccines. Testing for Tuberculosis should be carried out every year or two years, depending on how often cattle are introduced. The veterinary service should be consulted for advice on routine tests and vaccinations.

In many areas ticks constitute a problem in livestock production. They are responsible for general unthriftiness and many diseases in cattle peculiar to the tropics. A cattle farmer should treat his animals as often as is necessary to control these vectors. At one time arsenical dips were used and were quite effective, but today many species of ticks have become resistant to arsenic. Similarly, resistance has been developed among many of the new synthetic insecticides in use, thus continuous use of any one insecticide should be avoided.

The method of mixing insecticides is always indicated. Hand spraying can be done in the case of a small herd, but for a big herd a modern spray race should be erected instead of the old fashioned dipping tank. By means of the race, a design of which can be had from the leading manufacturers of dips, the animals are given a dense spray delivered under pressure from a system of pipes. The discharge fluid drains to a small reservoir from which it is circulated by a pump operated by a small engine or a tractor power take-off. The spray race uses a small amount of spray fluid which can be made up each time the job is to be done, thus it is easy to switch to new insecticides as against what would be entailed with a dipping tank.

Spraying should be done at intervals of at least two weeks. Regular spraying should continue even when animals are relatively free of ticks, because by spraying, many other external parasites such as mites, lice, etc., which suck the blood of animals, are also destroyed.

The screw worm fly and many other types of common fly can be a menace to livestock production. It is estimated that the loss to the livestock industry from screw worms in Jamaica runs into Thousands of Pounds annually. The screw worm fly merely waits for an abrasion in which to lay its eggs. Common sites are the navels of new born calves, and wounds resulting from castration and dehorning. When the larvae hatch they feed on the flesh. The best weapon against this is management practices to eliminate the fly and to prevent the occurrence of wounds. All animals should be checked carefully once or twice a day depending on the size of the herd. Good fly repellents are always available and no farm should be without them. In addition, a cheap but effective disinfectant should be available. All these can be obtained at any livestock equipment store. A good plan is to keep a veterinary first aid room or box. Such items as Epsom and Glauber salts, castor oil, linseed oil, copper sulphate, phenothiazine and dusting powder should always be on hand.

Water Supply. It pays to have good watering facilities, so that animals can always have access to clean fresh water.

Pastures should be so laid out that a water trough can serve two or more paddocks. Good troughs are usually 16 feet long and 3 feet wide. Troughs with oval shaped bottoms are desirable because they are easier to clean and drain. Floats should be so made to ensure a continuous supply of water. It should be remembered that water comes even ahead of feed in importance.

Mineral Supplement. When cattle are grazed on permanent pastures that are not properly fertilized, depending on areas, it will be useful to provide additional minerals in the form of mineral licks. One should avoid such minerals which make claims for supplying numerous trace elements. A salt lick is very often all that is needed. Some areas may be deficient in phosphorus, thus the plants growing thereon will also be low in this element. To overcome this, dicalcium phosphate should be fed free choice.

Labour. Labour very often claims a significant portion of operational expenses all because of poor organization. This item, however, can be kept to a minimum with properly laid out permanent pastures, automatic water supply, handling the cow herd as a unit, and castrating, dehorning and vaccinating while the calves are young and manageable. In the long run, it is best to get a few reliable cow hands and pay them well, than to carry a number of irresponsible people and pay them accordingly. Good wages, adequate housing, courteous treatment to the right type, pay large dividends.

Farm Accounting. There has been a widespread tendency on the part of beef producers to shun farm accounting, thus it is often difficult to know whether or not the enterprise is making a fair return. Because a good system of farm accounting is an asset to any business, it is recommended that its use be adopted regardless of the size of operation. In addition, every beef producer should have a good understanding of economic cycles, marketing trends and credit sources.

Organization. Working along with other farmers in a co-operative way rather than adopting the isolationist approach is always beneficial. Breed Associations and other organizations for livestock men have contributed significantly in the development of the well-known breeds of livestock as well as in the advancement of individual operators. It is therefore good business to support all reputable cattle organizations.

Aptitude. Finally, it is individual ability that counts, and this comes from average intelligence and love for the subject. Do you enjoy living on the farm? Do you have enough interest as to enable you to know each animal by name as well as each animal's ancestry? This is often a good index of your zest. If you have an aptitude for the subject you will not stop acquiring all the information possible on beef cattle production.

CHAPTER 48

Common Diseases of Horsekind

In this chapter a brief attempt will be made to describe some of the commoner diseases of horsekind and to tell the horse-owner when and how he can safely treat his own animals and when he should call for expert veterinary aid.

Wounds

There are 3 main types of wounds:

Cuts which penetrate variable depths but have little surrounding tissue damage:

Abrasions which are usually superficial but may have some tissues actually grazed or torn away; and finally

Punctures which may have a small visible opening but often penetrate to a great depth and form pockets.

Treatment. The first line of treatment is, broadly speaking, the same for all types of wounds.

(1) The affected part must be thoroughly cleaned making sure that the deeper particles of dirt are removed, if necessary by flushing the wound with water. It is important that clean and preferably boiled water be used. A few crystals of potassium permanganate or some other mild disinfectant should be added to the water. Soap and water is as good as anything and better than disinfectant alone.

(2) The hair should be clipped away from the wound edges, the clipped area should be cleaned and any loose hair sticking to the wound should be washed away.

(3) The wound should then be dressed daily with some wound oil or 1% acriflavin. Both of these are preferable to lamp oil (fish oil or stinking oil) and **on no account should a wound be packed with dung.** Following the application of the acriflavin, some form of dusting powder will help to dry up the wound. A prescription for a suitable powder is given at the end of this chapter.

The area around the wound should then have a fly-repellent smeared on it. Suitable fly-repellents are screw-worm smear and fish oil.

Cuts. In the case of a clean cut a clean bandage should be applied

wherever it is possible, in order to promote quick healing by bringing the edges of the wound together. If the cut is more than 24 hours old when it is first dressed healing will be much slower than if the cut is attended to when it is still fresh, because the wound edges soon dry and will not stick together even if they are tightly bandaged.

In the case of very bad cuts which are long and deep so that they gape open or if they occur on places that cannot be bandaged, such as the chest or flank, first aid should be given as described earlier and some attempt made to contact a Veterinary Officer who will decide if the wound can be stitched. If this cannot be done, the wound should be dressed daily with acriflavin and astringent dusting powder. The application of some screw-worm smear may be necessary to stop a bad cut from becoming fly-blown. As soon as the wound is dry the bandaging can be stopped but the dressing should go on for a few days longer.

Abrasions. The main line of treatment is similar to that for cuts, but bandaging abrasions is seldom possible. Since this sort of wound often covers a large area it is particularly prone to becoming fly-blown. If this has already occurred some diluted Jeyes fluid (1 part in 2 of water) or screw-worm smear should be applied in and around the wound to kill the fly larvae (maggots). In pocketing wounds it may even be necessary to flush the wound through with Jeyes so that it contacts the deepest parts of the wound. The dead larvae should be scraped out with a clean knife and screw-worm smear applied to the wound to prevent further maggots from developing.

Punctures. In the case of this type of wound it is very important to flush all the dirt out properly and to check any maggots from entering the wound from where they are very ~~difficult to remove. It is always advisable~~ to consult a Veterinary Officer about the desirability of an anti-tetanus injection in the case of puncture wounds especially those in and around the feet.

It is always necessary to rest a wounded animal as work retards healing and often increases the risk of the wound becoming infected with a disease such as tetanus.

Harness Galls

These are simply abrasive wounds caused by excessive friction of the harness and should be treated as such. The commonest positions in which to find galls are:

The Head. Especially on the bridge of the nose and behind the ears. These galls are due to rope halters that are too tight. Halters should always have room for two fingers-width to be placed under the halter rope on the nose and for three fingers under the rope on top of the head.

Treatment for abrasions has already been described. If the gall is not

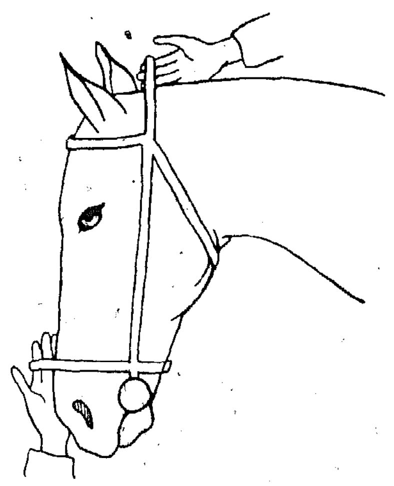


Fig. 1. Correct Harnessing

severe it may be possible to continue working the animal but some clean rags should be bound over the rope where it is chafing the skin after the ropes have been adjusted properly.

The Withers. Galls here are due to badly fitting packs. Even if a sack is used under the pack, unless it is folded correctly galling will still occur. The sack should be split open along its seams and then folded smoothly across the back; the pack can then be put in place. If a saddle with a broken framework has to be used, two sacks may be necessary to prevent galling. A correctly fitting saddle should not come into contact with the backbone at any point.

In all cases of galled withers work must be suspended until complete healing has occurred. This will only take three or four days in an early case but if the animal is worked with a gall it may take several weeks rest to cure the gall. Early rest is therefore important however great the inconvenience, otherwise a lengthy period of treatment when the animal cannot be worked, will follow.

The Girth. Some animals are naturally thin-skinned behind the elbows and will gall repeatedly. Such animals must be rested and their wounds treated in the correct manner. On their return to work a piece of padding such as tyre tubing should enclose the girth and cover the gall or, failing this, the girth should be bound with soft rags (which should be washed or changed every week or they will become hardened with sweat).

Excessively tight or loose girths should never be used unbound because they cut into the skin behind the elbows, which becomes softened by sweat. In animals with soft skins, rubbing the area daily for a few weeks with proof rum will help to harden the skin.

The Collar. Galls here are usually around the points of the shoulders and are most frequently due to bad packing of the collar lining, which

should be firm and smooth all over the surface. Trusses must be the same length or there will be an uneven pull which will cause sores to come rapidly. Overloading of carts or drays will also do this. The animal should always be able to start its pull without great difficulty; if it needs assistance, the cart is overloaded.

Rope collars for the out riders should always be well bound with sacks and made as smooth across the chest as is possible.

All haulage work must be suspended until collar galls have healed, but with small collar galls the animal can do pack work. Should it be lame or stiff in the front legs even this sort of work must not be allowed.

The Tail. Galling under the tail is most common in pack animals from (*a*) too tight cruppers, (*b*) rope cruppers insufficiently bound, or (*c*) badly fitting packs which slip forward even when on level ground.

Daily cleaning of the wound thoroughly is very important here, as tetanus germs are passed in the dung and some may remain on the underside of the tail and contaminate the wound so that in three or four weeks the animals will show symptoms of this disease.

It will be seen from the last few pages that nearly every case of galling is due to carelessness in fitting the harness and if this cause is removed, treatment is quite simple and there should be no excuse for any further trouble. If these wounds are neglected, the consequences can be very serious as well as costly. Prevention is always better than cure.

Abscesses and Haematomas (Blood Blisters)

From time to time owners of horsekind observe odd lumps which seem to arise overnight under the skin of their animals. Such lumps may be quite large in size; they are usually found on the side of the body or on the flanks or belly i.e. in the places where the skin is loose; but they are seldom seen on the legs. Such lumps usually result from injuries and they are frequently full of blood (haematomas) or pus (abscesses).

Haematomas are really bad bruises in which a small blood vessel has burst so that there is a sack of blood under the skin. At first these blood blisters are soft but later fluid is absorbed from them and they become firm and hard. Generally they are replaced by scar tissue under the skin and after a few weeks they begin to shrink in size. It is important to leave them alone since if they are lanced, the blood vessel that burst originally may burst again and the animal may lose a lot of blood.

Abscesses start off looking like haematomas and some may actually start life as haematomas. However, the essential difference in the case of an abscess is that some infection has been introduced under the skin causing formation of pus ('corruption'). The abscess containing this pus usually grows as more pus is formed, eventually it becomes so turgid that the skin bursts. Occasionally, abscesses burst internally and discharge poison all round the body often with serious results.

Before an abscess bursts, the skin over it becomes very tense while at one point it softens. At this point it is possible to have the abscess lanced with a sharp knife, but this should only be done if it is ready to burst and must be carried out in such a way that the pus will drain out properly. In order that this may occur the abscess should be opened as near as possible to its lowest point. When an abscess bursts or is lanced it is important to clean it out thoroughly and to wash it thorough with diluted disinfectant. If this is not done, the skin will heal with some germs still inside and another more serious abscess will form. After the abscess has been cleaned and washed, it should be dressed with astringent or sulphanilamide powder daily.

All discharges from abscesses, all cotton wool, bandages and cloths which have been used should be collected and burnt or buried or otherwise disposed of so that flies or other animals cannot come in contact with them.

It is important to distinguish between haematomas and abscesses since if the former are lanced the consequences may be serious. In cases of doubt it is safest to do nothing as nothing can be done for an haematoma and nothing must be done to an abscess until it bursts or is ready to burst. **Hot fomentations** will help to soften both types of swelling and are to be recommended.

Ruptures (Hernias)

Between the skin and the organs within the abdomen (liver, kidneys, spleen, bowels, etc.) is a layer of muscle and tendons lined by a thin membrane called the peritoneum. When an animal has a weakness in this muscle layer or when it has an accident, these muscles may tear so that the abdominal organs are squeezed through and lie under the skin. The organ usually concerned is the bowel. This bowel lying in a pouch of peritoneum bulges out the skin at some point, and this bulge is known as a rupture or hernia.

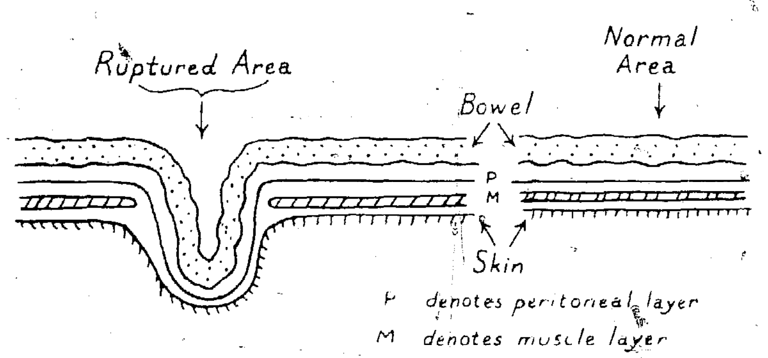


Fig. 2. Ruptured Area

Ruptures are most commonly seen at the navel or near the scrotum where the muscle layer is always somewhat weaker. Following accidents, however, ruptures may occur at any point over the abdomen and small ones are commonly seen behind the ribs.

Ruptures are fairly easily diagnosed since it is usually possible to push the contents of the rupture back into the abdomen, and to feel a definite border to the tear in the muscle layer. Abscesses which may look like ruptures will not vanish if you push them and are firmer to the touch.

Treatment. Small ruptures do no harm if untreated. Ruptures at the navel and scrotum need to be treated if they are at all large. The only treatment is to sew up the torn muscle under a general anaesthetic. This, of course, must be done by a Veterinarian.

Fistulous Withers and Poll Evil

Fistulous withers and poll evil are two allied conditions.

Cause. The conditions are caused by bruising and damage to the bones of the skull (poll evil) or spine (fistulous withers), such as by continuous pressure of harness or saddle. Bangs bacterium (*Brucella abortus*) is sometimes related to the infection of the bones that follows.

Symptoms. The damaged bone dies and forms an abscess which burrows its way out of the skin and appears as a small sore (sinus) on top of the shoulder or the head. This sinus may have more than one orifice, each of which may discharge pus. These orifices are often related to a large tender swelling, in some cases only this swelling appears. This abscess advances forward, downward and inward and pus gathers between the muscles and sometimes under the shoulder blade.

This condition is always serious, but the deeper and nearer the head the abscess, the worse is the case, as the infected tissues may extend to the ligament from the head to the shoulder and so reach and break out in the neck. An abscess high on the withers is the easiest type to treat as it drains most readily.

Treatment. The condition is very difficult to treat as the abscesses are so difficult to drain. Various cures will temporarily heal the skin wounds but the infection will invariably break out elsewhere.

It is always worth while consulting a veterinary surgeon. In the deep seated cases he may be able to open up abscesses under an anaesthetic. In minor cases the sinus can be cleaned out as well as possible and a bit of gauze saturated with weak tincture of iodine inserted from top to bottom, and left for three days to drain. Such first-aid is however usually temporary since unless the cause is removed the condition will recur.

Tetanus (Lock Jaw)

Cause. This is a very common and often fatal disease of horsekind in Jamaica. It is caused by a bacterium (*Clostridium tetani*) which is to be found in dung and soil all over the world. It is particularly common in warm swampy or heavily stocked areas and the disease can occur in most species of animals and in man.

~~The germ gains entrance~~ to the body through wounds which become contaminated with soil or dung. Since the bacterium belongs to a family which grow best in the absence of air, deep dirty lacerations and puncture wounds are the types of injury most likely to lead to tetanus. In these wounds the germ lies between raw flesh and a mass of dirt, away from any air, and it soon forms poisons (toxins) which enter the body.

Symptoms. These arise within a period varying from a few days to a few weeks after injury. The toxins spread along the nerves up to the brain and when they reach it they over-stimulate it so that the first symptoms are of mild muscle spasms which increase in severity until the muscles finally become rigid and unable to move.

The first symptoms likely to be noticed by the owner is a slight muscular stiffness in the hind legs; this rapidly gets worse. At an early stage the tail is raised and carried away from the body. The ears are drawn back so stiffly that they almost meet. The animal soon becomes so stiff that any movement is difficult and painful. At this stage the jaw muscles usually go into spasms so that the jaws are locked tightly together and cannot be parted. Advanced cases of tetanus are very sensitive to noise and to bright light and any sudden noise may cause them to go into violent spasms. In the later stages the body temperature is raised several degrees and may be very high just before death.

Treatment. It is essential if tetanus is suspected to call for veterinary aid very promptly. Even so, this disease can develop so rapidly that by the time help arrives the case may be too advanced to respond to treatment. Rare cases recover without any treatment, but the usual case dies in a few days unless treatment is started at a very early stage. The only first aid that the owner can give to an affected animal is to shut it in a dark quiet place and leave it undisturbed.

Prevention. This consists on the farm, of the prompt treatment of all wounds, especially those about the feet and those under the tail since in these two places wounds are very likely to be contaminated by dung.

All valuable horsekind and any horsekind or pigs on properties where tetanus is common should be vaccinated annually with tetanus toxoid which will prevent the disease from developing even if infection of a wound should occur.

Parasitic Diseases of the Skin

This subject is dealt with comprehensively in the Extension Circular No. 44 entitled *External Parasites of Livestock*, and only a brief mention will be made here of these conditions.

Mange

Cause. One of several species of mites can cause various types of mange. The two commonest types are *chorioptic* (leg) and *sarcoptic* (body mange). Neither form is often seen in Jamaica.

Symptoms. The mites are too small to be seen with the naked eye but the affected area of skin becomes bald, scabby, thickened and is very irritant; the animal may stand and bite it until it becomes very raw.

Treatment. Isolate from other animals as mange is very infectious. Clean affected areas with soap and water and then treat skin with gammexane or any other approved anti-mange dressing (derris, sulphur in oil, etc.) at three day intervals until the irritation ceases.

Lice

Cause. The biting horse louse (*Haematopinus asini*) or the sucking lice of horses (*Bovicola equi*).

Symptoms. Itchiness and scurfiness of the skin especially in the regions of the mane and tail where the rubbing caused by the irritation may cause many hairs to fall out.

Treatment. As for mange.

Ticks

Cause. Although the cattle tick (*Boophilus annulatus*) may be found on horses, the usual horse tick is *Dermacentor nitens*.

Unlike cattle which may succumb to tick fever, horses in Jamaica do not catch any specific disease from ticks but the ticks themselves can be a source of nuisance to the animal especially in the tail region or in the head where the animal may rub itself sore in an attempt to dislodge the ticks.

Treatment. Washing, spraying or dusting the animal with a gammexane preparation is preferable to picking the ticks off since the latter course sometimes causes festering due to the head of a tick being left in the skin.

Ringworm

Cause. This disease is caused by a fungus or mould. Several species of this can affect horses but the commonest ones belong to the groups designated *Trichophyton* and *Microsporon*.

Symptoms. The first sign of ringworm in horses is a circular, scabby, bald patch of skin about twice the size of a penny and usually situated on the neck or over the shoulders. This patch often vanishes in about two weeks but new areas of ringworm appear during this time and the disease may persist on an animal for many months. It does not seem to worry the animal at all but since the disease can be serious in other animals and persons handling affected horsekind, it is important to treat it promptly.

Treatment. The scales must first be softened using liquid paraffin or glycerine and then they should be scraped off with a piece of wood. After this, the affected place should be dressed daily with an efficient ringworm dressing such as Whitfield's ointment.

Red Mites

These mites are small red relations of the ticks. They attack all stock but prefer horsekind because of their finer skin. For this reason the mites are found mainly on the head and legs where they cause much discomfort and irritation. The only parasitic stage of the mite's life cycle is the larval phase which lasts for about two weeks. This stage is readily controlled by spraying or washing the affected parts weekly when the mites are proving troublesome.

Non-parasitic Skin Diseases

Urticaria (Nettle-rash) and Photosensitization. These are both allergic conditions occasionally encountered in the Island.

Cause. The origin of both conditions is somewhat uncertain. Urticaria seems to be due to the animal either contacting or eating something to which it is sensitive. Photosensitization is a condition in which the animal is sensitive to the sun's rays. It occurs mainly in animals with very light coloured skins.

Symptoms. Urticaria causes the animal to come up in a series of small circular skin weals usually about the size of a penny. Sometimes these weals fuse together and a whole area of skin becomes swollen and watery. This swelling is not painful and 'pits' when it is pressed. Photosensitization is somewhat similar to this except that it mainly affects white skinned areas. In severe cases fluid may emerge through the skin which then become cracked and sore.

Treatment. Animals subjected to photosensitization should be given some shade and kept out of the sun as much as possible. Affected animals should always be given a dose of salts and severe cases should have the sore skin dressed with a soothing lotion. This ailment responds very well to certain injections but since it normally cleans up spontaneously in a day or so it is hardly worthwhile calling a veterinary surgeon unless the animal is very distressed.

Ulcerative Lymphangitis (Farcy)

Farcy is the name given to two allied conditions affecting the skin and underlying tissues of mules and horses especially around the legs. The name is unfortunate as it is used in other parts of the world to denote the skin type of glanders—a much more serious and deadly disease which does not occur in Jamaica.

Cause. The disease is in reality 'Ulcerative Lymphangitis' caused by a germ known as *Corynebacterium ovis* with other bacteria and it now appears that both *Button* and *Water* farcy in Jamaica are usually caused by the same group of germs. The germs gain entrance to the body through cuts or abrasions in the skin to which they are probably carried by ticks and flies. The small wound-fly or gingi-fly (*Hippelates* sp.) and the screw-worm fly are most important in this respect, since they fly from wound to wound carrying germs.

The germs live for some time around mule pens and other places where horsekind are herded together and infection is most common under crowded conditions.

Symptoms. Although the infection always enters through a small wound this has usually healed when the disease really shows itself some weeks or months later. Most often the legs are affected since, especially in working animals, these receive many small cuts and abrasions, but *farcy* can affect the face, neck and almost any part of the body.

The first sign is a swelling and tenderness of the skin. This may occur at the site of the original infection or higher up the leg. The hair falls out and the skin becomes rough and scaly, eventually bursting to allow the pus to escape.

At this stage and before, the horse or mule is lame and the leg tender, especially if the sore is near a joint or tendon. *Water* farcy usually forms a bigger sore with more damage to the deeper tissues, more pain and tenderness than the *button* farcy.

The discharge of pus usually relieves the condition to some extent and the wound may heal. Infection, however, persists in the deeper tissues and sooner or later a further sore appears. The germ spreads along the lymph spaces and so the next abscess forms higher up the leg, usually on the same side and often over a joint or tendon. If the case is neglected, it may spread to the top of the leg and to the lymph glands of the chest or flank. By this time, the animal is completely incapable of work.

Farcy is not a killing disease but causes much suffering and ill health in horsekind and is responsible for much loss of working time. Its infectious nature is often not realized as it may be some months between infection and the onset of the symptoms and for this reason there is a tendency to accept the disease as a *necessary evil* on properties where mules are kept.

Treatment. Treatment of individual animals for *farcy* is not a worthwhile procedure. This has been proved in other countries where the disease occurs, and by organizations such as the Royal Army Veterinary Corps, caring for large numbers of mules and horsekind. Owners of large properties in the Island who have adopted the policy of slaughtering affected animals, find that *farcy* is completely wiped out within a year or two and no further cases then occur. There can be no doubt that destruction of affected horsekind is the best policy, and by this means England, the U.S.A. and other countries have completely eradicated *farcy* within a few years.

Treatment of individual animals has been attempted and under exceptional circumstances may be justified in Jamaica, in the case of a valuable breeding animal. No known treatment will effect a permanent cure once the lymphatics are involved and although a temporary abatement of symptoms often occurs a relapse invariably supervenes. Single, primary open sores often respond to early treatment with penicillin and dusting powder, but there is some doubt as to whether such cases are really true *farcy*.

Solutions of arsenic and mercury salts administered by intravenous injections are sometimes used but should only be given under veterinary supervision. Local applications to the abscesses of mercury and arsenic ointments also relieve the symptoms to some extent. Ripe abscesses may be opened and the pus removed and disposed of (preferably by burning) out of reach of flies. The wound is then washed in disinfectant and a dressing such as iodine or mercurochrome applied. An efficient fly repellent oil should always be applied to *farcy* sores. All these treatments merely put off the inevitable end for a short time only, so that it is always most economical to slaughter badly affected animals rather than to let them stay around and spread the disease.

Prevention. A great deal can be done to prevent the disease recurring if affected cases are slaughtered and the remaining horsekind have all sores properly treated until completely healed. Animals with sores being treated should be isolated and any fly-blown wounds should be dressed with a screw-worm remedy rather than with 'jeyes'. Care should be taken to prevent unnecessary wounds and galls from arising by handling and harnessing mules correctly.

Diseases of Foals and Cubs

Joint Ill (Navel ill). This is probably the commonest disease of very young animals of all kinds. It is caused by germs entering the navel either at, or soon after birth. In rare cases infection can occur prior to birth from germs which pass through the mother's body and settle in the foal while it is in the womb, only becoming active after birth.

Symptoms. In the last mentioned form the foal may be born dead.

Usually, however the first symptoms are those of a foal that will not thrive. Infection may localize in various organs, usually the joints (hence the name *joint ill*) or in internal organs where a variety of symptoms may be set up. If the germs pass into the general circulation (blood poisoning) the foal becomes very sick and develops a very high temperature in which case pneumonia may develop. In less severe cases, e.g. joint abscesses, the animal's progress may be only slightly retarded. However, the damage once done is usually permanent and affected foals seldom make hard-working adults.

Treatment. By the time that symptoms show it is usually too late to treat these cases with any success. Sometimes joints may be poulticed and a course of penicillin injections may be tried, but the results of these treatments are not encouraging. If there is an obvious abscess or sore at the navel this should be dressed and treated in the approved fashion. The great danger, however, lies in such abscesses bursting internally and not externally. It is as well to seek veterinary advice early in the case of any young foals which fail to thrive properly.

Prevention. All foals and cubs should have their navels dressed with a suitable antiseptic as soon after birth as possible. Suitable dressings are tincture of iodine, 'Dettol', acriflavin, sulphanilamide powder, etc.

Retained Meconium

This is another common complaint of young cubs and foals. It is most commonly seen in male foals from mothers whose condition is poor.

Cause. The meconium is the dung formed by the foal before birth. It tends to collect in the rectum of the unborn foal but should be passed in the first 24 hours of life.

Symptoms. Within 24 hours of birth, the foal becomes dull and refuses to suck. Affected foals may show signs of colic and kick at their belly or walk around aimlessly. These colicky pains cause periods of straining in which the hard dry meconium passes to the anus without actually passing out. A few hours of this and the bowel stasis makes the animal very ill and if unattended, it will die.

Treatment. An enema of soap and water or mineral oil must be given and the meconium gently eased out of the rectum, using the forefinger. Much patience is necessary as it may need several attempts at 15 minute intervals to get all of the meconium away.

Prevention. An ounce of liquid paraffin or mineral oil given soon afte birth helps to prevent this condition from occurring.

Diarrhoea

Any digestive upset will cause a young animal to *scour* or *have operation*. The cause of the trouble may be overeating on the part of either the foal or its mother, or a sudden change in the diet of the mother; this will alter her milk and make the foal scour. If the mother has recently been worked and comes in sweaty, her milk may also upset the foal.

Symptoms. The foal's droppings are yellow or white and watery with an unpleasant smell. The foal itself is dull and lethargic. Its temperature may be raised and it shows little inclination to suckle.

Treatment. This can be carried out in two stages. Firstly, give a laxative to remove the irritant matter and then give a mild astringent to allay any soreness to the bowels. A suitable laxative is liquid paraffin of which 1–4 ozs. can be given according to the size of the cub or foal. This should be followed by a dessertspoonful of chlorodyne or a mixture of 2 teaspoonfuls of kaolin plus an equal amount of chalk in half a pint of water. This should be repeated twice daily for 2 or 3 days.

The Digestive System

One of the commonest symptoms of illness in animals is that of losing the desire to eat (Anorexia). This may mean that there is something wrong with the animal's mouth or digestive system or it may mean that the animal has an infection or fever of some kind. If the animal seems to want to eat but eating appears painful and after a little chewing the food is spat out, it is likely that there is something wrong with the teeth. If swallowing seems to upset the animal, then the throat is probably the cause of the trouble. Should the trouble be in the stomach or intestines the horse will have colic and show obvious signs of abdominal pain. If the trouble cannot be located in this way it is likely that the animal has some sort of generalized illness of which loss of appetite is only one symptom and further observation will probably reveal other symptoms.

Bad Teeth

There are two main conditions affecting the teeth of horsekind—Caries and Sharp Mouth.

Caries is a disease in which rotting matter gets trapped in crevices either in or between the teeth and there rots a hole in the tooth and exposes the nerve. The symptoms are exactly the same as in humans; the tooth is painful and the animal will try to drink and eat using the other side of the mouth in order to stop food and water touching the exposed nerve. Unfortunately, it is not possible to put a horse in the dentist's chair and fill or stop the tooth, so that the usual treatment is for a veterinarian to extract it—not an easy procedure.

Sharp Teeth (Razor-mouth). The back (molar) teeth of horses meet each other at a slant so that although the centres of their grinding surfaces rub on those of the opposite jaw it is possible for the outside

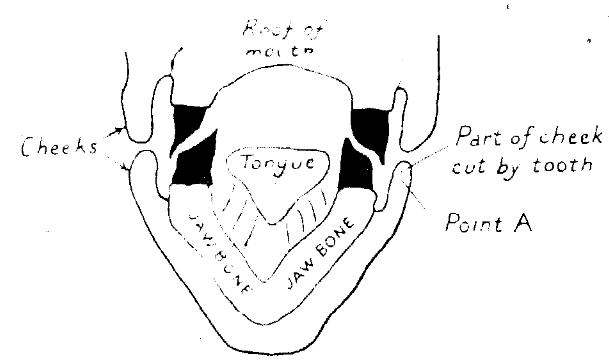


Fig. 3. Cross-section of head of horse

edges to grow out and become sharp or razor edged. This tendency is especially marked in some horses whose lower jaw is unduly narrow.

Symptoms. Because of this sharpness the teeth cut the tongue and gums and make it painful for the horse to chew. Affected horses are usually quite well in other ways and are very hungry but eating is so painful that they just pick at their food and it is often dropped out of their mouths after a few slow painful chews. Pressure on the side of the cheek at point A in Figure 3 causes the horse to flinch very quickly.

Treatment. This condition is easily treated by a veterinarian, by filing the sharp edges with a special rasp.

Lampas

This is a swelling of the palate just behind the upper incisor teeth.

Cause. Faulty chewing due to indigestion or general poor condition from worm infestation and malnutrition.

Symptoms. Reluctance to eat coupled with a swelling just behind the upper front (incisor) teeth.

Treatment. This really depends on the cause of the indigestion which should be rectified. As a general rule it is advisable to examine the back teeth for razor-edge to see if they need rasping and also to give the animal a good dose of salts and treat it for worms.

Choke

This is a condition seen most commonly in cattle but occasionally encountered in horsekind. It denotes the state when a piece of fruit or root gets stuck in the oesophagus or gullet (the pathway from the mouth to the stomach).

Symptoms. The symptoms are most alarming; the horse usually stands with his front legs apart and his head and neck outstretched and makes violent swallowing movements followed by an excessive amount of dribbling from the mouth. Choked horses frequently have a worried expression and are very excitable.

Treatment. The stoppage is usually in the neck region and may be felt as a hard lump in the very lower part on the left-hand side of the neck. If it can be felt, vigorous massage may break it up and enable it to pass on to the stomach. If nothing can be felt or moved, it is best to leave the animal alone and tie it up short where it has no chance to eat or drink anything and to call a veterinarian. Choked horses are really very hungry, but any food just makes the stoppage worse. If the animal is reasonably comfortable, he can, if necessary, be left for a day or two away from food although water should be provided and the blockage may gradually be dissolved by the body. Do not attempt to push a stoppage by using any instrument in the horse as these are likely to harm and possibly kill the animal.

Colic

Causes. Colic is the word used to describe an acute digestive disturbance in any animal, especially horsekind. It usually results from faulty or improper feeding such as a sudden change of food, e.g. from old grain or roughage to new. Overeating such as occurs when animals are deprived of food during the day's work and are allowed to engorge themselves in the evening when they are too tired to chew and digest their food properly often causes colic. It may also be seen in stormy weather when cut grass or grain may be sour or wilted. Certain plants such as the pods of the cashew tree irritate the intestines if they are eaten and may cause severe colic.

Symptoms. The term *colic* describes a variety of conditions which can occur in the digestive tract, the most important forms are:

(1) **Impactions**—When some part of the bowel is stopped up.

(2) **Dilations**—When a part of the bowel is blown up by gas and much wind is passed.

(3) **Twists**—When one part of the bowel gets twisted around another part.

(4) **Spasmodic**—When the bowel wall goes into spasm at short intervals.

All forms show the same symptoms early on. The animal is restless, sweaty and paws the ground. It may repeatedly turn and look at its belly or try to ease its pains by getting up and down or sitting back on its haunches like a dog. Often the animal stands and strains giving its owner the impression that it is trying to pass urine unsuccessfully.

Impacted colics tend to have a dull pain coming on slowly and gradually getting worse. They are usually due to overeating or to sour food. These cases always have severe constipation.

Dilations may arise more suddenly and are characterised by the passing of much gas and a severe pain.

Twists usually follow one of the above forms in which the animal rolls violently and gets a twist. Such cases suffer frightful pain and invariably die.

Spasmodic colic also arises very suddenly and after lasting from between a few minutes to a few hours it ceases quite suddenly. Affected cases have bouts of pain at regular intervals of a few minutes.

Treatment. This is a matter demanding considerable experience but if assistance is not immediately available, the owner of a colic case can render quite useful first aid. A veterinary surgeon should be called at once and meanwhile all food should be withheld and treatment should depend on the type of symptoms shown. The doses below are for a donkey—a mule or horse can be given $1\frac{1}{2}$ or twice (if a large animal) these doses.

(1) For severe pains—
$\frac{3}{4}$ ounce of chloral hydrate in 1 quart of water

(2) For Impactions (mild pains and constipation)
Epsom Salts $\frac{1}{2}$ lb.
Ginger (Powder) $\frac{1}{2}$ oz.
Water 1 quart

(3) If there is marked gas production (flatus)
Oil of Turpentine $\frac{1}{2}$ oz.
Raw Linseed Oil $\frac{3}{4}$ pint.

Prevention. Horsekind should not be worked for long periods without any food or drink and should not be allowed to engorge themselves at the end of the day. Sudden changes in the food, sour or wilted food (especially cane) should not be allowed. Animals should not be given water if they are very hot and sweaty. They should be allowed to dry off and preferably brushed down before feeding or watering.

Enteritis (Diarrhoea or 'operation')

Cause. There are many causes of diarrhoea in horsekind. The commonest is the eating of bad, mouldy or sour food. Diorrhoea also often follows in other forms of sickness such as worms, strangles or pneumonia. It may occur alone when the animal has a chill or infection in the bowel.

Symptoms. The dung is fluid and frequently passed. If there is an inflammation of the bowels, the animal has a temperature and mild colic. Should this become severe the animal loses a lot of fluid and becomes dehydrated, hidebound and very weak.

Treatment. In cases due to incorrect feeding it is a simple matter to stop feeding bad food and the diarrhoea will soon cease. If, however, the animal has an inflammation of the bowel, it should be nursed carefully, bedded down well and offered a little food every 2 or 3 hours. To alleviate the tenderness in its intestines either powders of 1 oz. each of kaolin and chalk or ½ a fluid ounce of chlorodyne solution should be given in flour or arrowroot gruel twice daily.

Worms

For a more detailed account of the life cycles, treatment and management of affected animals reference should be made to Extension Circular No. 37 *Internal Parasites of Livestock*.

Large White Round-worm (Ascarids). This worm (*Ascaris equorum*) may be the cause of unthriftiness in foals and yearlings. Its presence can be proved by demonstrating the eggs or seeing the worms in dung samples. It is a difficult worm to remove although 1–2 teaspoonfuls of turpentine in half a pint of oil given on an empty stomach sometimes help. A new drug, Piperazine, is extremely effective but rather expensive.

Red Worms (Strongyles). These worms (strongyles) are minute blood-sucking worms which occur throughout the intestines of horses in enormous numbers. They are the commonest cause of poor condition in adult horsekind. Phenothiazine is a very effective treatment, and details of dosage are marked on the tin.

Pin or Seat Worms (Oxyoris equi). These worms live in the last part of the bowel. They may be up to 3 inches in length and are white and slender. An intense irritation around the anus is caused by the presence of oxyuris. This makes the horse stand and rub its backside on fences or posts until the hairs in this region become ragged and torn. A similar condition can be caused by ticks, lice or mange around the tail but if oxyuris is the cause of the trouble cream coloured masses of eggs and worms will be seen near to the anus. The usual treatment is a teaspoonful of oil of chenopodium per 250 lbs. body weight given in a pint of linseed oil after a 36 hour fast. A safer alternative is a strong salt and water enema.

Bots

Bots are the larvae of flies (*Gastrophilus* spp.) which lay their eggs on the skin hairs of horsekind. The larvae hatch in a few days and get to the animal's mouth either by crawling over the skin or by being licked in by the tongue. After a few weeks in which they live beneath the lining of the tongue, these larvae, now about the size of fly maggots, pass down into the stomach. There they use up much of the animal's food, which nourishes them instead. Consequently, the horse loses condition.

After a period of some months in the stomach the grubs pass out in the dung and bury themselves in the ground from where they emerge as adult flies some weeks later. They may be recognized in the dung as brown maggots about half-an-inch long.

Treatment is to give carbon-tetrachloride, 10 c.c. per 250 lbs. body weight or carbon disulphide, 1 c.c. per 50 lbs. body weight.

Diseases of the Respiratory System

Sore Throat. Sore throats in horses usually denote an early symptom of an infection of the throat or chest. The symptoms of this condition are those of fever (sweating, constipation, a high temperature, loss of appetite) with a definite discomfort around the throat. The head is often stretched out stiffly to make the throat more comfortable.

Treatment. This really depends more on what is the underlying cause of the **sore throat** than on treating the condition itself. It is important to keep the horse warm and dry and to keep up his strength by tempting him with a little food. He will probably find most food too difficult to eat so that it should be mixed with something sloppy such as molasses to make it easier to swallow. If the horse has a definite fever, veterinary aid should be sought at once and the animal should be stopped from working.

Fever and Chills

The term *fever* denotes the changes that accompany a rise in body temperature. The normal body temperature of horsekind is within one degree either side of 100·5° F. With the exception of conditions such as heat-stroke, a rise denotes an infectious condition in some part of the body. The site of any infection that causes the temperature to rise may be difficult to detect. However, if there is an obvious disorder of the bowels, skin, eyes, or chest, one can expect that there is an infection in that organ. Fever can be described as occurring in three stages.

Stage 1: The first symptoms observed are those of an animal that is drowsy and only picks at its feed. The coat looks rough and the animal feels cold. There is usually a slight constipation and the animal pants and shivers periodically.

Stage 2: This follows less than a day after stage 1. The temperature now rises and the animal tries to check this by panting, sweating and passing dung frequently. There is often a discharge from the eyes and nose at this stage.

Stage 3: This shows a subsidence of the symptoms and ends in either recovery or death.

The commonest seat of the trouble in a fevered mule or donkey is the chest. With a straightforward cold or chill the animal passes through **Stage 1** and maybe **Stage 2** of fever and then quickly recovers. The chest of these animals is however very sensitive and various complications can and often do follow what starts off as a simple chill.

Treatment. Since pneumonia, strangles and coughs all follow from chills it is advisable to always take great care in treating such cases. Simple chills need no special drugs. They do, however, need careful nursing. Protection from rain is essential but affected animals need not necessarily be housed. Their appetite should be frequently tempted with some fresh cut guinea grass or a bowl of corn, and their bowels should be stimulated with a mild laxative such as 4 ozs. of salts. If the animal tends to sweat and shiver a lot some sacks should be sewn together or a blanket used to cover the chest and back.

Strangles

Symptoms. This is a contagious condition seen in young horses; it usually follows a cold or chill. Mild cases merely resemble a severe chill but the usual strangles case develops much more markedly. There are thick discharges from the eye and nose and the glands in the throat become enlarged and painful. These glands become full of thick yellow pus (corruption) and in time may burst like abscesses. This condition is rarely seen in Jamaica.

Treatment. It is usually advisable to call a veterinary surgeon to treat these cases—he may recommend the use of antibiotics and other drugs in certain cases. As first aid measures, the eyes and nose should be cleaned regularly and the swollen glands should be fomented until they burst, when they should receive the normal treatment for abscesses. Affected animals should be isolated and fed on sloppy gruels which are easily swallowed. All discharges from strangles cases should be disinfected and destroyed.

Pneumonia

When the infection such as that following a chill or strangles spreads down into the lungs this condition is called pneumonia.

Causes. The germs causing pneumonia only cause trouble when the animal's resistance is lowered from other causes. Animals in good condition have a strong resistance to any infection, but when an animal in poor condition is allowed to get over-tired and wet it will easily contract a severe chill which may lead to pneumonia.

Drenching pneumonia is a pneumonia that follows faulty drenching of an animal when the liquid instead of being passed down the oesophagus (gullet) to the stomach, is instead poured down the trachea (wind-pipe) to the lungs. Here it causes a severe pneumonia and even gangrene (death of the tissues) of the lungs so that a thick, evil smelling discharge comes from the nostrils.

Symptoms. These are similar, at first to those of a severe cold or strangles except that the throat glands do not enlarge. When the infection really settles in the chest, the animal pants and blows when it breathes and it easily gets short of breath. Affected animals usually have a high temperature; often they will not eat and are reluctant to move about at all.

Treatment. The main principles of this are similar to those described under strangles. With pneumonia, however, the infection itself can more often be successfully treated with antibiotics under the supervision of a

veterinary surgeon. As mentioned earlier, nursing is of prime importance here. Do not administer any drenches to horsekind suffering from ailments of the chest since in a horse that is short of breath drenching is likely to induce a drenching pneumonia and this type of pneumonia will often defy any treatment and end fatally.

Coughs

Causes. Coughs can accompany any form of chest disorder since they are mainly due to irritation of the throat, windpipe or tubes of the lung (bronchi). Such an irritation may be caused by a mild infection, by dust or lungworms. Sometimes horses with bad hearts have a soft cough since their poor circulation gives them a tendency to gasp for breath.

Symptoms. The type of cough often gives some indication as to its cause. Hard harsh coughs often originate in the throat while a deep barking cough is more likely to start in the lungs themselves. A mild irregular moist type of cough is often indicative of lungworm infection.

Treatment. This depends on the origin of the cough. Heart coughs need to be treated as for weak hearts. As yet there is no dependable treatment for lungworms in any species of animal. Throat coughs can be eased with an electuary containing:

Powdered Camphor	½ oz.	1 tablespoonful 3 times daily
Potassium Chlorate	1 oz.	
Honey	4 ozs.	
Glycerine	4 ozs.	

This should be smeared on the tongue so that the animal can swallow it in its own time.

Diseases of the Heart and Blood Vessels (including dropsy and swollen legs)

In old horses as in old people the heart often begins to feel the strain of living and does not function as well as it ought. Such animals tire easily and are not of much use for work. A milder symptom of a bad heart is dropsy (oedema). This is an accumulation of fluid under the skin, usually that of the legs and belly. It arises because the heart is not pumping as well as it ought to so that fluid leaks from the blood vessels and tends to gravitate to the lowest parts of the body. Mild cases of oedema often respond well to treatment but they are always likely to recur. A substance called digitalis is used to treat these cases but its dosage must be worked out by a veterinarian as it is a very poisonous medicine.

Diseases of the blood vessels which are so common in old people are rare in animals. Such diseases may be suspected in animals that periodically fall down or faint for no apparent reason. Swollen legs in horsekind are also a symptom of a poor circulation. They may, however, follow injuries to the legs or feeding on a diet that is too rich in corn. The simplest and most effective way of reducing these swellings is to stand the animal in water or to hose down its legs for 10 minutes two or three times daily.

Miscellaneous Disorders

Tumours (Neoplasmas, Growths, Cancers). Tumours can occur at practically any place in the body of a horse and they can be in many different forms. With the exception of warts they are, however, rarely seen, except in old animals.

Warts in horsekind are a very simple form of growth and are usually fairly easily treated. If the wart has a stalk a thin piece of cord can be tied around this and in a few days the wart will fall off. Flat warts without stalks will often respond to a suitable ointment. If, however, the wart is on a sensitive area such as the mouth or breasts, it is not advisable to use such ointments. In these cases, the warts can be removed surgically by a veterinarian.

Any obvious lump on an animal may be a growth but before jumping to conclusions about this it is important to make sure that the lump is not a rupture, an abscess, a bruise or, in the throat region just a swollen gland. Firm swellings on bones in horses are rarely growths; they are usually the results of damage to the bones.

Poisoning

There is a tendency, unfortunately all too common, to attribute many illnesses to poisoning. Actually, poisoning in horsekind appears to be a rare occurrence as they are fairly fastidious animals and take some care in choosing what they eat and drink. They are seldom dipped and so seldom suffer from poisoning from this cause.

Symptoms. Each poison ingested causes its own sort of symptoms. Since poisons in animals are usually taken by mouth, the early symptoms usually involve the digestive system, e.g. colic, diarrhoea, vomiting, constipation. After a period other organs may be involved and the animal may sweat, or strain, or pant.

Treatment. Since the cause of the poisoning is usually unknown, it is seldom possible to know the correct antidote. First aid measures should be along the lines of relieving pain and of minimising the effects of any poison already taken. A good drench for this purpose is $\frac{3}{4}$ oz. of chloral hydrate and $\frac{1}{2}$ oz. turpentine in a pint of gruel to a donkey or double these amounts for a horse or a mule. An hour or two later $\frac{1}{2}$ lb. of epsom salts can be given to try and remove the poison from the bowel. These drinks can be repeated in 8 hours if necessary.

General Information

Castration. It is impossible to do justice to a subject as complex as castration in a chapter as short as this. There are, however, enough veterinary surgeons on the Island now for any horse owner to have his animals castrated by a properly qualified person. The extra few shillings will be well spent in having the job properly done with a minimum of cruelty involved.

If the job is not done by a veterinarian, the horse owner should ensure that the person doing it has clean hands, a clean knife and cleans the area of operation before and after he removes the testicles.

Foalings and Cubbings. If human assistance is needed here it is absolutely vital that before anyone puts a hand into the mare or jenny, they clean the back end of the animal and get someone else to hold the tail to one side before they put their hand into the vagina. The operator's hands must be well cleaned and disinfected and properly lubricated with oil, liquid paraffin or soap.

The foal or cub should be born with its head and legs stretched out before it. Never pull on the legs unless you are quite sure that the head is not twisted back or jammed. Try to make sure that the foal is not twisted before you pull because if it is twisted and you pull you will only jam it in

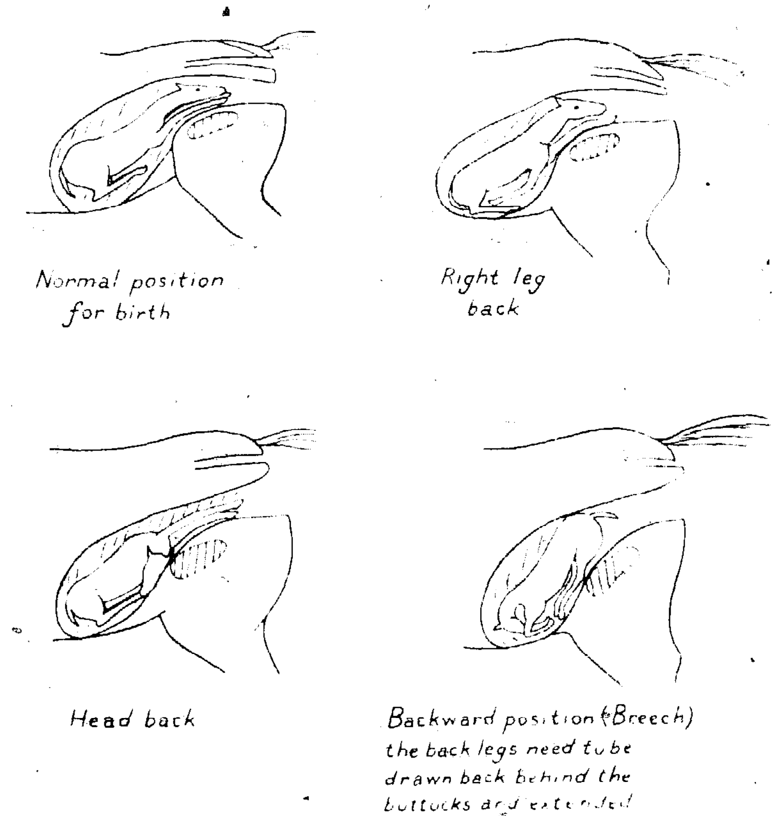


Fig. 4. Foaling

the mother's passage. If the cub or foal appears to be fixed the great secret is not to pull hard and tear the mare, but to push back the foal, try and find out why it was getting stuck, correct this and ease it out. Never be in too much of a hurry to pull. On the other hand once a foal starts to show itself it should be born within twenty minutes, if it is not try to find out why, but remember at all times that a steady pull does far less harm than a series of jerks. The above sketches show how to deliver a few common abnormal positions of foal or cub.

Destroying Horses

When an animal has a bad fall or is involved in an accident with a car or truck from which it sustains serious injuries such as a broken leg, it is only fair to it to destroy it as soon as possible. There is only one way in which it is at all humane for a person who is not a veterinary surgeon to destroy animals and that is by shooting them. If you cannot get a vet to shoot your injured mule or donkey, then ask the police to do it for you as soon as possible.

The correct place to shoot horsekind is the point where the two lines drawn from the base of the ears to the opposite eyes meet each other. (See sketch.) The gun should be pointed through the head and body towards the animal's tail. Do not allow anyone to stand behind the animal's head as the bullet may be deflected and pass out of the body.

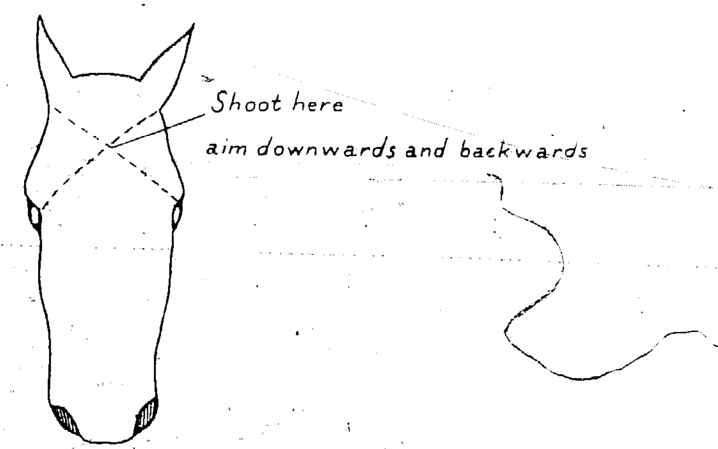


Fig. 5. Where to shoot horsekind for humane destruction

The First Aid Box

Some useful medicine to have handy in case of trouble are listed below.

1. 1% **Acriflavin** solution. This is a useful alternative to **Dettol** or **Iodine** as an antiseptic for wounds since it colours the skin yellow and shows if the wound has been recently dressed.

2. **Screw-worm Smear** such as Smear 62 obtainable from the

~~Jamaica Livestock Association or the~~ Jamaica Agricultural Society. This acts both as a preventive and as a killer of maggots.

3. **Phenothiazine worm powder** also obtainable from the J.L.A. or J.A.S.

4. **Astringent Powder** for dusting on wounds after cleaning them and dressing with acriflavin. A useful formula used by the Department of Agriculture is given below:

Sulphanilamide Powder	—3½ pts.
Alum Powder	—2 pts.
Zinc Oxide	—2 pts.
Boric Acid	—2 pts.
Iodoform	—¼ pt.
Charcoal	—¼ pt.

5. **Epsom Salts.**

6. 1 oz. of oil of **Turpentine** in 1 quart Linseed oil. For mild indigestion (horse dosage the whole bottle—small donkey ½ bottle).

7. **White Liniment** for sprains and strains.

8. **Sulphanilamide powder** for infected wounds.

9. A **wound oil.**

(a) Oil of turpentine 1 pt.
Fish Oil or Raw Linseed oil 5 pts.
(b) Fish oil alone
(c) Iodoras paste

These will all prevent flies from gathering on or around clean wounds.

CHAPTER 49

Small Stock and Poultry

PIG REARING

Introduction

Pigs surpass all other farm animals in efficiency of converting feed into edible flesh. No farm should be complete without a pig or a number of pigs according to the amount of surplus or waste feed from the cowshed, field and household. In the past nearly every small farmer and householder in the country had a pig. This was fed on the surplus from the ground and house, breadfruit, mangoes, garbage, etc. The pig was killed when fat and provided the owner with a little extra cash and the district with fresh meat. This form of pig rearing should be encouraged. One pig kept by each small farmer would do a lot to increase the food supply of the country. If farmers are going into pig rearing as a business it is important that the pig is fed to make the maximum growth, and the right kind of feed is given to make the most economical gains per pound of feed consumed. The secret of success in pig farming is to breed quickly, feed well, and make a quick turnover.

The pig has the highest dressing percentage of any animal averaging 70–90% depending on the age and condition of the animal. Very little is wasted in the slaughter of the pig.

Types of Pigs

Pigs are divided into two types, pork and bacon. Each type possesses a combination of characteristics which makes it useful for a special purpose. The bacon type is represented by the Tamworth and Large White or Yorkshire. The principal breeds of pork or lard pigs are: Berkshire, Poland China, Duroc Jersey.

The chief breed of pigs found in Jamaica is the Berkshire—although from time to time other breeds have been imported such as Duroc Jersey, Poland China, Large Black, Essex, Wessex Saddlebacks and Tamworth. The Large White is, however, in favour now, extensive trials with this breed, under proper conditions, having proved very successful. There has been the tendency to import the black or sandy coloured breeds into the

Fig. 1. Large White, a fine bacon-type pig

tropics as they were stated to be more adaptable to the warmer conditions, the lighter skinned pigs being subjected to blistering and less tolerant to the heat. The pork type of pig is compact with a wide and deep body, the shoulders and hind quarters full, and well fleshed down to the hocks. The head and face are usually wider and shorter than the bacon type.

In conformation, the bacon type gives the impression of being lean and lanky. They are longer in leg and body with less width in back and lighter shoulders. One of the most important parts of the bacon pig is the ribs. These should be long and deep, as from the side of the pig comes the best cuts of bacon.

In former years there was a sharp distinction in the general conformation of the bacon and pork types of pig but this is being gradually changed due to the consuming public who require smaller cuts and more lean meat. Therefore, the breed today is not as important as formerly, as by selection within a breed a bacon or pork type can be produced and the proper carcass obtained by correct feeding.

A brief description of some of the breeds is given below:

Bacon Type

Large White or Yorkshire. Pigs of this breed are white in colour with dished face and erect ears, the body long, and supported by rather large legs with medium-sized bones of good quality. The body is smooth and deep and cut excellent slices of bacon. The sows are very good mothers and produce large litters.

Tamworth. This is one of the oldest breeds known, being developed in the midland counties of England. This breed is golden red in colour, the hair fine and straight. The body has much length and depth, the head is narrow with a long snout, the ears are erect, of medium size with a tendency to incline forward. The sows are prolific and produce large litters and are very good foragers. They make good crosses with the Large White and Berkshire.

Lard or Pork Type

Berkshire. The Berkshire originated in the county of that name in England, and was one of the first to have a breed society to develop it. The colour is solid black with six white points—nose, feet and end of tail. The head is short and dished, the body long, with back level and ribs well sprung. The breed are noted for their foraging ability and hardiness. The sows are easily handled and good mothers. The breed is early in maturing and make good crosses with the bacon type pigs.

Poland China. The breed originated in the State of Ohio in the U.S.A. The colour is solid black with white markings confined chiefly to face, nose and tail. The head is of medium length, wide between eyes, and the face slightly dished. The ears are of medium size and stand away from the head for about one-third of their length. The back is strong, well arched, and of medium width. It is a very popular breed in the States, is reared in large numbers and is adapted to general farm conditions. The spotted Poland China is an offshoot of the Poland China—the colour is spotted black and white.

Duroc Jersey. This breed also was developed in the U.S.A. in the State of New Jersey and is now known as the Duroc. The colour desired is a medium cherry red, although lighter and darker shades of red are accepted. The snout is of medium length and the face slightly dished, wide between the eyes and tapering well to the nose. The ears are medium, pointing forward, downward, and slightly outward. The body is upstanding with good depth, and a strong back well arched. Pigs of this breed weigh 200 lb. or more at six months of age. They are hardy, prolific and possess considerable uniformity.

Other well-known breeds such as the Large Black, Essex and Wessex Saddlebacks, while not coming under the heading of either pork or bacon, are breeds which can be fed to give a reasonable bacon or pork carcass.

Choosing a Breed

At the present time in Jamaica there is very little difficulty in choosing a breed as only the Berkshire, Wessex Saddleback, or Large White breeds

are available. Always get a purebred sire and purebred sows. If you cannot get purebreds get the best available grade animals with good type and conformation. Buy from a reliable breeder. It is generally advisable to buy sows or gilts already bred when buying foundation animals as this will lessen the risk of buying animals that may be too fat and give trouble to breed. The female should show femininity especially in the head and should be upstanding with legs of sufficient length so that the udder will not touch the ground when she matures. The back should be well arched but not too broad. She should be well developed and have two rows of teats, at least six in each row. Her legs should be strong and well placed under the body, with good feet and short strong pasterns.

Emphasis is placed on strong pasterns as when the sow gets fat or heavy in pig she will have difficulty in walking if the pasterns are weak and unable to bear her weight. The heart girth should be full, with no depression behind the shoulders. As to disposition, the sow should be motherly, quiet, gentle and kind. A good breed sow will permit the attendant in the pen with her at all times. A cross, nervous or irritable sow is undesirable and should be eliminated from the herd. This trait may be hereditary, so it is not advisable to retain pigs from such a sow in the breeding herd. Within certain limitations you can tell an animal as a breeder in three ways: by type, pedigree and progeny. The brood sow should produce pigs that will make good feeders, gain fast and dress out profitably. The sow should be an easy breeder and be able to raise large litters.

The Boar. The boar is known as the 'Head Hog', and it is said 'the boar is half the herd'. He exercises great influence on the type, weight-gaining ability and size of the littler. A sow can only influence the number of pigs she produces each year, probably twelve or fourteen, and between fifty and sixty in her life-time. A boar influences the type and character of ten or twelve times that number, depending on the number of sows bred to him. Therefore it is very important that only the very best boar should be used. He should also be selected with the view of correcting any weakness in the sows, such as lack of depth or too much leg. The best age to select a boar is when he is about six months of age. At this age he should be developed enough so that any serious defect can be seen. Masculinity should be one of the strong points. He should be large and rugged. Masculinity is shown by a short, thick, well crested neck, well developed shoulders, a strong, wide, well arched back, deep smooth sides, and a good covering of flesh. He should have strong legs and pasterns with plenty of bone. The boar should show ten or twelve nipples. These are heritable and are transmitted to the females. His sex organs should be well developed. A boar with one testicle should never be selected as this is an inherited trait. A good disposition is also essential as the boar has to be driven and handled, and a cross boar is a dangerous animal.

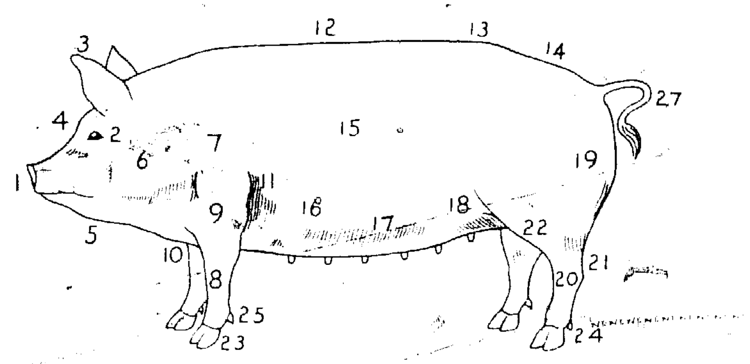


Fig. 2. Points of a Pig

1. Snout	10. Chest	19. Ham
2. Eye	11. Heart girth	20. Hind leg
3. Ear	12. Back	21. Hock
4. Face	13. Loin	22. Stifle
5. Jowl	14. Rump	23. Front pastern
6. Neck	15. Side	24. Hind pastern
7. Shoulder	16. Front flank	25. Dew claws
8. Front leg	17. Belly	26. Feet and toes
9. Forearm	18. Hind flank	27. Tail

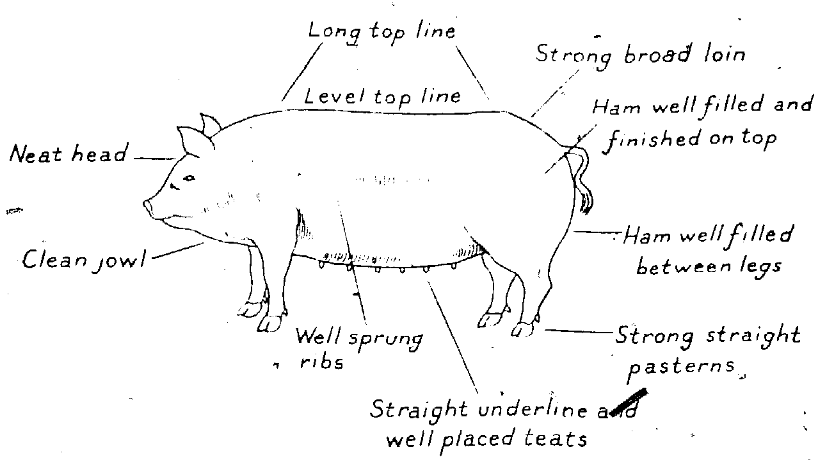


Fig. 3. Points to look for in selection

Definition of Terms

Boar: A breeding male of any age.

Sow: A female of any age which has had a litter.

Gilt: A young female pig, usually under one year of age, which has not had a litter.

Barrow: A male which was castrated when young and before becoming sexually matured.

Stag: A boar which was castrated after becoming sexually matured.

Farrowing: The time the female gives birth.

Litter: The number of young born.

Shote or Shoat: A young pig, any sex. (In Jamaica this term usually refers to a young female pig.)

Breeding

There are two methods of breeding: hand coupling and letting the boar run with the sows.

Hand coupling has the advantages:

(1) Accurate breeding records can be kept.
(2) Boars can service many more sows.

Gilts should be at least nine months old at breeding time and weigh 220–250 lbs. Breeding a gilt when she is too young may stunt her and result in small weak litters. The older and more mature the gilt the better are the chances for a large litter of strong healthy pigs.

The sow should come on heat about three to four days after weaning her last litter and will remain on heat for about two to four days and if not bred will return on heat every twenty-one days. The signs of heat are restless activity, swelling of the vulva accompanied by a slight mucous discharge, frequent riding of the other sows. The question is often asked: are two services better than one for settling the sow? Recent research shows that two services at an interval of twelve to twenty-four hours are better than a single service. The first service should be given on the second day of the heat period, and the sow served again after an interval of twelve or more hours if she is still on heat. This should only be done on farms where the boars are doing light service. One service given late in the heat period is usually more sure than one early in the heat. After the sow has been bred, place her in a pen by herself until the heat has passed. Keeping her quiet will aid conception.

The physical condition of the sow at breeding time has a lot to do with the number of pigs. Excessively fat pigs and pigs in very poor condition often fail to conceive or produce very small litters. The practice of flushing thin sows by feeding extra grain two or three weeks prior to breeding is often followed. A better method is to have the breeding sows in good condition at all times. Sows in good flesh but not fat will come into heat regularly, conceive easily, and have large strong litters.

If the boar is much larger than the sow it may be necessary to use a breeding crate. It is very difficult to get an old boar to use a breeding crate if he has not been trained from when he started to serve. Designs for the construction of breeding crates can be obtained from the Ministry of Agriculture.

The question of raising two litters a year is not one that has to be given much consideration in Jamaica as there is no winter to contend with and there is a market for fresh pork throughout the year. The time of farrowing two litters a year will depend on the location, as in different parts of the Island the time of farrowing will have to be arranged to meet weather conditions and seasonal supplies of feed such as breadfruit, mangoes and garbage from hotels, etc., which may be more abundant at different periods in different areas. In order to produce two litters a year, the life of a brood sow should be arranged as follows:

Served by boar	1st January
Gestation period (112 days)	1st Jany. to 23rd April
Suckle pigs (10 weeks)	23rd April to 2nd July
Wean pigs	2nd July
Served by boar	5th July
Gestation period (112 days)	5th July to 25th Oct.
Suckle pigs (10 weeks)	25th Oct. to 3rd Jany.

Young gilts should not be bred on the two litters a year plan but on three litters in two years. This will give them an opportunity to make more development. This method would also apply to sows where feeding conditions are not first class, this system giving the sow a longer interval between weaning and breeding to enable her to recover condition. The young pigs will also have a couple of weeks longer on the sow. If a large number of breeding pigs are kept, it is more economical both in feeding and management to have them farrow as close together as possible. This saves space

Gestation Table

The Gestation Table below gives dates of Breeding and farrowing for Sows (based on 112 day gestation period):—

Date bred	Date due	Date bred	Date due	Date bred	Date due
Jan. 1	Apr. 23	May 10	Aug. 30	Sept. 10	Dec. 31
Jan. 10	May 2	May 20	Sept. 9	Sept. 20	Jan. 10
Jan. 20	May 12	May 30	Sept. 19	Sept. 30	Jan. 20
Jan. 30	May 22	June 1	Sept. 21	Oct. 1	Jan. 21
Feb. 1	May 24	June 10	Sept. 30	Oct. 10	Jan. 30
Feb. 10	June 2	June 20	Oct. 10	Oct. 20	Feb. 9
Feb. 20	June 12	June 30	Oct. 20	Oct. 30	Feb. 19
Mar. 1	June 21	July 1	Oct. 21	Nov. 1	Feb. 21
Mar. 10	June 30	July 10	Oct. 30	Nov. 10	Mar. 2
Mar. 20	July 10	July 20	Nov. 9	Nov. 20	Mar. 12
Mar. 30	July 20	July 30	Nov. 19	Nov. 30	Mar. 22
Apr. 1	July 22	Aug. 1	Nov. 21	Dec. 1	Mar. 25
Apr. 10	July 31	Aug. 10	Nov. 30	Dec. 10	Apr. 3
Apr. 20	Aug. 10	Aug. 20	Dec. 10	Dec. 20	Apr. 13
Apr. 30	Aug. 20	Aug. 30	Dec. 20	Dec. 30	Apr. 23
May 1	Aug. 21	Sept. 1	Dec. 22		

as when the litters are weaned they are of the same age and size and can be run and fed together; also they would be ready for market at the same time and make room for the next lot of litters.

The gestation period (period of pregnancy) is the interval between breeding and farrowing. Under normal conditions the interval is 112 days but it may vary from 110 to 115 days.

Feeding

One of the first things to be considered in taking up pig rearing is the question of feed. It is not advisable to go into the pig business without an ample supply of cheap feed available throughout the year.

The pig properly fed excels all other meat producing animals in the efficient utilization of feed. Although pigs differ in gaining ability, a fair average for healthy pigs fed a balanced ration is from 1 to 1½ lbs. daily gain from birth to a slaughtering weight of 225 lbs.

A fair estimate is one pound live weight gain for every three pounds feed consumed up to the weight of 200 to 225 lbs. After this they make slower gains and are less efficient because they eat more and gain less. The digestive tract of the pig is comparatively small when compared with sheep and cattle. This is because the pig has a single stomach, while the stomachs of sheep and cattle have four parts which enable these animals to handle large amounts of grass and other bulky feeds. Therefore the pig has to be fed more concentrated feeds largely in the form of grains and meal. Moreover the process of digestion in the stomach of cattle and sheep produces certain vitamins which can be used by the animal. The digestive process in the pig does not do this so the ration has to be rich in proteins, minerals and vitamins.

Pigs at various stages of growth require different rations. Young growing pigs and pregnant sows require a greater percentage of protein than do fattening pigs and as pigs become fatter and heavier less protein is required.

There are five feed constituents that the pig must be provided with to be thrifty, to grow, get fat and reproduce. These are carbohydrates, fat, vitamins, proteins and minerals.

Carbohydrates. Carbohydrates are important in animal feeds because they are the source of energy needed for carrying on normal body processes and activities. Carbohydrates are found in sugar and starches. Feeds such as corn, guinea corn, rice and sweet potatoes are high in carbohydrates. In the rations for pigs carbohydrates are the most abundant and usually no fault can be found with this element in pig feeds as long as it consists of mainly digestible matter.

Fat. Heat, energy and fat are also produced by the fat an animal eats. Most rations contain enough fat in adequate amounts. The fat content of a ration should not exceed eight percent as too high a fat content is likely to cause a soft oily fat in the carcass. One pound of fat is worth about two and a half (2·5) times as much as a pound of carbohydrates in the production of heat, energy and body fat.

Proteins. Proteins build tissue, nerves, muscle and organs in the body. Protein is more often lacking in pig feeds than any other food element, as most feeds, such as corn, potatoes, breadfruit, etc. are low in protein. Protein in the ration should be from two sources, those of animal origin forming at least 10% of the diet as well as those from plant sources. Protein from animal sources is contained in meat meal, blood meal and skimmed milk. Vegetable proteins are found in such feeds as beans, peas, coconut meal and alfalfa meal. The amount of protein in the ration must vary with the class of pig being fed. Do not use the same ration for pigs of all ages as the percentage of protein required decreases with age. Young growing pigs need 18 to 20% protein, sows 13 to 15% and fattening pigs of 150 to 250 lbs., 14%. A ration too high in protein will be expensive, and one too low will slow up gains and increase feed costs. Pigs on good pasture need 2% less protein in their rations.

Minerals. Minerals are required for proper bone growth and functioning of the body processes. Minerals are the chief constituents of bone. Ninety percent of the mineral matter of the skeleton consists of calcium and phosphorus and three percent of other minerals. This is why it is important that the ration, especially for growing pigs, should contain a fair amount of calcium and phosphorus. Minerals needed in small amounts are iron, magnesium, copper, cobalt, iodine, zinc and manganese, these last five being known as trace elements. Most of the common feeding stuffs contain many of the above minerals in sufficient quantity to meet the needs of the pig. It is however usually necessary to supply additional amounts of calcium, phosphorus and salt. Iron and copper are essential in the diet of the baby pig to prevent anaemia. Iodine deficiency may result in hairless pigs at birth. It is specially important that when the bulk of the protein in the ration is of vegetable origin the ration should be fortified with salt and other minerals. A good mineral mixture can be made up as under:

General Mixture

- 60 lbs. steamed bone meal or di-calcium phosphate (deflorinated)
- 20 lbs. air slaked lime
- 20 lbs. common salt

A More Complex Mixture

- 50 lbs. steamed bone meal or di-calcium phosphate (deflorinated)
- 50 lbs. finely ground limestone
- 25 lbs. common salt
- 25 lbs. red oxide of iron
- 1 lb. pulverized copper sulphate
- 1 oz. cobalt chloride or cobalt sulphate

The more complex mixture is mainly for pigs which are being reared indoors or in areas where there is a lack of trace elements. The general mixture can be self fed or mixed at the rate of two pounds to 100 pounds grain feed.

Vitamins. Vitamins are required for the normal growth and maintenance of life, for proper body functioning, reproduction and to build up resistance to disease. Due to the conditions under which pigs are reared in Jamaica it is hardly likely that there would be much vitamin deficiency as most pigs have access to green feed and plenty of sunlight. Vitamin 'A' is supplied through green feed and Vitamin 'D' by sunlight. The provision of lush green pastures, or an abundant supply of green cut feed, such as cane tops, spanish needle, water grass, will supply nearly all the vitamins required by the pig.

Antibiotics. Several antibiotics and residues from their manufacture are available for the more efficient feeding of pigs such as aureomycin, streptomycin, penicillin, terramycin and bacitracin. Briefly, antibiotics are substances produced by the activities of certain bacteria, moulds or other micro-organisms that have the ability to inhibit or slow the growth of other harmful micro-organisms in the animal body. Best results are obtained when fed to growing and fattening pigs, or to small pigs as soon as they are able to take grain feed, when under certain conditions of management and on certain basic diets antibiotics help to make faster gains with lower feed intake. There is little gained by feeding antibiotics to bred sows and gilts. Antibiotics are put on the market by the various well-known drug houses in the form of supplements. Each pound of supplement is guaranteed to contain a certain amount of antibiotic—usually 2–5 grams per pound. This is mixed by the dealers in preparing pig rations.

Antibiotic supplements are usually fed in combination with vitamin 'B12' (animal protein factor). The greatest value of antibiotics for practical pig feeding lies in their capacity to control scours in young pigs and the ability to assist runty, unthrifty pigs to develop after a few weeks of feeding. It should be kept in mind that the use of antibiotics should not replace sanitation, good feeding and management. Antibiotics are best mixed with feeds by professional feed mixers who are able to assess the type and amount of antibiotic needed in relation to the basic feed mixture and who can ensure thorough mixing of the substance with the bulk feed.

Feeds

The most common feeds used in Jamaica for feeding pigs are coconut meal, rice bran, green bananas, sweet potatoes, breadfruit, cocoa head, and garbage. The pig cannot utilize large quantities of bulky feeds and must therefore be provided with a certain amount of concentrates.

Corn. Corn is one of the best feeds for pigs. It is rich in nutrients, is easily digested and can be used for both growing and fattening. For growing pigs and sows it is best to use one part coconut meal to one part of corn. Owing to the high price of corn it is now prohibitive as a pig food. In feeding corn it is advisable to grind it so as to reduce the amount of loss. When the corn has been kept for some time, and becomes hard, it is advisable to soak it in water for about twelve hours before feeding.

Coconut Meal. This is one of the cheapest protein feeds available and provides a balance to starchy foods such as corn, bananas, breadfruit and the various tubers.

Bananas. These have about one-quarter the feeding value of corn. Rejected bananas are an excellent feed for pigs; but should not be fed to pregnant or nursing sows as they have a tendency to affect the milk supply. Bananas can be fed at the rate of four lbs. to one lb. meal for fattening purposes.

Breadfruit. This has about half the feeding value of corn. Breadfruit should be allowed to become full before it is fed, as too much feeding value is lost if it is used before it is mature. Breadfruit can be used in proportion of one part coconut or mixed pig meal to two parts breadfruit.

Sweet Potatoes. These have the same feeding value as bananas. Due to the value of the crop for human consumption, only rejects are usually fed to pigs.

Cocoahead, Toya, Baddoe. All these tubers have similar feeding value which is about one-third that of corn. The feeding of three pounds of tubers to one pound balanced pig meal for sows and growing pigs, and four pounds to one pound for fattening pigs, gives a good inexpensive ration.

Separated Milk and Butter Milk. These are very valuable for feeding pigs, and should, if possible, be fed fresh from the churn and separator. They supply protein of the highest quality, and are high in vitamins and in calcium and phosphorus. It is very essential to feed milk by-products when the ration is high in corn to balance the ration. Milk, separated milk and butter milk have their greatest value in getting the weaning pigs off to a good start. Skimmed milk is very important as a source of protein in the feeding of pigs for bacon where a certain amount of lean meat is required. Milk by-products should be fed at the rate of three lbs. to one lb. of grain. In feeding butter milk the first draining after the butter is made is the most valuable and too much water cuts down the feeding value.

Molasses. ~~With the high price of corn~~ much more use could be made of molasses for feeding pigs. Molasses, like corn, is high in carbohydrates and low in protein, therefore in feeding molasses in place of corn an extra protein has to be fed. Molasses can be substituted for about one-third of the corn fed. Following ~~feeding experiments carried out in Florida,~~ it is recommended that molasses be fed according to the weight of the pigs as follows:

From weaning to 100 lbs.	- -	10 percent of the ration
From 100 to 150 lbs.	- -	20 percent of the ration
From 150 to 200 lbs.	- -	40 percent of the ration.

Studies show that feeding molasses has no effect on the quality and palatability of the carcass.

Rice By-Products. With the increase of rice planting in Jamaica there will be some by-products such as rice bran, rice polish and rice meal available for pig feeding. Care should be taken, however, to see that these by-products do not contain too much of the rice hulls which have very little feeding value. The rice hulls are the outer coat of the seed, and are tasteless, tough and woody and should not be fed to pigs. Rice bran is the germ and the inner coat of the seed and has an analysis of 12·8% protein, 13·4% fat, 13·0% fibre. Rice polish is the last coat of the seed removed when the rice is receiving the final polish. It contains less fibre than the bran, but has approximately the same analysis for protein and fat, namely, protein 12·7%, fat 11·5%, fibre 3·0%.

Rice meal is the small and broken grains which are removed in the milling process. It is lower in protein and fat than corn, but contains more starch. It can be fed in the place of corn, and produces firm, hard pork. Due to the high fat content rice bran and rice polish should not form more than one-third of the ration for fattening pigs as it produces a soft pork. Care should also be taken in feeding it to pigs of weaning age as it is apt to cause scouring. For older pigs and brood sows, rice bran and polish can be fed in equal parts with corn or other grains, with a suitable protein supplement. Care should be taken in storing large quantities of rice bran or polish that it does not go rancid on account of the high oil content.

If it has been thoroughly heated and dried at the mill the keeping qualities are improved.

Green Feed. This is a very important part of the ration for pigs especially if they are confined and are not receiving pasture. There are numerous weeds which the pig will eat, such as pursley, Spanish needle, etc. Chopped sugar cane is also enjoyed by the pig.

Garbage. This edible refuse from households, hotels, institutions, etc., has considerable feeding value when utilized as pig feed. Garbage varies in composition depending on where it is obtained. Household garbage is usually ~~not as good as that obtained from hotels and restaurants.~~ The frequency of collection of garbage is also important as fresh garbage has a higher feeding value and there is less risk of sickness due to feeding stale refuse. The protein content of garbage has been found to be approximately 17 percent, ~~and approximately 70~~ percent water. One ton of garbage will produce from 35 to 75 lbs. of liveweight gain depending on the quality: the garbage-fed pig does not usually produce as fine a carcass as the grain-fed pig due to the variation in the quality of the garbage. It is advisable to cook or sterilize garbage being fed to pigs as this will assist in controlling diseases especially 'swine fever', which is often spread through garbage from hotels and restaurants which use a lot of pork, bacon, ham, etc. Care should be taken in feeding garbage to sows with sucking pigs as due to the variations in quality, the young pigs often get scours.

Weaning pigs should not be fed entirely on garbage but should receive some grain supplement to help them to continue growth. A mineral mixture should always be available for pigs on garbage. Care should be taken to see that all pigs feeding on garbage are vaccinated against 'swine fever'. A pig farmer who has a contract for swill or garbage should try to impress upon the supplier the danger of injurious articles and foreign materials such as broken glass and crockery, tin cans, paper, being thrown in the swill, as well as dish water which is apt to contain lye, strong soap, or washing powder, any of which can be injurious to the digestive system of the pig. A too sloppy garbage also contains a lot of water which adds to the cost of collection.

Pastures. Pastures and green feed are essential to the economical rearing of pigs. Although they have a limited stomach capacity for handling roughage they can make efficient use of a certain amount of pasture and legumes such as alfalfa, clover, etc. Good pasture can save about 10 to 15 percent on the amount of concentrated feed needed to produce 100 lbs. gain. Pastures are rich in the body building materials needed by young growing pigs and brood sows, especially in lime and phosphorus which are required for building bones. A number of small paddocks are better than one large, as they can be rotated. This encourages better growth of grass and will also help to control intestinal parasites. Some of the paddocks can also be planted in sweet potatoes or peanuts and the pigs can be turned in to forage for their feed. It is estimated that 15 to 20 pigs can be carried on an acre of good pasture.

Some of the local grasses which should make good pastures for pigs are fine small grasses such as Para, Crab and Pangola. The grass selected should be adapted to local soil and climatic conditions and able to withstand trampling. When feeding pasture it is advised to put sufficient pigs in the paddock to graze it down quickly so that they will get the grass at the best stage and can then be removed so the grass can recover for the next feeding. Rooting by pigs is detrimental to pasture. Rooting is often the result of a poorly balanced ration so if the pigs are properly fed and continue to root then they should have rings put in their noses. Pigs on pasture should be provided with plenty of drinking water at all times, and shade should be supplied if not provided naturally.

Feeding the Sow. During gestation the sow should gain in weight gradually. Young gilts should carry more flesh than older sows at farrowing. This will enable them to stand up to the strain of rearing a litter of

young and help them to keep growing. The profits in pig rearing depend more on the management of the sows during pregnancy than during any other period. When the brood sow is poorly fed small and weak litters will result. It is important that the sow be given a ration that is high in protein and minerals. The reason for this is that the sow producing two litters per year has a heavy demand on the mineral and protein supplies of her body.

No hard and fast rules can be laid down with regard to the quantities of concentrates to be given sows since this will be determined by the condition of the sow after weaning. Taken generally they should receive 3 to 4 lbs. feed during the first 12 weeks of pregnancy, and 5 to 6 during the last 4 to 6 weeks. During the last week of pregnancy the amount should gradually be reduced so that at farrowing she is receiving half the amount. It is also advisable at this stage to feed a laxative feed. The addition of bran will counteract the tendency of the sow to become constipated at this period. During pregnancy she should receive an abundant supply of succulent green feed.

During the first 24 hours after farrowing, the sow should receive no food, only water. If, however, she shows signs of being hungry a thin slop can be given to quiet her down. The ration for a few days after farrowing should be laxative and gradually brought on to full ration in 7 to 10 days. It is essential that after farrowing the sow should not be underfed nor given anything that will cause digestive disturbances in the young pigs. Sour milk should not be fed at this time. The feeding of the sow after she recovers from farrowing must of course be liberal in order to ensure a good milk supply for the young pigs. A sow not properly fed loses condition rapidly and the young pigs do not attain the size they should have at weaning time. Minerals and vitamins are also very essential at this time and the ration should be well fortified. The weight of normal healthy pigs at birth varies between 2 and 3 lbs. If the sow has plenty of milk, and the young pigs are creep fed, and receive an ample balanced ration after weaning they should make a gain of one lb. a day or over up to one year of age. The weight should be around the following at various stages:

Birth	2½ lbs.	16 weeks	84 lbs.
4 Weeks	14 lbs.	20 weeks	120 lbs.
8 Weeks	28 lbs.	24 weeks	160 lbs.
12 Weeks	52 lbs.	28 weeks	200 lbs.

Feeding Young Pigs. Piglets will usually start to eat when they are about three weeks old, when the milk production of the sow also starts to decline, and should have some food available to satisfy their appetites. The feed for the young pigs should not be high in fibre as this will tend to make them pot-bellied. Corn-meal, and skimmed milk would be a very good ration. If the pigs are receiving skimmed milk, then it is not necessary to feed blood or meat meal but a mineral mixture should be available. If the pigs are started on feed early, they do not get such a set-back when weaned from their mother's milk. Young pigs when kept on concrete or wood floors for two or three weeks and receive no other food except the milk of the sow, sometimes suffer from anaemia, due to lack of iron in the blood—the milk of the sow being low in copper and iron. To overcome this, the young pigs may be turned out to pasture to obtain iron from the soil, or better still, a fresh sod of earth with grass attached may be placed in the pen daily. Swabbing the sow's udder once a day with a saturated solution of ferrous sulphate until the pigs are six weeks old will prevent anaemia. It is advisable when the young pigs start to feed from the trough to make a creep so that they can be fed separate from the sow, in a corner or part of the pen partitioned off with enough room so that the young pigs do not have to fight for trough space; the entrances to the creep should be wide and high enough so the young pigs can easily enter but the sow kept out.

Feeding Gilts. Gilts kept for breeding purposes should have a liberal feed but not a full feed, to keep them growing but not fat. They are best reared at pasture or in citrus groves where they will forage and so receive exercise and will not be over fed. The feed of the gilts should have a higher protein content than the sows as at this time they are building muscle and bone.

Feeding the Boar. The boar is often the most neglected member of the herd. In many cases he does not receive the best of care often being confined and gets very little exercise.

The mature boar should receive ½ to ¾ lb. grain per 100 lbs. body weight, a maximum of 5 lbs. and should receive plenty of green feed. The aim should be to keep him in good breeding condition and not to get too fat. He should have a large pen or paddock to provide ample exercise as most boars become too heavy and fat due to lack of exercise. The boar can be allowed to run with in-pig sows. This will help to keep him quiet. Health and vigour are essential to a satisfactory breeding boar, as health and condition at the time of service is a major factor in determining the number and size of the litter.

Housing

The housing of pigs is one of the first and most important things which you must consider if you want to be a successful pig farmer. It is necessary to house the pigs properly in order that you may have absolute control over your business. Proper management is impossible without good housing. This is especially true of disease control, and particularly the control of worm infestation.

The cost of the housing will depend upon the materials used in construction. In this respect, materials should be chosen which are strong enough to prevent the pigs from breaking out and which will last a long time.

Before you start building, it is advisable to give thought to the location

of the building. Some or all of the following points should be taken into consideration in selecting a site for your pig house.

(*a*) **Road Access.** Since it will be necessary to transport feed for pigs, it is advisable to site the house as close as possible to a good road.

(*b*) **Soil Type.** If possible, do not site the house on heavy clay land since drainage will be difficult. This is especially important where a breeding herd will be run in paddocks.

(*c*) **Water Supply.** A supply of water for drinking and washing out purposes must be available. You will require about five gallons per day per sow. Smaller pigs will need less.

(*d*) **Drainage.** Whenever possible, select a site which has a natural slope.

(*e*) **Ventilation.** Avoid sites where there is little or no breeze available. Where buildings have to be sited on the plains which are much hotter than the hills, the building should be placed where it has the greatest amount of shade and can catch whatever breeze there is.

(*f*) **Expansion.** If there is any possibility that you may wish to expand your enterprise, make sure that the buildings are placed so that any future expansion can take place on the same site.

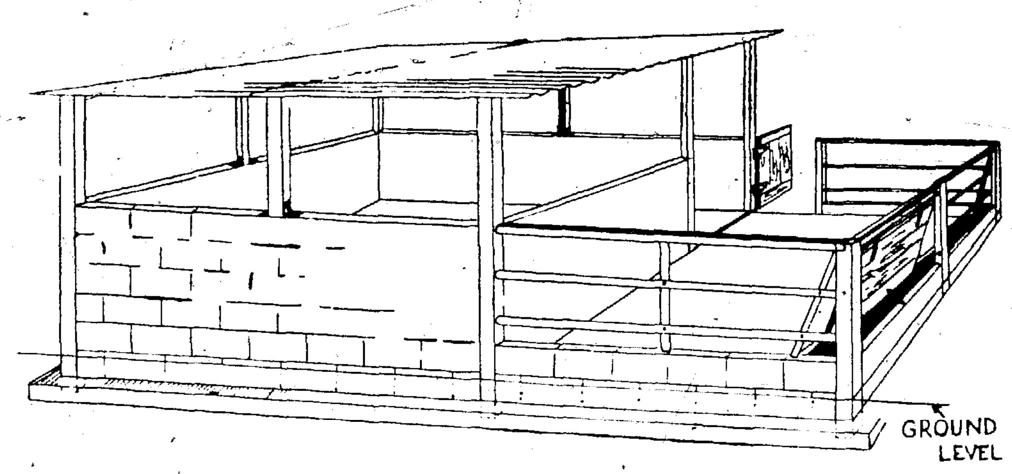


Fig. 4. All-purpose pig pen

The correct building should be so designed that it can be used for all classes of pig stock. These include:

(*a*) a suckling sow and litter,
(*b*) eight fattening pigs,
(*c*) two or three in-pig sows,
(*d*) one boar.

It is not by any means the only design or type of pig housing, but it is one which would fill most of the needs of the average pig farmer.

The type of construction should require the least amount of year-to-year repair. A great deal of skill and common sense can be used in the construction. Some suggestions for other usable materials are as follows:

(*a*) For the walls:
round wood (stockade style)
old lumber
bamboo (treated to preserve)
hog wire

(*b*) For the roof:
aluminium
flattened oil drums
thatch
split bamboo (treated to preserve).

Bear in mind, though, that there are three basic principles which you should follow:

(*a*) the floor areas shown in the plan,
(*b*) the construction and slopes of the floor,
(*c*) the construction of the feeding trough.

Details of these three points will be found in the diagrams and plans.

The construction of what might be called the 'superstructure' can be made of whatever materials are available to you, providing they are sound and will last for a reasonably long time.

Plan. The Plan shows the pen as having a covered sleeping area (9 ft. 4 ins. × 9 ft. 4 ins.—approx. 87 sq. ft.) and an open dunging area (9 ft. 4 ins. × 6 ft. 10 ins.—approx. 63 sq. ft.). These floor areas are important in providing the pigs with adequate space for sleeping and dunging. Reference to the table below will show that the floor area of the pen is adequate for all classes of pig stock.

Class of Stock	*Sleeping Area sq. ft.*	*Dunging Area sq. ft.*	*Trough Length ft.*
Suckling sow	80	60	1′6″–2′0″
In-pig sow (per sow)	20	15	1′6″–2′0″
Boar	80	60	1′6″–2′0″
Fattening pig (per pig)	8	6	1′0″

Trough Length. The length of the trough in relation to the floor area is of vital importance. One sees so many times a pen sufficient to accommodate 20 pigs, with trough space for only five pigs. The all-purpose pig pen has been designed to allow for the correct length of trough in relation to the floor area. It is a matter of building economy to relate the trough

length to the floor area. The dimensions of the pen should *not* be radically changed without consideration of these factors.

Floor. The construction of the floor is shown as 4 inches of concrete (1 : 3 : 6) on 2 inches of sand. For most locations, this should be adequate. In some areas (where, for example, there is heavy clay) it may be necessary to have a foundation of 4–6 inches of stone. When laying the concrete floor, you should pay attention to the slopes indicated to ensure proper drainage of the pen. It will be noted that the outside dunging area has a steeper slope than the sleeping area.

Creep. Provision has been made in the pen for a removable creep front (see plan and sketch of creep). The creep is designed for supplementary feeding of baby pigs. A small trough should be placed inside the creep for the baby pigs. When the pen is needed for in-pig sows, a boar or fattening pigs, the creep front should be removed.

Feeding and Water troughs. Details of the feeding trough are shown in the sketch. Special note should be taken of the design. The trough is of half-round section. This is to provide for easy cleaning. It must have no corners where stale food can collect and ferment as this will lead to digestive upsets in the pigs. A small drain should be provided at one end of the trough which should be washed out at least once a day. The sketch shows a 'swing-front' to the trough. Although more expensive and difficult to construct, experience has shown that, in the long run, you will show a saving in terms of labour and feed costs. When feeding the pigs, the swing-front is pushed into the front position—towards the pigs. The feed is placed in the trough (without interference from the pigs and without getting half the feed over the pigs' heads). The swing-front is then pulled into the back position so that the pigs can get at the feed.

Instead of the swing-front, you could use rails spaced about 9 inches apart or a solid wall. Remember, though, that neither of these is as satisfactory as the swing-front.

An automatic water bowl is a worthwhile investment. It will conserve water and ensure a constant supply to the pigs. The bowl can be connected either to a piped water supply or to a tank or barrel situated near the pen.

If a concrete trough is made, it should be rounded at all corners and have a small drain-plug.

Roof. The roof can be covered with any suitable material providing it is water-proof and will last. In some areas, it may be necessary to cover the sides, especially round the creep, to protect the pigs from wind and rain. This covering could be removable to allow maximum ventilation in hot weather.

General Construction. Pigs are powerful and destructive animals and will break out if given the opportunity. An initially strong construction is worth while from an economy and maintenance point of view. It will pay you in the long run to start off with a good, strong, well-designed pig pen.

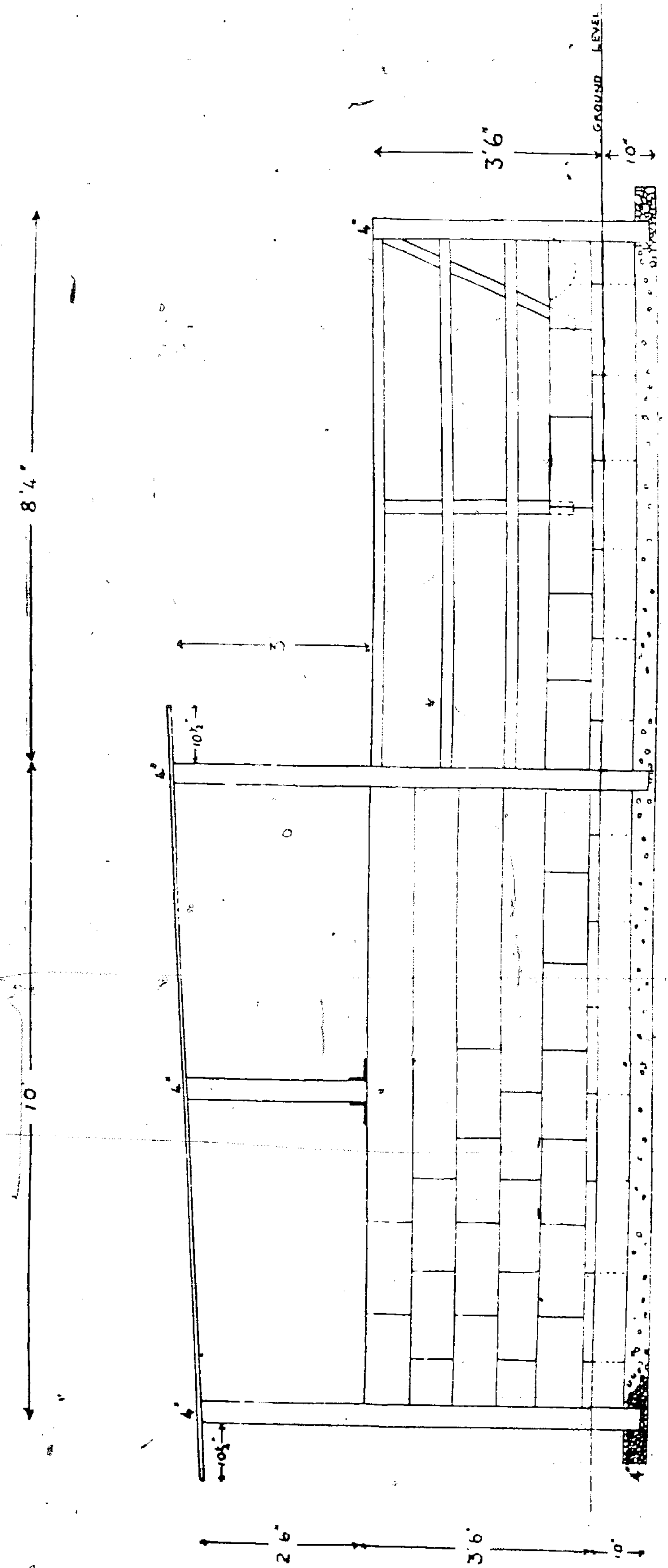


Fig. 5 All-purpose pig pen *(side elevation)*

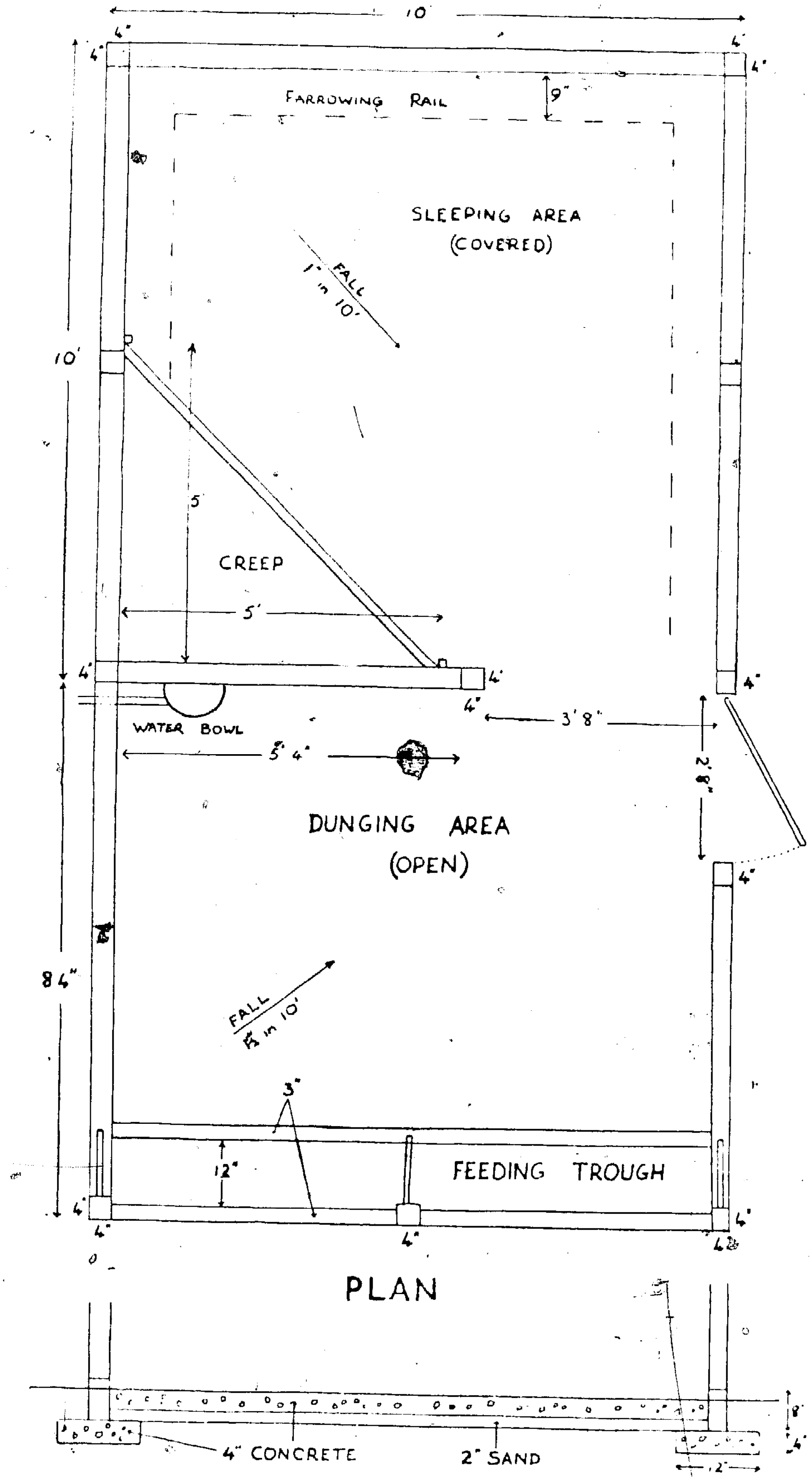


Fig. 6

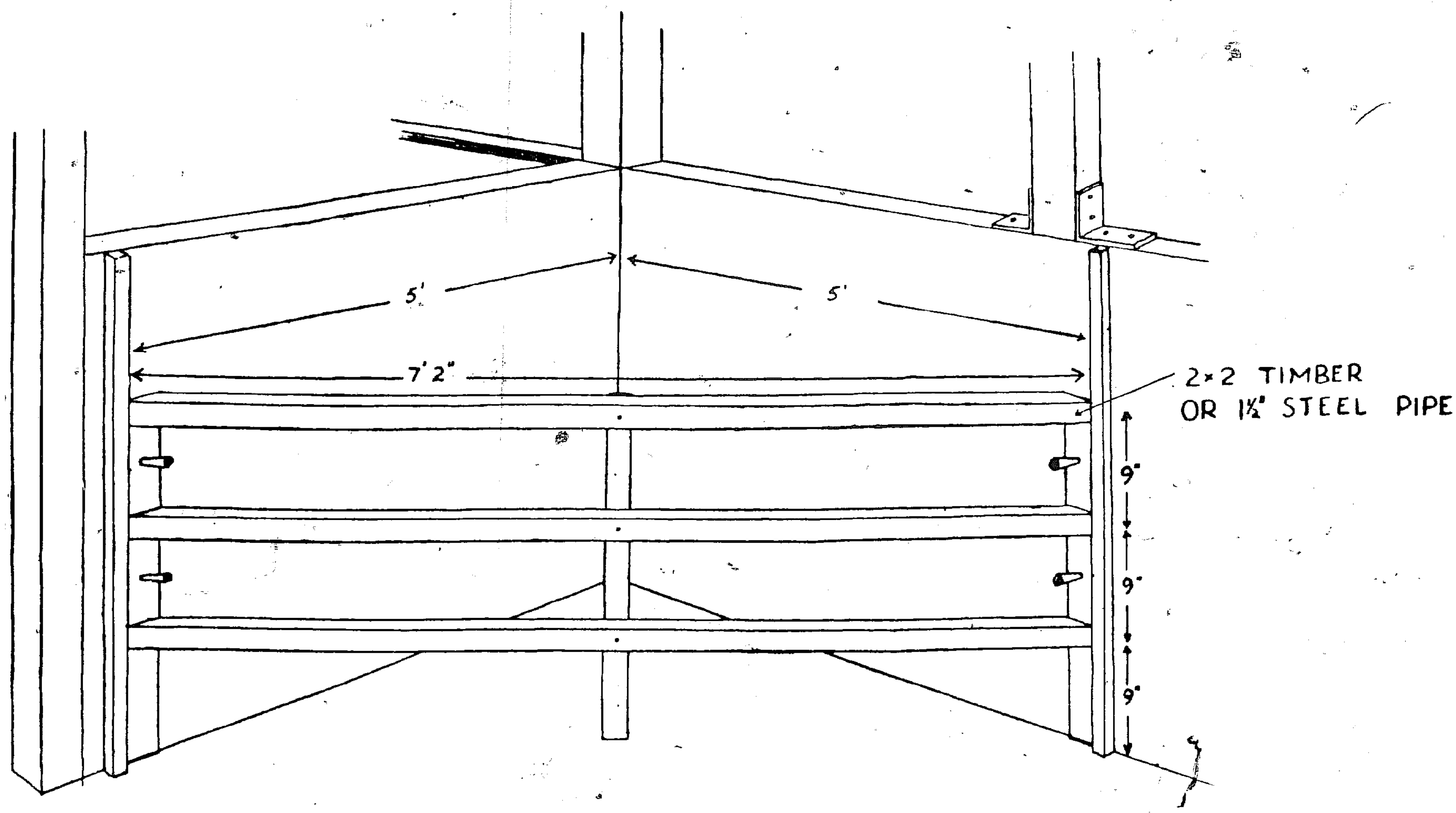


Fig. 7 Creep for all-purpose pig pen

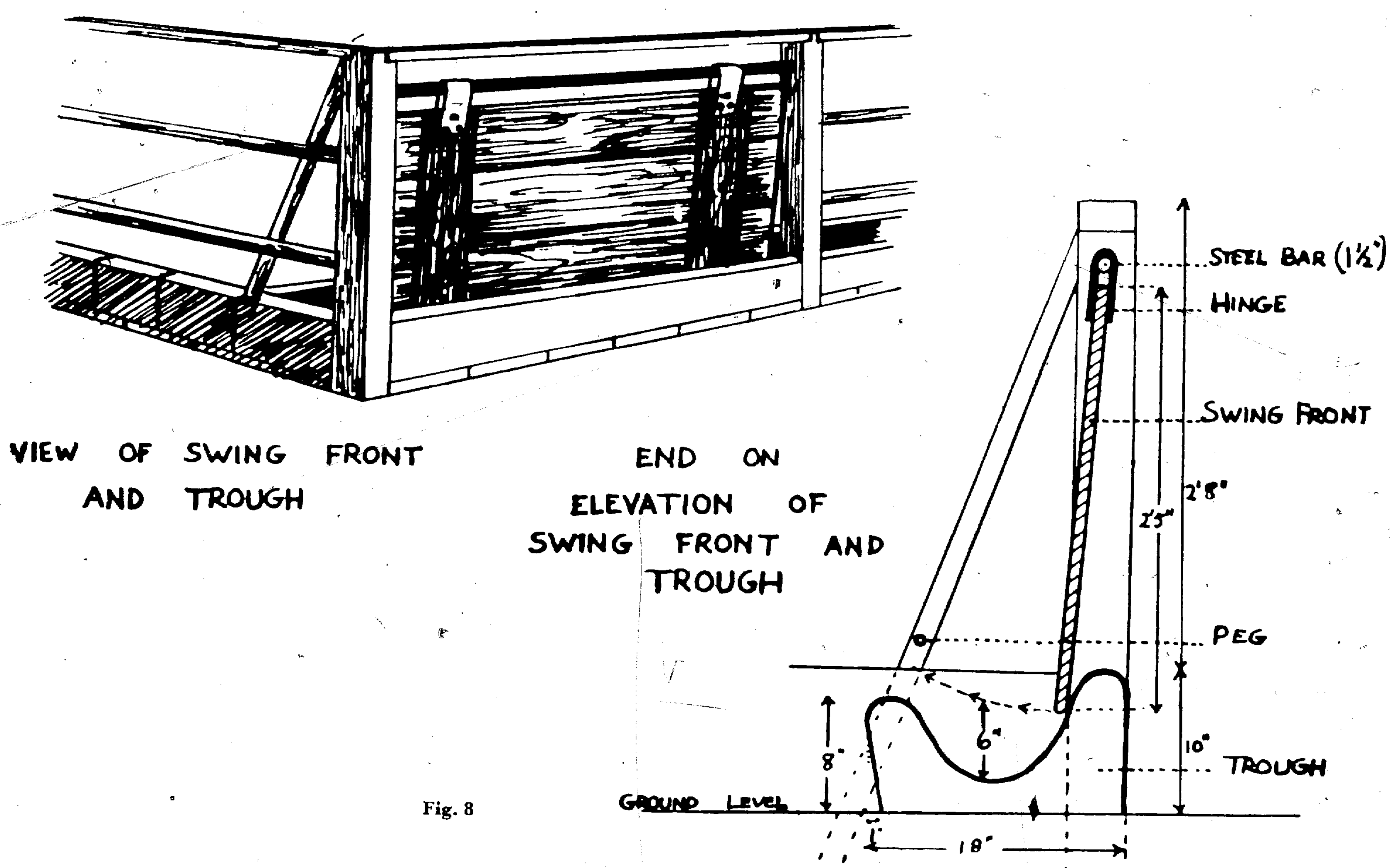


Fig. 8

Management

The use of good breeding stock, feeding a balanced ration, providing shelter and practising good sanitation is the surest way of making pigs pay.

Care at Farrowing. The difference between profit and loss in pig rearing is decided at the time of farrowing. It is estimated that about four out of every ten pigs born never reach maturity, meeting an early death from some cause: being eaten or crushed by the sow, through cold, or starvation due to the sow not having sufficient milk. Many of these deaths can be avoided by a little more care and attention at farrowing. If good records are kept, the date on which the sow will farrow will be known within two to three days. Physical evidence will indicate when the sow is about to start farrowing; usually when milk fills the udder the sow will farrow within 24 hours and she will be observed to be gathering straw, etc. to make a bed in the pen. The sow should be moved to the pen in which she is to farrow some ten days or a week before the event takes place, so that she will become acquainted with her new surroundings. The pen should be about 8 × 8 feet and should previously have been well washed out and disinfected. If the sow has been running out of doors she should be given a good wash down so as to remove any worm eggs and other parasites which might be harboured on various parts of the body; special attention being paid to the legs and feet and teats. The pen should be equipped with guard rails of 4 × 2 inches boards that project about nine inches above the floor and nine inches from the wall right around the pen. This will prevent the sow from crushing the pigs when she lies down. In some large herds a farrowing crate or farrowing jacket is used. These crates are 3 feet wide and 8 feet long, 3 feet high and 10 feet from the ground. The width is divided into two sections, one of 2 feet for the sow, and the other to enable the young pigs to get away from the sow. The sows are placed in the crates two days before farrowing and remain in for two or three days after. This method is reported to reduce the loss of pigs from crushing, eaten by dam, etc., by five per cent.

Bedding should be placed in the pen but should be fine and short, heavy coarse long bedding often resulting in the young pigs becoming entangled in the bedding and also making it more difficult for them to get out of the way when the sow lies down. When the sow begins to show signs of farrowing she should be watched continually, even if it means sitting up at night, which is very desirable, but seldom done. Close supervision at this time may mean a difference of two or three pigs saved in each litter. As soon as the pigs are born they should be dried and put in a warm place away from the sow. A good wooden box with some straw or bags for a bed is suitable. Not many people remove the pigs from the sow at birth but if this is done it ensures that none of the piglets stray away from the sow and

get chilled. The young pigs can be placed with the sow soon after she has finished farrowing. Sometimes if the young pigs are small and weak, it is advisable to keep them away from the sow two or three days, placing them with the sow five or six times a day to suckle until they get strong enough to fend for themselves. When the pigs are born the navel cord should be clipped off about two inches from the body and dressed with iodine. Artificial heat for warming the young pigs after birth is very seldom required in Jamaica, but in areas where it may be quite chilly at certain times of the year, a quart bottle of hot water wrapped in a bag and put in the box with the young pigs will assist in keeping them warm. If any of the pigs appear lifeless when born, remove any mucous from the mouth and nose, and give them a few slaps on the side; this treatment may start breathing.

Sows not Milking or Refusing their Young. The failure of sows and gilts to produce milk often occurs. This can be caused in a number of ways, such as being in a run-down condition at the time of farrowing, an inadequate diet, or inherent inability to produce milk. Another cause is fever in the udder which can be caused by the sow lying on a cold floor; when this occurs, the udder is tender, and the sow refuses to let the litter nurse and she may dry up. Often gilts which are overfat at farrowing will sometimes have very little milk, due to the formation of fat in the udder instead of milk secreting tissue.

The diet can be the cause of shortage of milk if it consists entirely of corn, bananas, potatoes or other root crops which are high in carbohydrates. Cutting out some of this feed and replacing it with a balanced feed or skimmed milk or buttermilk will correct the trouble.

Occasionally, a sow refuses to own her litter after farrowing. This generally happens with young gilts and may be due to pain and irritation. If this happens, try taking away the young pigs for an hour or two, and then put one or two outside the gate of the pen. Their squealing and desire to feed will attract the attention of the sow. If she comes to the gate and shows interest they can be placed in with her, and if she lies down and lets them nurse the others can then be put in. In such a case watch the sow carefully and do not leave the pigs alone with her until she has shown that she will care for them properly. Some sows kill their pigs as soon as they are born. This may be due to the sow becoming cross and irritable while farrowing and may also be due to pain. The fact that sows kill and eat young pigs may also be due to faulty nutrition during the gestation period, the ration being short in animal protein such as meat, fish or blood meal. Eating of the young pigs is often a bad trait. It is advisable to fatten such sows and sell them for slaughter.

Needle Teeth. At birth pigs have temporary tusks which are long and sharp and are of no use to them but can cause considerable damage to other pigs with whom they fight or play. They can also injure the udder of the sow and make her very nervous of nursing her litter. These teeth which are two on each jaw should be cut down to the gums with a pair of pincers or cutting pliers. They should be cut clean so as to leave no jagged edges, and so that the gum is not injured leaving an opening for infection. Under ordinary conditions, little notice is taken of these 'black' or needle teeth and very little damage seems to be done.

Orphan Pigs. Some sows litter more pigs than they can economically rear. It is always a good plan to have three or four sows littering as close together as possible, so if one has a large litter and the other a small one, they can be 'evened-up' by putting some from the large litter to the small one, or if there are two small litters they can be given to the sow which has the most milk and will be the best mother, so enabling the other sow to be dried up and bred within another three weeks. The exchange and transfer of pigs should be done a few hours after birth, as after a few days the sow will have only as many teats functioning as there are pigs nursing and if any new ones are placed at this late period they will have to fight with the others for a nipple. When placing young pigs with another litter it is a good method to remove the sow from her own litter for about half an hour, and rub all the pigs over the back with a little thin oil such as linseed oil, etc. This makes all the pigs smell alike and the sow will not drive away the strange pigs. In case the sow dies or does not have sufficient milk, it will be necessary to raise them by hand. This can be done using cow's milk. A suggested dilution of cow's milk for orphan pigs is set out below:

1 pint cow's milk
$\frac{1}{3}$ pint lime water
1 tablespoonful sugar of molasses.

It should be fed with a baby's feeding bottle, with nipple, or the pigs taught to drink by placing the milk in a shallow pan so that the milk just covers the mouth when the nose is pushed in the milk. This causes the milk to get on the tongue and they will make some attempt to drink. After one or two lessons they should drink without trouble. It is better to teach them to drink rather than suckle from a bottle as it saves trouble later on in weaning them from the bottle.

The average composition of the milk of the sow and cow is shown below. A good sow with eight or more pigs suckling, when properly fed will produce about one gallon of milk.

	Sows	Cows
Total solids - - -	19·0%	12·8%
Butter fat - - -	6·7%	3·7%
Casein and albumen -	5·9%	3·5%

Identification. To keep accurate records you must have some system of identifying pigs. This especially applies to the pedigree breeder who sells pigs as breeding stock and which have to be identified throughout their life. Each pig should be marked shortly after birth at the same time that the needle teeth are being removed. Another advantage is that after weaning several litters can be run together and there will be no trouble of identifying the members of the different litters. Two systems of earmarking or notching are used; one is to give all the litter the same number, this system being used mainly when pigs are being reared for bacon and will soon be slaughtered. The pedigree breeder uses the system of individual numbers for each member of the litter, as the pigs are usually registered in the breed Herd Book.

The marking can be done with a regular pig earmarker which is constructed to cut a 'V' shaped notch in the ear. If a proper earmaker is

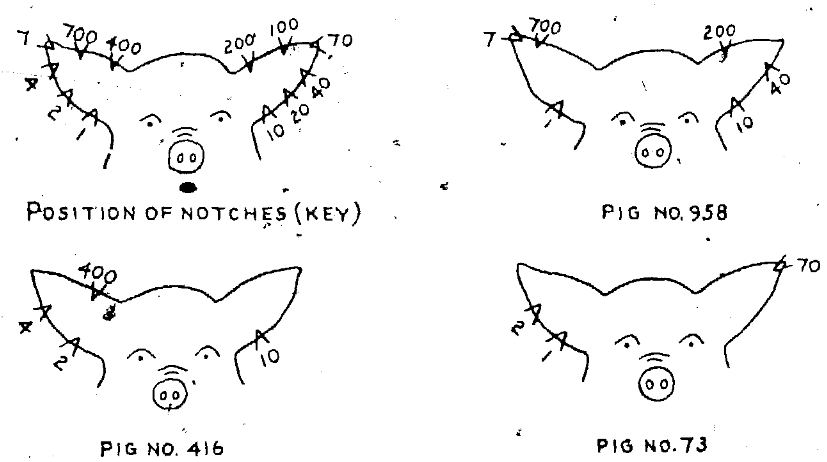


Fig. 9. Identification of Pigs

not available, then the cuts can be made with a pair of sharp scissors. One of the most simple and easily remembered systems of marking pigs is shown above.

Castration. Pigs may be castrated any time over four weeks old, or even earlier, the sooner done the better but most certainly before they are weaned. At this time they are small and easily handled, the wounds heal quicker and the pigs do not receive such a set-back as they would after weaning. Before castration, pigs should be kept off feed for 10–12 hours and should be free of mud and dust so as to prevent any infection of the wound. The hands and the instrument used should be thoroughly washed and disinfected, and the scrotum should also be thoroughly disinfected before the operation. Two people should assist in castration, one to hold the pig and the other to operate—the pigs can be held by the hind legs with their heads hanging downwards, with the underline of the pigs facing towards the operator—the pig can be held steady by the knees of the person holding. The other position is the person holding the pig to sit astride a narrow bench or box and hold the pig on its back by grasping the fore and hind legs in each hand, the rear end of the pig facing the operator. With the fingers and thumb, hold the testicle firmly and cut the skin with a very sharp knife parallel to the middle line of the body, separate the testicle from the surrounding tissue, pull away the cord and scrape it clear of the body until it is severed. Do not make a clean cut as this often results in excessive bleeding. When cutting the scrotum care should be taken to see that the cut is made low enough to facilitate dressings. Disinfectant should not be poured into the wound as this retards its healing process. The wound should be kept clean and painted with a fly-repellent. The pigs should be kept out of mud holes and dirt for a few days and examined daily to see that the wound is healing well.

Weaning. Weaning time is a critical period in the life of a pig. The time of weaning will depend, to some extent, on the system of breeding being used and the size and vigour of the litter. Weaning usually takes place at the age of 8 to 12 weeks. It is best when weaning to move the sow from the litter, leaving them in the pen to which they are accustomed. This prevents them pining too much. The feed of the sow should be reduced two or three days before weaning so as to prevent the udder becoming caked. If the sow's udder becomes very distended after weaning it may be advisable to turn the sow back with the litter for a few minutes and let them nurse once or twice. The ration of the young pigs should be increased in protein content so as to replace the milk of the sow which was a high protein feed. The feed should include some form of animal protein such as meat meal, blood meal, or skimmed milk. The gilts and boars of the litter can run together until four months old. After this time the boars should be separated.

Vaccination. Hog cholera or swine fever is one of the most destructive diseases of pigs. Even though it is recognized as such, some breeders still take a chance and do not vaccinate until the disease strikes the herd. *It is always best to vaccinate against this disease.* Vaccination can be done at any time but it is better to do it at six to eight weeks of age before the pigs are weaned. The vaccine takes about three weeks to give immunity and lasts for about nine or ten months or sufficient time for the pigs to be fattened and slaughtered. Sows and boars kept for breeding should be vaccinated every year. Vaccination gives protection but does not cure the disease.

Wallow. Pigs do not sweat and so it is very necessary to provide them with some method of keeping themselves cool in the hot weather. The most common way is to provide a wallow. The usual wallow made by the pigs is a nuisance and a menace to the health of the pig being a source of infestation by worms and diseases. A sanitary wallow can be made of

concrete about 6 × 8 feet square, shallow at one end and one foot deep at the other. It should be made so that it can be drained, washed out and refilled with clean water every ten or fourteen days. If the pigs have lice, pouring a little crude oil on the water will assist to control them.

Shade. Pigs suffer from heat more than any other animal and therefore natural or artificial shade should be provided. Trees provide a good shade if they are in a clump and spreading low so that the pigs can obtain shade no matter at what angle the sun shines. If pigs are running in pastures or citrus groves where shade is scarce, a temporary shade can be made by erecting a cheap framework of round wood about four feet high and covered with branches, bamboo, grass, straw, etc. A good shade should be large enough for all the pigs to get shade and does not permit the morning or evening sun to heat up the ground where the pigs have to lie.

Rubbing Post. To control lice, a rubbing post fixed securely in the ground at an angle of 45° and wrapped round with a bag soaked in old motor car sump oil is very effective. The post should be at an angle so that the pig can get underneath the post and rub its back.

Water. An important matter is a good clean water supply. Pigs tethered out on trees or kept in small pens often only get water twice a day when it is poured into a dirty trough. Usually the pigs turn it over before drinking enough. If pigs get plenty of water less feed will be required to produce gains. The amount of water consumed by pigs depends on their size, the type of ration fed and weather conditions. An 80 lbs. pig will drink about two gallons of water daily.

Fences. If pigs are being run in pastures, citrus or other orchards, these must be well fenced. Stone walls are very effective if high enough to prevent the pig jumping over; otherwise pig mesh wire is the best. The height of the fence depends on the size of the pasture. For a large pasture where the pigs are not likely to keep to the fences, a wire 24 to 26 inches high should be used. In smaller pastures it is advisable to use a mesh at least 32 to 36 inches in height. If only mesh wire is used for fencing, a strand of barbed wire should be run on the bottom of the fence on the inside a few inches above the ground. This will prevent the pigs from digging up and getting out underneath the mesh.

Ringing. All pigs like to root in the soil. This is very useful when pigs are cleaning up peanut or sweet potato fields; but can be very damaging in pastures. Rooting can be prevented by placing a small ring or two in the snout. If the pigs are being run on pasture then this should be done when they are small and easily handled. In ringing larger pigs, a small rope fastened round the snout and tied to a strong post can hold the pig as the more the pig holds back the easier it is to ring the pig. Various sizes and types of pig rings are on the market.

Troughs. Most of the troughs used for feeding pigs are made of wood.

A few are metal. Those where pigs are reared under an intensive system are of concrete forming a part of the building. The troughs are often the most insanitary part of the equipment. Very seldom does the trough get a real good cleaning. Insanitary troughs lead to disease and nutritional disorders. There are three general shapes of troughs—flat bottom, 'V' shaped or rounded. The flat bottom is the easiest to make and clean. The troughs should be made of heavy wood—2-inch plank being suitable. This prevents the pigs from overturning them. For mature animals the troughs should be 24 inches in width and 12 inches deep. The length depends on how many pigs are to be fed. The space per pig should be from 12 to 15 inches so that an 8-foot trough 24 inches wide would be sufficient for 16 pigs.

Feeding Floors. In places where garbage, mangoes, coconuts, etc., are being fed to pigs out of doors it is advisable to make a feeding floor of concrete. The size depends on the number of pigs; but it should be made with a good strong foundation so the pigs cannot dig it up. The edge should be raised two or three inches so as to prevent the food being pushed off. It should have a slight slope to facilitate drainage. A feeding floor has the great advantage that any refuse left after the pigs have been fed can be easily swept out and removed. The drinking troughs can also be placed on the floor and the water will be kept much cleaner.

Tethering. In Jamaica where climatic conditions are good nearly all the year round one of the most economic methods especially for the small farmer with one or two breeding sows is to tether them out. There are several methods of tethering: a collar of leather or rope round the neck, a rope around the pastern of the foreleg, but the best and most comfortable is a harness which fits around the shoulders in the same manner as a harness used for dogs. An advantage of tethering a sow with a young litter is that it prevents them being dragged all over the place.

Tethering enables better control of parasites and disease as the pig can be moved to a clean piece of ground more often. One of the drawbacks of tethering is that very often the pig is forgotten and suffers from lack of water, shade and shelter. *These are important and should always be provided.*

Herd Records. Records are essential for the proper management of a herd of pigs. Without records success in any business is dependent on chance. It is necessary for the purebred breeders to keep more detailed records than the commercial breeder as it is his business to supply breeding stock to the commercial breeder from sows with the ability to rear large and heavy litters to weaning age which will make good growth and gains from weaning to slaughter, and make economical gains for the amount of feed consumed. The records to be kept are date of service, name of boar, date of farrowing, number and sex of pigs born (earmarks and names of pigs—this applies to purebred stock). Weights of the litter should be taken 24 hours after birth—they can be weighed individually or collectively,

and again at 6 weeks. Weighing at 6 weeks will enable the breeder to see which sows have plenty of milk and are doing the pigs well. The weights will also assist in culling the poor sows and selecting young pigs for replacements from the best sows. Records of the amount of feed consumed should be kept. This will enable you to see amount of feed consumed to make a pound of gain. The weighing scale and the feed scoop should work together for successful pig rearing. A record book is important. There is less guess and gamble when facts about each pig and litter are put down in black and white.

Common Diseases of Pigs

Parasites and disease cause heavy losses of pigs each year. They are the reasons for many runted pigs which are unprofitable even though they are well fed. Swine fever, pneumonia and parasites are the diseases which cause the greatest loss among pigs in Jamaica. Most diseases and ailments of pigs can be avoided by sanitation and preventive vaccination.

Hog Cholera or Swine Fever. This disease causes the heaviest losses among pigs. It is caused by a small germ known as a virus. The disease is dealt with more fully in Extension Circular No. 38. It is highly contagious, and usually many animals are affected at one time. The first signs are loss of appetite and high temperature, followed by weakness and a staggering gait. The sick pigs may be found lying by themselves and the eyes may be inflamed with a whitish discharge which gums them together. There is no treatment for the disease. Vaccination is the only safe protection and means of prevention. Young pigs should be vaccinated against swine fever at 8 to 10 weeks of age and breeding sows and boars ever year. If swine fever is suspected the Chief Technical Officer or your nearest Veterinary Officer should be notified *at once*. He will visit and advise you on how to prevent the disease spreading to your other pigs and to your neighbour's.

Erysipelas. While this disease is not common in Jamaica, it may be mistaken for swine fever and veterinary help is needed to obtain a correct diagnosis.

Erysipelas is also known as 'diamond skin disease' by the diamond shaped areas which sometimes appear on the skin. The disease occurs in an acute form which is rapidly fatal, and chronic form when it is localized in the tissues or joints of the animal. The losses from this form are due not only to the deaths but to the unthriftiness and failure to make gains. The symptoms of the acute form are a high temperature, accelerated and jerky breathing and reddened areas on the skin of the abdomen. There is usually a thin watery discharge from the eyes. In spite of appearing ill, pigs suffering with acute swine erysipelas will move around when disturbed, but quickly lie down again usually on their breasts or sitting upright. The treatment of swine erysipelas is expensive, and although some animals may recover they are usually unthrifty.

Pneumonia (inflammation of the lungs) in pigs is nearly always a result of chilling or exposure as a result of poor husbandry or housing. It sometimes accompanies some of the infectious diseases such as swine fever. The symptoms can be recognized by the heavy laboured breathing or thumping which it is sometimes called. Pneumonia is very prevalent in the rainy season and although the pigs will go out in the rain they should be provided with a dry sheltered place for sleeping. If your pig gets pneumonia call in the veterinarian, put the pig in a shed with plenty of dry bedding, water and a little feed. Nursing is the most important part in the treatment of pneumonia.

Enteritis. Lack of proper feeding as well as several kinds of germs cause enteritis or inflammation of the intestines. The disease usually attacks pigs from six weeks to four months. The symptoms are high fever, lack of appetite, severe diarrhoea, which is often bloody, and unthriftiness.

In treating enteritis, attention should be paid to the diet. Milk and wet mashes are most suitable. Good sanitation is essential for prevention. The pigs should be moved to clean quarters and provided with plenty of dry bedding and clean water. If the pigs have fever, consult your veterinarian for medical treatment.

Mange is a very troublesome parasitic disease affecting pigs. There are two types of mange, the sarcoptic or common mange and the red mange or demodetic type.

Mange is caused by tiny mites like minute grass lice which burrow into the skin and live there. They cause intense itching and irritation. Pigs with mange scratch and rub and do not gain weight. The skin around the eyes, ears and neck becomes inflamed, scurfy, rough and cracked. Mange mites are extremely difficult parasites to control and repeated applications of suitable dressings may be necessary for complete eradication and cure. The treatment consists in first removing the scabs and dirt from the affected parts with a stiff brush and warm soapy water. Lime sulphur wash, gammatox, and DDT washes are effective in treatment. The mites live for weeks in pens and bedding not exposed to direct sunlight. The houses should therefore be thoroughly cleaned out and scrubbed and then washed with a strong solution of gammatox or DDT to which a wetting agent (such as a soap substitute powder) has been added.

Lice. These are the most common of external parasites and are found where the skin is tender and where the pig cannot rub itself properly. Lice are blood suckers and lower the vitality of the pig making it susceptible to disease. One of the most widespread and economical means of control is the use of crude oil or used crankcase oil. If a rubbing post is put in as recommended in this chapter, there should be no trouble in controlling lice.

The Jigger Flea or Chigoe. The jigger is a member of the flea family

and is mostly found in the drier sandy areas living on plants and dry herbage, from which it passes to man and wild and domesticated animals, especially pigs. The female, when ready to lay eggs, buries herself in the skin of the host (usually between the claws and around the pasterns). When the jigger gets under the skin it enlarges and assuming the appearance of a bladder is filled with eggs. The presence of jiggers causes inflammation and ulcers or wounds which may become gangrenous. Care should be taken in removing jiggers from the skin not to crush the bladder as this may cause more young jiggers to escape and give rise to more serious trouble.

To control jiggers the breeding places should be sprayed with an insecticidal solution, or dusted with a good insecticide. Gammexane and DDT are both suitable. The areas of the limbs affected by the jiggers should be well washed off with an antiseptic solution and smeared over with an insecticidal dressing such as gammexane ointment, or a similar mange dressing.

Intestinal Parasites (Worms). Worms are one of the most serious problems in pig rearing as there are over thirty species which can be found in the intestinal tract of pigs. The chief species and the most common are the round worm, lung worm, kidney worm, stomach worm and tape worm. Pigs become infected by swallowing the worm eggs. These worm eggs are microscopic in size and are found in the dung of infected pigs, among manure, bedding and in water holes, wallow and places where pigs feed and congregate. Pigs can be treated to rid them of worms, but the soundest practice is to practise a good system of sanitation where the pigs cannot get infected when they are young. Treatment for worms can be done by giving the medicine in the food or by dosing each animal individually. Great care has to be exercised in dosing pigs as they are difficult to handle and are liable to choke. Two of the main medicines for worming are oil of chenopodium and sodium fluoride. Doses and methods of administration can be found in Extension Circular No. 37—*Internal Parasites of Livestock*.

Constipation. Constipation is often the result of lack of exercise and too much concentrated feed. It is often noticed in pregnant sows which are inclined to take very little exercise and are well fed. If a sow gets constipated, mix four ounces of linseed oil once daily in her feed. If this is not effective, then three to four ounces epsom salts should be given. The ration should be changed to contain plenty of bran which has a laxative effect and to include plenty of green feed.

Sun-Stroke and Sun-Scald. White pigs are more susceptible to sunburn or sun-scald than black pigs, but in both cases adequate shade should be provided. Pigs are easily affected by heat and should not be exposed for long periods to the direct rays of the sun. They should not be driven for any long distance in the sun or unduly excited on a hot day. If pigs are to be moved or handled it should be done in the early morning. This applies especially when pigs are being sent to a show, as fat pigs are most likely to suffer from heat prostration. In the case of sunstroke or heat prostration the head, but not the body, should be bathed in cold water or have ice applied to it, and a stimulant such as a teaspoonful of brandy or whisky given every hour until improvement is seen.

GOATS

In former years goats were reared in Jamaica by the peasantry chiefly for milk, and the sturdy quality of the latter's physique was no doubt attributable to their being reared on goat's milk. With the advent, however, of cheap tinned milk (and later, a consequence of World emergencies), the consumption of goat's milk decreased, and the consumption of goat's flesh steadily increased until now the demand is greatly in excess of the diminishing supply. The Government of Jamaica does not consider goat rearing an economical venture and therefore does not provide in its services for this. The use of bucks at a few of the remaining Livestock Improvement Centres and as Approved Sires, is fast dying out.

If the goat is acknowledged to be a destructive animal, the point for consideration in amelioration is that an advantage in goat rearing lies in the fact that these animals need no more than the natural herbage for their sustenance.

Goats as Dairy Animals. Raising goats for milk purposes is more profitable than to raise them for meat. When milk is the object, dairy animals should be the aim in breeding. A number of the males and undesirable does will have to be disposed of as meat stock, but meat production should be a secondary aim.

The common goat is a poor producer of milk, although occasionally a large-sized doe possessing a well-developed mammary system will produce a fair quantity of milk. Large amounts of milk are obtained only from dairy breeds or those possessing blood of a standard dairy breed. With regard to the latter group, it should also be noted that the farmer should not expect simply by crossing his doe with a buck of good milk strain to obtain off-spring yielding two and three quarts. He will be disappointed. The well-known breeds are the result of care in breeding, selection, good care and feeding, for many generations. The progeny must, therefore, receive from the farmer something of the same kind of care in feeding and housing and general attention.

The recent (1958 onwards) great upsurge in construction of residential and industrial buildings in the urban areas of Jamaica, particularly around Kingston, has resulted in the removal of much of the area used for goat-rearing. Hence the potential for production and disposal of goat's milk

has been drastically reduced. This leaves the rural areas only where increasing activities under the Farm Development Scheme provide still less area available to the extensive rearing of goats, here directed mainly to the production of flesh.

Making your Choice. To be successful the keeping of dairy-type goats would entail:

(i) An outlay of capital for the purchase of stock and necessary equipment.
(ii) Provision of grazing paddocks of Guinea or other grasses, such as Pangola, which need not be a pure stand, but may also include shrubs since goats like to graze above their heads. Small trees, such as Glyricidia (Quick Stick) may be planted as fences on the boundaries, from which the goats will delight in stealing a few bites.
(iii) The enclosing and sub-division of the space decided on.
(iv) The fitting up of a shed or stable to accommodate the goats, the kids and the buck. If the owner is really ambitious, he may also provide accommodation for in-bred females.

These having been provided it is best to start with one, or at most two, goats, preferably mature does with kids, or expected to have kids soon.

Breeds. For milk-producing types the principal breeds from which a selection may be made are the Saanen, the Toggenburg, the Anglo-Nubian and the British Alpine.

The first two originated in Switzerland and are very good producers, though the Saanen, being of white pigmentation, is likely (under our tropical conditions) to have sun-scalds on the skin, and must be kept in a cool location. It crosses very well with other types. The Toggenburg shows a little more fleshing than the Saanen, though not quite as heavy in milk production. The Anglo-Nubian is the result of crossing (in India) between suitable Indian goats and the old English goat. Characterized by heavy drooping ears and a 'Roman' forehead and nose, its coarse hair, and being a fairly large animal, it is a hardy type, yielding a fair amount of milk and a good amount of flesh.

The British Alpine is a smaller animal of black-and-white colour, a good milker, quiet and docile. A good general-purpose goat is produced when these two latter breeds are crossed.

Selecting the Doe. In buying a goat, have her milked in your presence to test both yield and docility. Feel the udder thoroughly. It should be large and wide, soft and spongy to the touch, and carried well up under the body, the teats well-formed and of good size. After milking, a good udder should appear wrinkled and reduced in size.

The legs should be straight and strong, the face 'feminine' in appear-

Milking. Cleanliness is essential to the production of safe, wholesome milk. Also provision should be made that milking can be conveniently done. A clean milking platform with a ramp leading up to it, is recommended. With the doe raised to a satisfactory height the milker can work comfortably, and can milk the animal dry. The stall should be provided with a short side rail and a stanchion in front, with a box containing a little grain to keep the doe occupied and contented during milking.

With the doe in position clean the udder with a cloth dipped in warm water. Press the upper region of the teats and milk fast, stripping to the last drop. By massaging the udder more milk may be obtained. Do not keep the doe near the buck; this prevents a taint to the milk. In any case it is never advisable to keep the male near to the females.

Milk can be a safe food or an unsafe one, and goats may be a pool from which **Undulant Fever** (Maltese Fever) may be derived. Hence a periodical Veterinary Test to ascertain the freedom of the flock from this disease is indicated. (It should be borne in mind that this disease is related to Contagious Abortion.)

Care of Kids. Special care should be taken for the first six weeks of the young goat's life to see that it gets a fair share of the mother's milk and that it gets a good start in life. Treating the navel with a mild disinfectant mixture such as Jeyes' Fluid mixed half-and-half with castor oil should be done as soon as the kid is born. This will prevent entry of organisms harmful to the animal which may lie dormant for years, or may show up in a few weeks in swollen joints, or in a form of diarrhoea. More desirable forms of disinfectant are Smear 62, Screw-Worm Smear, or other proprietary mixtures which also reduce the chance of maggots getting at the navel without affecting the tissue of the kids' flesh as Jeyes' Fluid does.

At birth some kids are not inclined to strenuous activity and do not go readily to suckling. There should be an early watch for this, as the new born kid may not recognize the relationship between food from its dam's teats and survival the day following. It will be necessary, therefore, for the attendant to induce the kid to suckle by gradually introducing the teat into the kid's mouth and squeezing milk into the mouth. This nursing should be continued until it is certain that the kid is well on the way to self-feeding. In any event a large amount of the colostrum (first milk) should be taken by the kid as colostrum:

(*a*) regulates bowel action;
(*b*) provides defences to the kid's system through its bloodstream.

While allowing large amounts to be taken, the attendant must be sure to milk out any surplus after the kid has been satisfied. If a very large quantity is available another stripping-out in the late afternoon would be advisable.

The kid may be left with the doe for a week or more when the colostrum will have cleared, the kid suckling at its pleasure. The youngster should now be strong enough to be separated from its dam during the night, to allow removal of some of the milk next morning for the farmer's use, the kid remaining with the dam during the day, until late afternoon. This will have the effect of inducing the kid to commence eating herbage. He can be helped along by providing some concentrates or ground grain to replace the nursing at night now lost to him. When he has become accustomed to this, he may be separated earlier in the day, at say 1 p.m. thus allowing, a short while later, a supply of freshly drawn afternoon milk for use in the home.

He may be separated from the dam finally at five to six months of age. Whether the dam is again 'in kid' may determine the time of weaning.

Abundant water should be provided, also minerals in the form of salt lick whether in powder or brick form.

An early start should be made in teaching the young animal to accept grain; in fact, the earlier the better, as this will cause a brighter and better appearance at weaning and should prevent a set-back then.

Bedding for Kids. Young kids should be allowed to lie on clean dry bedding at nights, for which purpose dry grass or rice straw may be used. Overcrowding should be avoided, and they should be kept dry and away from draughts.

Open space for romping in the open, with heaps of stone on which to jump, is not only helpful but necessary for kids.

Grooming and Care of Hoofs. Once a month wash the goats thoroughly with soap. Bucks may be washed oftener. Also once a month spray with a *mild* mixture of Cooper's dip after washing. *Mix* the dip *strictly in accordance with the directions of the makers.* Half an ounce (fluid) of dip to one gallon of water. (For half-grown animals *two* gallons of water.)

The spraying is a preventative against lice, although for lice an application of Agrocide well dusted on is recommended in preference.

Every three months pare all hoofs. This is more easily done after the goats have been washed. Use a sharp knife. If hoofs have been neglected and there is a tendency to foot rot, clean and dip in a solution of copper sulphate (bluestone), using one part of powdered sulphate to ten parts of water.

RABBITS

Rabbit breeding deserves more attention from the farmer. Not, however, the kind of breeding consisting of throwing a few does and a buck into a wattle pen, pushing in a few soap boxes, throwing in a bundle of mixed spanish needle and other feeding once a day, and leaving the rest to luck and nature. That way failure lies.

The rabbit is perhaps the easiest of the domestic animals to rear, given a fair chance and a little intelligent attention. They adjust themselves rapidly to any climate or condition, and require little care or attention.

Commercially, rabbits are not a get-rich-quick proposition, but when business methods are applied to their rearing a fair return is possible. Apply the same business methods to the rabbitry as to any other agricultural venture, spend a little money on giving it a fair start, begin with good stock, give them reasonable attention, and the results will justify the attempt. More than this, in these days of shortage of meat and high prices, the rabbit goes a fair way in solving the housewife's constantly recurring problem of 'what to provide today'.

Having regard to the general meat shortage and the large proportion of foreign residents now in Jamaica, who are accustomed to and have no prejudice against rabbit meat, a good and profitable market is waiting for the go-ahead farmer who can make *regular and dependable* supplies of freshly-dressed carcasses to those city groceries who keep a refrigerated meat box in their shops.

Besides the carcasses, everything else appertaining to the rabbit has a value. The pelts when properly stretched and dried have a ready sale, the offal (head, feet and entrails) can be ground up and combined with a mash for pigs and poultry, while the manure is of excellent quality and plentiful.

Selection of a Breed

It is best to select a good strain and keep to that. The most popular are:

Belgian Hare,
Flemish Giant,
New Zealand Red,
New Zealand White.

For many years the Belgian and the Flemish were most popular, but today perhaps the most satisfactory breed for commercial purposes is the New Zealand White. (The pelts are in good demand by furriers.) The flesh is white, firm, fine-grained and of good flavour. The live weight, when well cared, averages 8–10 lbs. The young at three months old should reach good market weight—4 lbs.

A good doe should produce a large litter four times a year.

The Hutch

Proper housing, draught-free and protected equally well against rain and sun is essential, and sufficient space should be allowed for the rabbits to move around. Over-crowding should be avoided.

The best plan is to provide separate compartments for bucks, breeding

does, males nearly mature, females ditto, and one for youngsters just after their mothers have weaned them. Allow 4 ft. in length × 30 ins. deep × 28–30 ins. high for single compartments, and about 6 ft. long for the groups, and 3 ft. off the ground.

As far as possible hutches should be of a self-cleaning type, that is to say, the floor should be constructed altogether of mesh wire, the mid and after portion of a close mesh, so that the rabbits can move about comfortably on it; the front portion, for about 18 inches across, of a coarser mesh, to allow droppings to fall through when the hutch is being cleaned. All compartments should be provided with sleeping or breeding boxes tucked 'privately' away at the further end of the compartments. Enough space should be allowed for the rabbits to lie on top of the boxes, a location of which they are fond.

The back of every compartment should be hinged so that it can be dropped down at will to allow easy access for handling the rabbits. The catch should be quite secure to avoid the lid dropping down accidentally.

The hutch should be thoroughly cleaned out once or twice a week.

Care must be taken to close board or otherwise protect from cold breezes and night draughts, and to place the front of the hutch, for preference, where it will catch the morning sun. Also the hutch should be either close fenced in, or otherwise so placed that it will be out of reach of dogs and cats.

Feeding Racks. Shallow troughs or a bit of galvanized water guttering will do very well for any grain or mash to be fed. For grass and leaves, do not scatter on the floor, but tie into small bundles with fine wire and hang along the inside of the front part of the hutches. The rabbits prefer to sit up to their meals. This way also avoids waste.

Breeding

Never place the buck to run with the does. When a doe shows signs of restlessness, put her to the buck. He will immediately serve her. Allow one or two falls only. That will be sufficient. The more the number of falls, the smaller the litter. If the doe will not receive the attentions of the buck, then she is not really on heat. Remove her and watch her for a more favourable time.

Make sure that the doe is not over-fat when putting her to the buck. The doe should be rested after weaning a litter before again putting her to the buck. She should not be allowed to litter more than four times a year.

Examine the hutch the day after the doe has littered, and never keep more than 8 kittens. The doe has only 8 nipples. Some have only 6. And for a first litter keep the number to 6.

Feeds and Feeding

For the main feed, mixed fresh grasses and plants like spanish needle, broom weed (roots and all), breadfruit leaves, trumpet leaves, a little (very little) mango or citrus clippings.

Never give Wet Grass or Leaves. For successful raising, a little supplement of grain is essential—ground corn, Guinea corn, mixed 'poultry scratch', corn bran mixed with coconut meal, dry bread crusts, etc. One handful each a day will be sufficient. A doe with kittens should always be allowed a little extra. Fresh, pure milk is a useful feed if a surplus is available.

Water. Contrary to popular belief, rabbits drink water readily. Always use an earthenware vessel (a small yabbah will do), but take care that the vessel and water are perfectly clean or the rabbits will not touch it. If possible rinse out and renew twice a day.

When to feed. A light feed of greens and the grain in the morning, and the main feed at sundown. Rabbits are nocturnal in habit.

Avoid feeding greens to very young rabbits. A little hay from half-grown Guinea or Napier grass or Guinea corn is best. It is also good to alternate a hay feed with green feed, say one to four, for the adults.

Finally, a good balanced feed is essential if rabbits are to be successfully reared. Carelessness and indifferent treatment can only lead to disappointment. It is also unfair to the animals.

Handling Rabbits

Never hold them up by the ears. There is plenty of loose skin at the back of the neck. Hold the rabbit by that with one hand, and support it by placing the other hand under the rump to relieve the strain.

When killing, grasp both hind legs at the hocks firmly with the left hand, keeping the back of the animal turned towards your right. Hold it up like that. In a few seconds it will cease struggling and hang quietly head down. With the edge of the right palm, give a smart 'chopping' blow to the back of the neck, immediately below the head. This stuns the rabbit at once. Now place it on its side on the ground, and with a sharp, thin, pointed knife pin it to the ground through the neck—not too low down near the windpipe, but higher up. This allows for free bleeding and white flesh.

The flesh bruises easily, but if the above method is carefully followed a clean unblemished carcass results. Also killing like this is practically painless to the animal.

Diseases of Rabbits

Hygiene. The roof of the hutch must be sound as rabbits soon get sick if wetted. Let the eaves of the roof overhang sufficiently to provide good shade and keep out driving rain. During the rainy season an old crocus bag or some coconut leaves may be hung up over the weather side to keep the rabbit protected against draughts and weather.

Food and water containers should be of metal or earthenware. They should be scoured out daily and fresh food (if mash is given) and water provided. It is a good plan to have two sets of utensils and to sun one set while the other set is in use alternate days.

An important part of any rabbitry of more than a dozen animals is the 'isolation hospital'. This is a cage or hutch of simple construction which can easily be cleaned out and disinfected. Here rabbits are put as soon as any sickness is noted and here they can be kept if treatment is necessary until the danger of infection is passed.

Management. Before a rabbit is put into a different hutch, scrub out the sides, floor, and any fittings with water, preferably hot water, with washing soda in it. Allow the sun or air to dry it well. Then disinfect with jeyes and water or with any similar type of disinfectant used at full strength.

If new rabbits are purchased or borrowed for breeding purposes, do not put them in with the others at once. Keep them for at least 14 days in a clean separate pen on their own; then transfer them to a clean hutch and disinfect that from which they have been removed.

The diet of young rabbits just weaned can be supplemented by a little cow's milk or skimmed milk if available. Do not put young stock and old stock together as the youngsters will not grow well. Keep adult bucks apart from does except for mating.

Non-Infectious Diseases

Diarrhoea. Diarrhoea may be due to infectious diseases or to errors in feeding. If more than one animal is affected or if the condition is persistent this should give rise to suspicion of infection and a fresh sample of droppings or a carcass should be examined by a veterinary surgeon.

The symptoms of diarrhoea are loose, smelly droppings, sometimes so bad that the droppings are quite fluid and the hindquarters become soiled.

Treatment is to clean and disinfect the hutch and provide clean, dry bedding especially if the rabbit is not on a wire mesh floor. See that all food is fresh and give green food only after it has quailed. If a mash is fed see that all utensils are clean and obtain food from a different source. Give a little food often and throw away any remaining from the last feed. Medicinally, one or two teaspoonfuls of raw linseed oil or of mineral oil may be given but care must be taken to see that the dose is given slowly and in such a way that the rabbit swallows the oil and that none goes down to the lungs.

Constipation. Constipation is usually caused by giving too much dry fibrous feed and by not providing any drinking water. It can also be caused by over-feeding with mash or grain or by other diseases such as fevers, 'colds' or pneumonia.

The droppings in constipation are scanty, are covered with a slimy mucus, and are hard and small. The rabbit has a miserable appearance, its coat is dull and 'hide-bound' and it may sit huddled up without showing any interest in its food or surroundings.

Treatment of constipation is to correct the cause of the trouble which usually means changing the feeding. Give some fresh green grass or Spanish needle and provide clean drinking water. Dosing with mineral oil (1 to 2 teaspoonfuls) or with castor oil ($\frac{1}{2}$ to 1 teaspoonful) may be carried out.

Pot Belly. This condition results from the fermentation of imperfectly digested food in the animal's intestine with the production of gas which extends the bowel and gives the abdomen the appearance and feel of a football. In some cases the pressure of gas can be great enough to cause rupture of the stomach and death.

The disease results from feeding an excess of fresh green food before it has been quailed. It also occurs as a symptom of certain other diseases such as coccidiosis, which interfere with the action of the bowel.

Treatment consists of cutting down on green food and allowing very succulent food to quail properly before feeding. Damp grass should never be fed. Give a diet of warm milk, or a thin porridge made with milk and corn flour.

Hair Balls. Hair balls occasionally cause trouble in the long haired breeds. They form in the stomach or intestine as a result of eating hair from the rabbit's own or from a companion's coat, and may result in severe symptoms and even death. The habit usually points to some defect in feeding as a result of which the rabbit has developed a depraved appetite.

Symptoms in mild cases are no more than a certain amount of unthriftiness and the appearance of hairs in the droppings. In more severe cases the rabbit appears dull and goes off its feed; it is usually constipated. Rapid loss of condition may occur.

Treatment with a purgative is indicated in mild cases, along the lines suggested under **Constipation.** The condition is often brought about by a shortage of roughage in the diet and it is usually worth while paying attention to the diet and ensuring that the green food given is adequately quailed, and that enough fibrous matter is provided in the feed.

Mastitis. Mastitis is an inflammation in the breasts or teats of the doe. It is quite a common condition and usually follows some wound or injury to the breast.

The affected part of the breast appears hot and red and is painful to the touch. As the disease advances the swelling may increase in size to form an abscess which may burst and let out pus ('corruption'). At this stage the doe is sick, appears miserable and will not feed. She cannot feed her kittens and they may die.

Treatment is to apply hot poultices of Kaolin or corn meal. Keep the underparts of the doe clean and give ample supplies of clean bedding. If the condition becomes severe it is as well to consult a veterinary surgeon.

Snuffles. Snuffles or colds in the head are sometimes seen in a rabbitry. They are caused by a variety of factors such as infection with germs and chilling or wetting.

The symptoms are sneezing and discharge from the nose. The animal rubs its nose with its front paws and the discharge may become matted on them.

The snuffles are best prevented by good hygiene and a well designed hutch with plenty of space for each rabbit. A good balanced diet is also important. Cure of the condition will not be achieved unless the predisposing cause is corrected. Sunlight and dry bedding are helpful. Medicinally, penicillin is sometimes of value.

Pneumonia. Pneumonia is a common condition, especially of young rabbits during the rainy season. It usually occurs when the hutch does not give good protection from the weather and results from the animal getting wet and chilled. Sometimes pneumonia results from an infection with some other disease.

Affected animals appear dull and refuse their food. They huddle in a corner of the hutch and are slow to move. Breathing is laboured and heavy and there may be 'cold' running from eyes or nose. There is usually some rise in body temperature or fever. The rabbit may die in two to four days.

Treatment is difficult. Give fresh, dry bedding and see that the hutch is clean and dry with no damp spots. Give a small amount of fresh, green food and plenty of clean water. If the rabbit is valuable it is worth while calling a veterinary surgeon who may give an injection.

Infectious Diseases

Mange. Mange is probably the most common disease of rabbits in Jamaica. There are two forms—ear mange (or 'canker') and head mange. Each is caused by a different type of microscopic 'mite' similar to a seed tick or jigger in appearance but barely visible to the naked eye, which burrows into the skin. Both diseases are easily spread from one rabbit to another.

Head mange is the more common condition. The mites affect the skin of the nose, lips and face and sometimes the feet and neck. They cause the hair to fall out and greyish or yellowish scabs to appear on the affected parts. Sometimes these scabs become so large as to resemble warts. The sores cause great irritation and the rabbits scratch the affected parts and often cause them to bleed. Affected animals lose weight and condition rapidly and may die from excessive thinness.

Ear mange 'mites' affect the internal part of the ear where they cause a smelly brown discharge and a great deal of irritation. The inside of the ear becomes caked with discharge and may bleed and ulcerate where the animal scratches it. Affected rabbits usually hold their head on one side and often shake their heads or scratch the affected parts.

Treatment is first of all to isolate the affected rabbits and put them in a hutch on their own away from healthy animals. This is to prevent others becoming infected. All bedding should be burnt and the hutch where the affected rabbit was housed should be scrubbed out, left to dry in the sun and then disinfected by painting with a preparation of benzene hexachloride (B.H.C.). Obtain a preparation containing about five per cent of the drug (B.H.C.) in emulsion form and dilute this 1 : 50 parts of water before use.

Curing head or ear mange is not really difficult but two factors must be borne in mind. Firstly, it is not always possible to detect early cases and rabbits may carry the mite for up to three months without themselves showing any symptoms, although they may infect others. Secondly, reinfection is easy if precautions are not taken to disinfect the hutch. Therefore in addition to the precaution of removing the sick rabbit and disinfecting the hutch also keep a careful watch on any other rabbits which have been in contact with the sick one and be prepared to treat them too at the first sign of trouble.

If the affected animal is in very poor condition and severely affected, it is best destroyed. Otherwise for head mange treat by cleaning off the scabs with warm soapy water and cutting away hair from all around the sore area; then drying the parts and applying the dilute emulsion (1 : 50 of 5% B.H.C. emulsion) generously. Repeat this treatment every 3 days until the sore has disappeared.

For treatment of ear mange clean out the ear with a piece of cotton wool or soft cotton cloth and remove all scabs and discharge. Dry as well as possible but take care not to harm the ear or cause bleeding. Then apply the same B.H.C. disinfectant as for head mange working it well into the ear. One treatment should be enough but severe cases may need a second treatment one week later.

Ringworm. Ringworm is occasionally seen in rabbits and is somewhat similar in appearance to head mange. It is important because man, dogs and cats can pick up the infection from infected animals. In case of doubt about suspected ringworm in a rabbit consult a veterinary surgeon.

Treatment is rarely justified in view of the danger of human infection and the difficulty of cleaning up the hutch, etc. Disinfection against ringworm is not easy and after an infected animal has been removed from a hutch it is best washed out and disinfected with a blow-lamp.

Coccidiosis. Coccidiosis is a common cause of unthriftiness and death in young rabbits. It is a disease caused by a germ which may affect either the bowels or the liver of the animal. In mild cases no symptoms other than

a loss in weight are seen, although the germ may be found by microscopic examination of the droppings. In more severe infections the droppings appear soft or loose and the rabbit appears sick and adopts a hunched-up attitude while sitting in the hutch. It loses interest in its food. Later as the disease progresses the droppings turn to diarrhoea and there is very rapid loss of condition before death ensues. These symptoms are principally seen when the bowel is infected, infection of the liver being usually a chronic condition causing less severe symptoms.

Rabbits which survive their first attack of bowel coccidiosis usually develop a partial immunity to the germ and can tolerate a moderate reinfection in later life. Symptoms of the original attack develop five days after exposure to infection and last ten to fifteen days.

Prevention of the disease will be assured if good hygienic hutches are built and pans for food and water so arranged that the contents cannot easily be contaminated by droppings. If hutches have solid floors they should be cleaned out regularly at least three times weekly. Liver coccidiosis is easier to prevent than bowel coccidiosis and is far less troublesome.

Treatment should be undertaken early and should be given to all rabbits in the hutch and nearby hutches. To treat rabbits they should be put on dry (grain) feed and the drug given to them in their drinking water or in the grain feed. The drug of choice is sulphamezathine which is given in place of drinking water as a dilute solution at one part in 500 of water. It is commonly marketed as a 16% solution which should be mixed at the rate of one ¼ oz. (one dessertspoonful) per pint of water. Alternatively the solid drug may be mixed with the grain feed at the rate of one to two grams (two to four tablets) per pound of feed.

Poultry Rearing

The Breed to Choose. In choosing a breed first consideration must be given to the purpose for which the breed is to be kept and the ability of the breed chosen to fulfil that purpose efficiently.

If the primary interest is egg production choose a breed capable of giving high egg production. If meat is the chief aim select a breed known for its good meat qualities, or if both eggs and meat are desired choose one of the dual-purpose breeds.

It must be pointed out however that under local conditions the egg and dual-purpose breeds are the best to choose from. Any attempt, as is so often the case, to keep several breeds at once will only lead to failure and disappointment.

The following breeds are listed according to their economic classification and will serve as easy reference when choosing a breed:

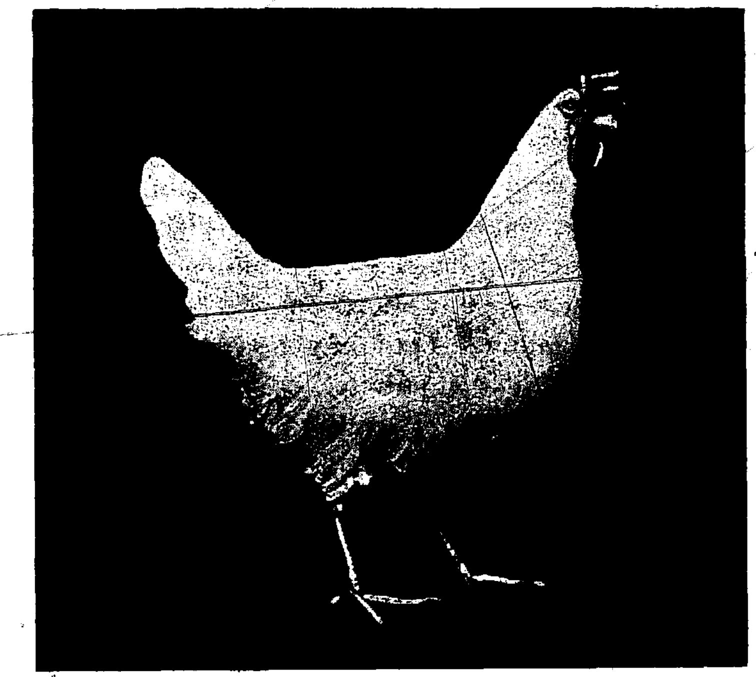
Egg Breeds	*Meat Breeds*	*Dual-purpose Breeds*
Leghorn	Brahma	Plymouth Rock
Ancona	Langshan	Wyandotte
Minorca	Cochin	Rhode Island Red
	Orpington	New Hampshire
	Cornish	Sussex
	Jersey Giant	Australorp.

A good type of White Leghorn Male
Note natural vitality and active appearance
(Courtesy of *Poultry Tribune*)

Ways of acquiring a flock. There are four main points in the life cycle of fowls at any one of which one may start. These are, hatching eggs, day old chickens, 'started chicks' and mature pullets or young hens.

To start by purchasing fertile eggs and hatching them under the common hen provides an easy way for the person without much experience in poultry rearing to begin. Hatching eggs should be selected from well fed, vigorous, and high producing hens. It is unwise to buy any kind of eggs and 'try them under a hen' and expect satisfactory results. Many flocks are not properly fed to produce hatching eggs; others may not produce fertile eggs, or the hens may be infected with pullorum disease which would be passed on to the chickens. It is therefore necessary to get the hatching eggs from a reliable source.

The most popular way at present to start poultry rearing is with day-old



White Leghorn Hen
Head and body characterisations indicating vigour
(Courtesy of *Poultry World*)

chickens. This method, however, requires more equipment and experience than the first. When buying day-old chickens choose those from a reputable source and provide a warm brooder, good feed and feeding utensils.

The third way of starting is to buy what is known as 'started chicks'. These may be chickens of any age from two to twelve weeks old. In many respects this is the best way for beginners. The cost of the 'started chicks' is, however, greater than that of day-old chickens, but many persons are prepared to pay the extra amount and avoid the risks in rearing day-old chickens.

The fourth way of starting is to buy pullets about five or six months old, just when they are about ready to lay, or perhaps have already begun laying. The chief advantage in this method is that there will be no need for brooding or for waiting long for eggs. Care should, however, be exercised not to buy culls.

When to Hatch. It is always to the advantage of the farmer to get his chickens early in the year. Results at the Hope Agricultural Station show that chickens hatched between January and the end of March do better than chickens hatched later in the year. They are spared many of the diseases which attack chickens hatched between May and July, and will start laying in August and September so that they will be in full production for the Christmas season when egg prices are highest.

Selecting the Hatching eggs. Eggs of good quality are necessary for good hatches. All eggs for incubation should be uniform in shape and size, and sound in shell, weighing not less than twenty-four nor more than twenty-eight ounces per dozen. Extremely large or small eggs should not be used for hatching. Shape, size, colour, and quality of eggs are characters which are inherited, and a selection for these points when hatching eggs should lead to greater uniformity of egg size from the resulting pullets. Hatching eggs must be selected from young, vigorous, and high egg-producing hens. Fresh eggs give better hatching results than old ones. They should be kept in a clean and cool place before incubation. Dirty eggs should never be incubated. Hatching eggs kept longer than ten days do not hatch as well as those incubated soon after being laid. It takes twenty-one days to hatch hen's eggs.

Incubation. There are two methods of incubating eggs, namely: natural and artificial. The hen incubates the eggs the natural way, and the incubator the artificial way. So far there is no incubator to equal the hen for efficiency in hatching eggs, but because it is impracticable to use hens to hatch the large number of chickens needed by the poultry industry at the time when they are most required, large incubators have been developed to fill the need, and have filled it very well.

The Natural Way. Before a hen is allowed to sit she should be examined to make sure that she is free from parasites and in a healthy condition. If there is any doubt that she is infested with parasites dust her with lice powder—sodium fluoride, Agrocide, or Black Leaf 40. Before giving her the hatching eggs test her to make sure she has serious intention of sitting. Put a few infertile eggs in her nest, and if she does not leave it except for food and water during the next two days it can be taken that she is out to sit. At the end of this trial period remove the infertile eggs and place the hatching eggs under her at night. The average common hen will cover nine to twelve eggs, and she is a better sitter and mother than the pure breeds. Of the pure breeds the dual purpose breeds are the best sitters and mothers.

Type of Nest. The nest box should provide ample room for the hen and eggs and protection from enemies and the elements. It should be in a secluded spot away from the laying hens and in a clean surrounding. The nest box must firstly be partially filled with earth, on this should be placed the nest material—soft dried grass, leaves or straw, which should be so heaped as to allow the eggs to remain in the centre of the nest without piling on each other. A dusting with Agrocide or tobacco dust will ensure against lice.

A number of hens may sit at the same time, but confine each hen to her nest. Examine the nest occasionally to be sure there are no broken eggs in it. If there are any broken, the shell and soiled nesting material should be removed.

Feeding the Sitting Hen. The best diet for the sitting hen is one

composed of such grains as corn, Guinea corn, or a mixture like 'Scratch feed'. Green feed and clean water should be provided at all times. Laying mash should not be given as the sole diet because it stimulates egg production. Because many hens are inclined to leave the nest with the first few chickens hatched, care should be taken that they stay until all hatchable eggs are hatched.

Artificial Incubation. Modern incubators are heated by coal, gas, oil or electricity. For the very best results in using any type or size of the modern incubator, locate it in a clean room and follow the manufacturer's instructions in operating it.

Day-old Chickens. Before the chickens arrive, clean feeders, waterers and brooders should be in readiness for them. In taking them home protect them from rain and sun. On arrival at home count them as they are taken from the box to be put in the brooder. The brooder should be at a temperature of 90° to 95° Fahrenheit. When removing the chickens to the brooder it is a good practice to dip the beak of each chicken in tepid water before it is put in the brooder. It is very necessary that the chickens are kept warm and comfortable because success depends on the right start.

Brooding. As with incubation, there are natural and artificial methods of brooding chickens. For natural brooding the requirements are few. A coop 4 feet long, 2 feet wide and 2 feet high, will provide ample space for a hen and fifteen to twenty chickens. The coop should be screened with 1-inch mesh wire to prevent rats, dogs, cats, mongooses or other enemies from destroying the chickens.

The brooding coop should be so made that cleaning is easy. The brooder should be changed to fresh ground regularly to provide fresh grass for the hen and chickens and to prevent any one spot from becoming contaminated. Chickens may remain with the hen until they are about five or six weeks old, by which time they should be fully feathered.

Artificial Brooding. Artificial brooding is necessary when large numbers of chickens have to be brooded at all seasons of the year, and because hens are broody only at certain periods, also because the brooding instinct is not well developed in the high egg producing breeds. While artificial brooding carries with it some problems not common to natural brooding, it has been a very important factor in expanding the poultry industry. The shape of the brooder will differ with size and method of heating it. There are artificial brooders manufactured to accommodate from fifty to five thousand chickens and the ways of heating them are by gas, steam, oil and electricity. Whatever may be the size or the method of heating, successful brooding will depend on:

(i) A dependable source of heat to keep the chickens comfortable at all times.

(ii) Provision of 6 square inches of brooder space for each chicken for the first two weeks, increasing it as the chickens grow older.

(iii) Avoiding overcrowding; maintaining good sanitation and ventilation.

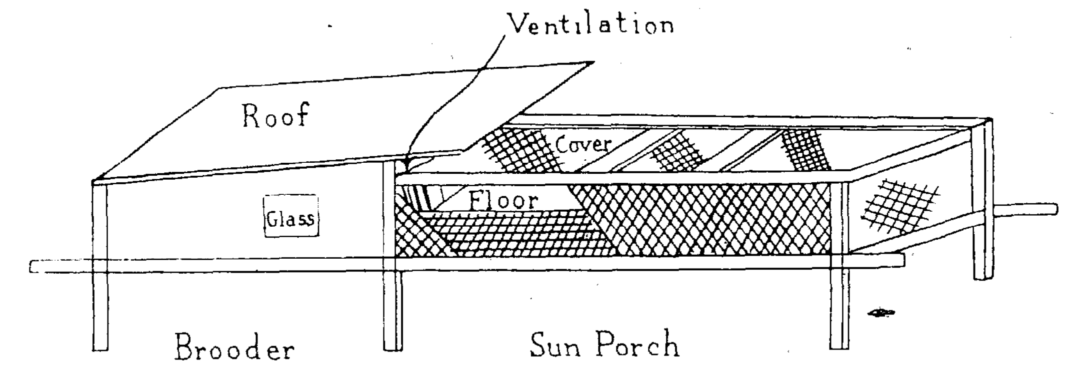
(iv) Provision of enough feeding and watering vessels.

Electric Brooder. Electricity provides a very dependable heat for brooding. Where a limited number of chickens is to be brooded and electricity is available it is possible to make a serviceable home-made brooder from an ordinary packing crate. Take a box 36 inches by 42 inches by 16 inches and turn it on one of its broad sides; open a portion of it to allow feed and water to be put in, and for the chickens to be able to move in and out at will. Make a hole in the centre of the top and suspend a sixty-watt bulb about 8 or 9 inches from the side of the box which is resting on the floor. In such an enclosure a sixty-watt bulb will provide enough warmth during the hatching season here for one hundred chickens from one day old to about two weeks of age.

Manufactured brooders are specially made for brooding and are equipped with temperature regulators to enable the temperature to be controlled at any desired level. For the first two weeks of life the temperature should be 95° Fahrenheit and thereafter should be lowered about 3° or 4° each succeeding week to 80° or 85°.

Lamp Brooder. Properly constructed kerosene lamp brooders are quite satisfactory for brooding a limited number of chickens where electricity is not available. The lamp must be protected so that the chickens cannot come in direct contact with it. An opening is made in the top or side of the brooder to enable proper combustion. Care should be taken not to fill the lamp with oil because the heat from the lamp may cause the oil to expand and overflow and encourage fire. The wick and the burner should be cleaned twice daily. The bottom of the brooder should be covered with dry sand, the top of which is removed each morning. The brooding routine should consist of regular and scrupulous care of the heater, frequent cleaning, disinfecting of the brooder and its surroundings, and a constant watch over the comfort of the chickens.

Feeding the Chicks. Feed and water are to be in the brooder before the chicks are put in. In a short while a few will be picking at the feed and others will be tasting the water. For the first and second days, in addition to the hoppers, they should be fed on clean paper or cardboard spread over the floor of the brooder. Feed given on the paper should not be more than can be eaten in an hour or two and the paper must be changed every time new feed is given. **Starting mash** must be fed for the first six weeks. The mash must be clean and fresh. Musty, old and worm infested feed should not be fed. A chicken eats only a thimbleful of feed per day during



A lamp brooder, with sun porch attached, for brooding a limited number of chickens

A Lamp Brooder, with sun porch

the first few days of life and from that thimbleful it must get proteins, carbohydrates, fats, vitamins and minerals in the right proportions to build bones, muscles and feathers. If, therefore, the feed is not of good quality growth may be slow or they may all die.

At the end of the sixth week the starting mash should be replaced by **growing mash.** This should be fed for another six or eight weeks before they are finally given **laying mash.** Usually cracked corn or Guinea corn may be fed by the end of the third week, gradually increasing in quantity as they get older. Also about the third week, green feed can be fed. The green feed should be the tender parts of water grasses, spinach or lettuce. If available, skimmed or whole milk will be helpful to the chickens from the first week.

It is advisable that feed should be kept before the chickens at all times. Where this is done every one will be given a chance to get enough food for maximum development. They will not over-eat themselves as is the popular belief. The hoppers should never be full because the chickens will 'bill out' the feed and waste it.

General Equipment

Litter. It is necessary to cover the floor with litter to absorb the moisture from the floor and from the droppings. The litter should be removed when it becomes soiled. It may be made of dried grass, wood shavings, or dried leaves. Strict sanitation is essential for successful brooding.

Hopper. Until the chickens have learnt to feed properly, they may be fed on newspaper spread over the floor of the brooder. When they have learnt to feed, provide small hoppers from which they will be able to get their feed without difficulty and without being able to get into the hopper to spoil the feed. For a hundred chickens up to three weeks old, three of the small type hoppers 2 feet long will be enough. As the chickens grow older the size and length of the hoppers should be increased.

Drinking Trough. A few canning tins, with two small holes close to the rim, filled and inverted into saucers will make very useful water fountains for the small chickens. When the chickens grow older provide larger drinking fountains. If skimmed milk is fed it should not be fed in tin containers but in earthenware ones.

Roosts. Roosts should be provided about the third week so that the chickens may learn to roost early. This will enable them to grow better as the congestion on the floor will be relieved. Roosts at this stage should, however, be very low.

Separation of the Sexes

As soon as the sex can be determined, the cockerels should be separated from the pullets. Leghorn cockerels can be identified when they are four to five weeks old, and cockerels of the heavier breeds when they are about six to eight weeks old. All the cockerels not wanted for breeding purposes can be sold when large enough for broilers or may be grown as roosters. Separating the sexes early will give the pullets a chance to develop more rapidly.

Culling

Types of Birds to Select. In actual practice the term 'culling' is applied to the removal of poor layers from the flock, but in its broader meaning should include the removal of undesirable hatching eggs, chickens, pullets, cockerels, hens and roosters. This method of picking and retaining the most promising birds assumes the ability to interpret their productive values as revealed by their body characteristics. In so doing at least two general purposes are served:

(i) Ability of farmers to recognize value as revealed by body conditions will be developed.
(ii) Increase in quality and quantity of production will follow.

This home judging is not only most important to the farmer but can also become most accurate. The more poultrymen know about culling the greater will be the progress in improving the quality and returns of their flock. Day by day throughout the year poultrymen are seeing their flock under known conditions and should be able to determine the best of their flock. The very good and the very poor ones are easy to identify, especially if the flock has been well cared for, but the medium producers are often a puzzle, and require some experience to deal with.

Why Culling is done. A flock that has not been culled may contain hens which have never laid, and at most seasons of the year there certainly will be birds which have stopped laying and are being kept at a loss.

There are instances where half of a flock is culled without affecting egg production. Because of the less crowded conditions the birds left in the flock will lay more eggs than before culling was done. In addition to the immediate benefits the poultryman will keep the birds which are most likely to produce well in their second year, as well as the most valuable breeders.

When to cull. Culling should start with the eggs. All eggs that are ill-shaped, weigh less than twenty-four or more than twenty-eight ounces to the dozen, and are lacking in uniformity of colour and shell texture should not be used for hatching.

Cull the chickens closely when they are hatched. Only well-developed, vigorous chickens should be put in the brooder. Breed is determined by body size, shape and colour. If the bird is not representative of the breed it should not be kept. Birds which grow slowly and reach sexual maturity late should not be kept.

For the laying flock, culling should be done during the months of July, August and September-just after the peak of the April and May production. The best hens will lay well during these months (July to September) after the average layers have stopped. The worst layers, on the other hand, stop soon after the spring rush and remain in a non-laying condition until spring of next year, at a loss to the farmer.

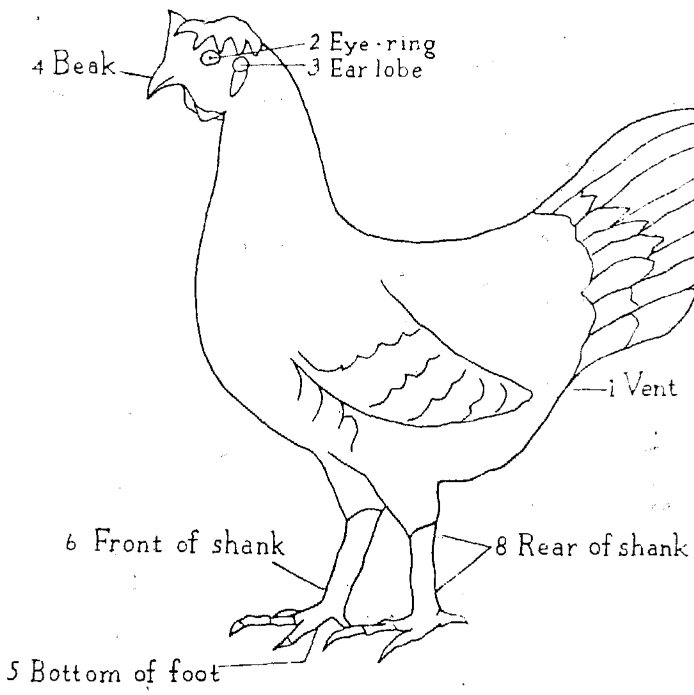
Laying and Non-laying Hens

(i) **Comb, Wattles and Ear Lobes.** The comb, wattles and ear lobes enlarge and contract depending on ovulation activity. If the hen is laying heavily, the ear lobes, comb and wattles are large, full, smooth and warm, while those of the non-layer will be dry, shrivelled and cold to the touch.

(ii) Head. The typical head of the high-producing hen is medium in length and width, clean cut, free from wrinkles or coarseness, with bright prominent eyes. The head of the poor layer is shrunken in front of the eyes, long and thin, with droopy eyes, or it may be large and coarse. The head is really the expression of all the other body characteristics, and a good index of laying ability.

(iii) Body Type. Because hens of high productive record differ widely in body type it is doubtful if any one type can be considered best for high egg production. The high egg producer must, however, have body room for a digestive system capable of handling a large amount of feed for heavy egg production. This will require a body that is deep and broad. The back should be broad and flat, with its width carried well back to the tail. The breast should be full and prominent with a long and straight keel bone. When laying, the good hen will be deeper in the rear than in the front, and when handled will show good width between the pubic bones and good depth from the pubic bones to the tip of the keel bone. The abdomen of the non-layer will feel hard, shrunken or fatty, and broken down in contrast to the good layer with a full and soft abdomen.

Pigmentation and Egg Production. Before the pullets start laying there is a visible yellow colour or pigment in the vent, eye ring, beak and shank of the yellow skinned breeds which becomes bleached in a regular way with egg production. This yellow colouring is also found in the ear lobes of the Mediterranean breeds. The yellow colour comes from the feed the birds eat, and is the same material which colours the yolk of the egg. With laying hens the colouring material from the food goes into the eggs they lay, and that in the parts named above fades out as indicated by the diagram below.



Order of disappearance and return of pigment

After about six to nine eggs have been laid the yellow colour fades from the vent which is the first to bleach. In many cases the production of about a dozen or fifteen eggs will bleach the eye ring. The ear lobes bleach a little more slowly than the eye ring. The beak requires from four to six weeks and the production of from thirty to forty eggs. The beak loses colour first at the base until it finally leaves the point of the beak. The shanks require the production of from one hundred and twenty-five to one hundred and seventy-five eggs to be completely bleached.

Other factors such as the rate of production, the breed of hen, age, size and health will also have an influence on the rate of bleaching. As soon as the hen ceases to lay the colour returns to the various parts in the

order in which it disappeared, but in a shorter time than it took to fade out. In applying the yellow pigment test care must be exercised to prevent errors. Fowls which have free access to abundant succulent feed or yellow corn in the feed will not bleach out as rapidly as birds lacking these feeds.

Moult. All birds change their feathers each year, and while they are growing new ones they generally stop laying. A few high producers, however, will lay while moulting. To make a high egg record hens must moult late in the year and renew their feathers in eight to ten weeks. Hens which moult early in the year may take six months to renew their feathers.

It must, however, be borne in mind that sudden change in feed and infection by internal and external parasites will often force the best layers into a premature moult.

The first year of laying is always the highest period of production, and because egg production declines with each succeeding year only the very best hens should be kept for the second year.

Selection of Breeding Stock. As with the laying flocks, which must be culled if production is to be kept high, so also should selection of the breeding stock to produce future generations be vigorous. Only the very best hens and roosters should be used for propagation.

Fowls for breeding should be non-broody and possess strong constitutional vigour, early sexual maturity, high egg records, good appetites, persistence of production and good feathering and flesh. Hens with all these qualities should be mated to vigorous roosters of the same breed or variety of known families of high egg records. Such roosters should be lively and bold, with close glossy plumage, bright eyes, masculine comb and wattles, broad breasted and with a proud and graceful air; crowing should be strong and clear, and spurs and claws strong and pointed.

One rooster of the egg breed can be successfully mated to twelve or fifteen hens of the same breed. With the dual-purpose breeds one rooster is sufficient for ten to twelve hens, and a rooster of the heavy breed will be adequate for eight to ten hens. These figures are for pen-mating where the male is restricted to a given pen and with the number of hens indicated.

Flock-mating permits the use of a number of males with a large group of females in one pen. Under most conditions, however, fertility in flock-mating will not be quite as high as pen-mating.

Both young roosters and hens give higher fertility than birds in their third or fourth year of production, but it is unwise to breed from pullets. Fertility is generally lower in the heavy breeds than the light breeds. Roosters should be with the hens at least eight days before eggs are saved for hatching.

It is to the advantage of the farmer to choose a breed and develop the breed chosen rather than to keep several breeds and strains and allow free mating and unselected hatching.

Progress in any breeding programme depends on rigorous selection and favourable environment which must strive to combine utility and beauty.

Feeding the Breeding Flock. Feed for the breeding hen must have all the nutrients for producing eggs of the highest quality. The breeding mash, as it is sometimes called, is fundamentally the same as the feed for layers, except that greater care must be taken to ensure an abundance of vitamins A, D, E and G, and that it is well balanced with respect to calcium and phosphorus. A higher level of animal protein in the feed is necessary in the breeding than in the laying mash. Any green feeds the birds will eat should be fed regularly and liberally. The same feed for the hen will suffice for the rooster.

Profitable Poultry Keeping. The common belief in Jamaica is that poultry-farming does not pay, but like any other type of enterprise profits and success depend mainly on a favourable relationship between costs involved in producing poultry products and the income received from these products. Profits are influenced by many factors, but the most important ones seem to be: size of business, egg yield per hen, fall rate of egg production, cost of feed and efficiency in the use of labour and equipment, efficient management, location, seasonal price variation, mortality and purchasing ability of the population.

Profits will also be affected by the quality of the stock used in starting. Pure-breds will lay a larger number of eggs than mongrels. They are so constituted that every particle of feed which is not utilized for body maintenance and energy will naturally go toward the formation of eggs rather than fat. The eggs produced are of greater uniformity as to size, colour and shape. Pure-breds for meat purpose will also produce better and more meat than mongrels.

The following suggestions will be helpful in increasing the profit from the flock:

(i) Use only stock bred for large egg size. Use birds capable of laying two hundred or more eggs a year. When hatching use eggs of desirable shape, colour and size.

(ii) Replace 40% or 50% of the flock each year with well developed pullets reared early in the year.

(iii) Feed a complete and well-balanced ration. Grain supplement should be fed in the evening. At all times provide a liberal supply of clean fresh water, and when possible skimmed milk. Provide green feed daily. Green feeds will help to provide gold-coloured yolk and other very essential elements for the layer. Feed mash and grain in clean hoppers.

(iv) To produce clean eggs provide clean litter on the floor and in the nest. Use wire netting to keep hens from under the roosts.

Prevent hens from roosting in the nests. Provide one nest for each five or six laying hens.

(v) Produce infertile eggs. Keep young cockerels from the laying flock.

(vi) Do not turn out birds in the mornings or evenings if the ground is very wet. Provide a comfortable house, adequate space and equipment.

(vii) Gather eggs frequently from the nest in clean baskets or other vessels.

(viii) Candle all eggs before packing them for market to ensure that they are free from developing germ, heat spot, blood spot or enlarged air cell.

(ix) Grade all eggs before packing. Grade is determined by weight, size, colour, exterior and interior appearance. The three standard grades used in many countries are set out below. The local grading, however, consists of only two grades. They are Grade A which includes all eggs weighing 22 ounces and over to the dozen and Grade B which includes all eggs weighing 18 to 21 ounces to the dozen.

Grade A

1. Shell must be clean, sound and normal.
2. Air cell not over ¼ inch in depth, localized and regular.
3. Yolk must be dimly visible, well centred and free from germ development.
4. White must be clear and firm.
5. The minimum weight must be 24 ounces to the dozen.

Grade B

1. Shell must be clean and normal.
2. Air cell must not be less than ⅜ inch in depth.
3. Yolk must be well centred and free from visible blemishes.
4. White must be clear and firm.
5. Minimum weight must be 21 ounces to the dozen.

Grade C

1. Shell must be clean and sound but may be abnormal.
2. Air cell may be over ⅜ inch in depth.
3. Yolk may be plainly visible and may show germ development but no blood spot.
4. The white may be weak and watery.
5. The minimum weight may be 18 ounces to the dozen.

(x) Better care of the egg on the farm will ensure high quality. Store eggs in cool place. The air should be moist and free from objectionable odour. Pack eggs with large end up and protect them en route to market from rain and sun, and avoid rough handling.

High quality eggs are always in demand and when packed in attractive and convenient cartons they have a strong appeal to the housewife.

Total egg production in the Island varies from month to month in a regular pattern. It is highest in April and lowest in October; between April and October production declines. Between October and April production increases each month.

Egg prices, however, are at the maximum in December and begin to fall early in January, reaching the lowest point in April when production is highest. To meet the demand throughout the year eggs are preserved during the period of heavy production for use during the period of scarcity. Such eggs are best kept in cold storage. Cold storage eggs are held at a temperature of 45° to 35° Fahrenheit with a relative humidity of 90%. Temperatures above these for any length of time will cause the air cell to enlarge, the thick white to become watery, and the vitellin membrane surrounding the yolk to become soft, thus causing the yolk to spread. Eggs in such conditions cannot possibly bring the best price to the producer.

No amount of honest praise for eggs as an important and healthful food can offset the immediate and far too lasting reaction to poor quality, bad flavour and unclean appearance of eggs. The surest way to injure consumption is to sell or serve the consumer a stale egg for a fresh one. From the producer to the consumer every one must be quality conscious.

The meat breeds are specially developed to produce meat of a high standard. The production of poultry meat offers to the farmers, large and small alike, a fair return for the investments. This phase of poultry husbandry offers good prospects here with a growing population, nutritional consciousness and tourist development.

The procedure for growing the meat breeds is about the same as for the egg breeds. Fast rate of growth and good sanitation are of first importance for success. Generally, the types of poultry used for meat purpose are in the form of fowls, broilers, fryers, roasters, and capons.

Caponizing a Cockerel

The Capon has held the place of honour as the finest of table birds from ancient times.

The art of caponizing deserves to be much more widely practised in Jamaica. The advantage, commercially, is considerable.

The 'utility' breeds are the best for caponizing—Red Hampshires, Rhode Island, Plymouth Rock, Wyandottes and Jerseys. Perhaps the Red Hampshires are the best of all from which to select, as they grow and mature so rapidly.

Age at which to Caponize. The younger the better—when the cockerels weigh from one to one and a half pounds. It should be remembered that a Capon after one year becomes tough meated and is no longer valuable.

Preparation and Equipment. A Caponizing set is necessary. Sterilize the instruments and keep in disinfectant water until ~~taken out~~ for use. Do not feed for twenty-four hours. This empties the intestines and makes the operation easier. Withhold water also.

Have a clean operating table ready. Wipe down with disinfectant. Have also some string and weights for holding the birds steady.

The implements are—a sharp knife, or scalpel, a probe with tearing hook, a spreader for holding the ribs apart and a testicle remover.

Operation. Stretch the bird out with the legs extended and well up. Strap down with weighted cords over legs and wings. Pluck the feathers from the operating spot and sponge spot and surrounding feathers (to keep the latter out of the way). Operate quickly. Find the last two ribs. Make sure that thigh muscles are out of the way. Cut, making a 1 inch incision, not too near the back. Insert spreader and hold ribs ½ inch apart. The intestines can now be seen beneath the peritoneal membrane and abdominal air sack. Open these. The intestines should now be well out of the way and the upper testicle be visible, attached to the wall of the back. Take care not to rupture any primary blood vessels. Work the testicle remover carefully over the testicle, manipulating it so as to enclose the entire organ without including the artery. Remove testicle with a slight twisting motion.

Turn the bird on the other side and repeat the operation similarly for the removal of the other testicle. Be careful to remove the entire organ, not leaving behind any portion of it.

After Treatment. Release the bird gently. Place in a clean coop. Feed and water in moderation. Examine under the wings daily for 'wind puffs' or 'bladders'. Deflate these by snipping with a small pair of pointed scissors. In two or three weeks the wounds should be quite healed.

Practical Duck Rearing

In Jamaica duck eggs are not as popular as hen eggs for table purposes and in consequence only a limited number of ducks are reared, although for cooking purposes there is very little to choose between the two.

In general, ducks are not as suitable for household poultry keepers as hens, mainly because small holdings do not afford sufficient run space for even a small unit of ducks. On the other hand, it is erroneous to think that ducks cannot be kept successfully without running water or a pond. Even where breeding ducks are kept water is not necessary. Small ponds are undesirable, as they become fouled and unpleasant.

Large Section Essential. As has already been stated, small runs are not recommended. The ground becomes fouled, is of no value to the birds, and may well be a source of disease contamination. On the other hand, though the intensive system with a well-designed house without a run can be successful for poultry, it is not suitable for ducks. If kept wholly within a laying shed, ducks would trample the litter flat, foul it, and make essential the cleaning out of the house at short intervals.

Thus ducks are a satisfactory proposition for the householder only where there is a large section with well-established grass or rough herbage over which the birds can range.

Egg Breeds. The two breeds best suited for egg production are the Khaki Campbell and the Indian Runner. Both breeds are excellent for egg production, provided the birds come from good laying strains.

Meat Breeds. Common meat breeds to be found in Jamaica are the Pekin and Muscovy. The Muscovy does not grow as rapidly as the Pekin but make good mothers.

The standard weights of the Pekins are

Adult drake	9 lb.
Adult duck	8 lb.
Young drake	8 lb.
Young duck	7 lb.

while the standard weights of the Muscovy are

Adult drake	10 lb.
Adult duck	7 lb.
Young drake	8 lb.
Young duck	6 lb.

A Pekin Muscovy cross produces a hybrid or 'Mule' which is considered very suitable for the table.

Housing. Mild climatic conditions obviate the necessity for the construction of elaborate or costly houses for the accommodation of ducks. That does not mean that ducks can be herded profitably into any class of house. Houses should be built similar in design to ordinary poultry-houses—a lean-to building facing north or north-east, open-fronted, with a ventilation space at the top of the back wall. Buildings so constructed will afford the ducks most protection against prevailing winds and rains, while at the same time the sun's rays penetrate into the house.

Construction. The building which should be located on well-drained soil with floor raised approximately 6 inches above outside ground level, need not be deeper than 5 feet. The roof could be 6 feet high at the front and 5 feet high at the back, with a ventilation space of 3 inches at the top of the back wall. In estimating the size of the building, allow 3 square feet

of floor space for each duck; thus, a building 10 feet long and 5 feet deep will accommodate sixteen to twenty ducks. The best materials for the construction of duck houses is sawn hardwood and galvanized corrugated iron.

Floors. The floor of the house should be dry at all times; a damp or wet floor in a duck house may cause many deaths among the flock, while practically the whole flock will receive a check in growth or production. To ensure dry floors, excavate drains on the highest side of the house, so as to carry away storm water. Concrete floors are best, but earth floor which has been rammed down fairly hard will be satisfactory. To facilitate cleaning, cover the floor with coarse sand or a litter of hay, grass or straw. The litter will provide bedding for the ducks. Nests should be placed on the floor against the walls.

Breeding. Though breeding of ducks is not recommended for household poultry keepers with only small units, where it is desired, mating of ducks may be done satisfactorily with birds in either their first or second laying seasons. Six to eight ducks may be mated to a drake for a single-male mating. The number of ducks to each drake can be increased to eight to ten where mass mating, that is, a number of drakes to a flock of ducks, is employed. When ducks and drakes for breeding are being chosen those with long and deep bodies should be selected, and birds with coarse heads should be avoided if good egg production is required. The good laying duck has a fine head with the eyes placed high in the skull.

Hatching and Rearing. The household poultry keeper with a small unit of ducks should use broody hens for hatching, a good-bodied, heavy-breed hen being used to cover about ten or eleven eggs. The hen should be in good condition and fully broody, as the incubation period is twenty-eight days.

For housing her a box or coop with a fine wire-mesh bottom should be placed in a cool place on moist ground. Duck eggs require more moisture than hen eggs for satisfactory hatching, and natural moisture from the ground is an aid to good hatching. In dry weather the soil round the box should be kept moist with water, more particularly during the last week before the eggs are due to hatch. After the second or third day the hen should be taken off the nest daily for about a quarter of an hour, during which she should be fed and watered. Whole maize is an excellent food for broody hens, as it assists to maintain body condition.

Once the ducklings have hatched, if more than one hen has been 'set' at the same time, it will be possible to give one hen some of the ducklings from those hatched out under two or three other hens, as a hen will brood successfully more ducklings than she can hatch, up to a maximum of about fifteen to eighteen. The hen and her ducklings should be given a coop and be restricted to a limited area with low wire netting for a few days. After this the hen may be permitted to range over a fairly large area, but should be put back in the coop at night for a week or two until the ducklings can safely sleep at night in the open. Here again care should be taken to protect the ducklings against attacks by rats, which will readily kill ducklings during the first week or two of their lives.

Feeding of Ducklings. Ducklings are fed with moist crumbly mash. At the start and for about ten days young ducklings receive four or five meals of mash daily; the mash is fed on a board or shallow trough. Ample feeding space should be given to prevent the ducklings from scrambling over one another, and the mash should not be put down in deep layers, as it will soon be trampled down into a firm mass and become difficult for the young ducklings to pick up.

Standard chick mash No. 1 is satisfactory for ducklings, but is improved by the addition of 5% of dried milk powder (½ lb. of milk powder to 9½ lb. of mash) or alternatively the mash may be moistened with liquid skimmed milk.

When the young ducklings are ten weeks old they should be fed with standard chick mash No. 2 and meat meal at the rate of 9½ lb. of mash to ½ lb. of meal. Grain is not necessary during the early growing stages, but may be fed when the birds have developed feathering. Grain is best fed from a metal trough and should be just covered with water.

Ample clean water should be available to ducklings and ducks at all times, and it is strongly recommended that it be given in vessels which are both large enough and deep enough to permit the birds to immerse their heads completely.

Feeding of Laying Ducks. Laying ducks may be given two feeds of wet mash daily, in the morning and evening; if they are fed on grain and mash, mash should be given as the morning feed and the grain at night. Standard laying mash No. 1 is suitable. As for ducklings, the mash must be moist and crumbly and not too sticky, as in this condition it will clog up the birds' beaks. Ducks are heavy feeders and when in full lay will eat 5 to 6 oz. of mash per bird daily. They are heavy layers and if production is to be maintained, ample food is necessary. When good green food is short, ducks will benefit from the addition of fish oil in the mash at the rate of three tablespoons to every 10 lb. of mash.

General Management. Ducks should be kept apart from fowls, as they are greedy feeders and often prevent fowls from obtaining sufficient food. Their way of feeding is also slightly different. Ducks also make the drinking water unsuitable for fowls. A swimming pool is not a necessity but where ducks have access to a pool they keep in better health, their plumage is cleaner, and they are freer from external parasites. Moreover, a higher degree of fertility results if breeding birds have access to a swimming pool. As ducks usually lay in the night or early morning it is necessary to confine them to the run or house until about 9 a.m., otherwise many eggs may be laid in the pool.

Ducks should have a constant supply of clean, cool, fresh water, and when confined during the night water should be supplied and the water vessels should be deep enough for the duck to submerge its head.

Ducks are naturally clean in their habits, but if kept in a small enclosure improperly drained, filthy conditions will result. Therefore, strict sanitation should be practised.

When kept in large numbers, ducks, particularly Indian Runners, are very excitable and easily frightened; if frightened they are very liable to go into a partial moult.

Water. Water is one of the biggest factors in successful duck-keeping. Ducks should always have access to plenty of clean, cool, fresh drinking water. The water vessels or pool should be sufficiently deep to permit the ducks to submerge their heads. The water vessel should be kept under a shade tree or protected from the sun by providing shade. In rearing ducklings, it is a good plan to put a number of stones in the water vessels; this prevents the ducklings swimming and wasting the water.

Water vessels should be constructed so the ducklings can get out easily in the event of their swimming in the vessels, otherwise they may drown through cramp. This cramping is more likely to occur during cold weather.

Disease not Common. In general ducks do not suffer from disease to the same extent as other poultry. They are easy to rear as ducklings and have good constitutions as adults. On the other hand they are more nervous than pullets or hens and should be protected against sudden frights from dogs, cats, rats, and other vermin. If severely frightened, they will readily panic and pile up on top of each other in corners; a fright of this nature will often put them out of lay and may even throw them into a partial moult.

Pigeons

Squab Raising in Jamaica is not engaged in to any appreciable extent and deserves more attention, providing as it does a useful addition to the domestic meat supply even if not engaged in on a commercial basis. At a comparatively small outlay, accommodation can be provided anywhere—either in town or country—to raise a flock of pigeons sufficient to keep the family supplied regularly with squabs, with a margin left over to partly cover, from sales, the cost of feeding the birds.

Breeding. Young pigeons are sufficiently matured for mating at six months old. They should be allowed to mate naturally, choosing their own mate. The union lasts for life, the normal span of a pair being for about five years. In their second and third years they are at their best.

Once a pen of mated birds is established, it is advisable to leave them undisturbed. The introduction of additional birds tends to upset the harmony of the flock, and mature birds introduced to new accommodation take a long time to settle down—often two or three months.

Selection. Pigeons should, like poultry, be selected on a commercial basis. Unprofitable pairs producing infertile eggs or too few or unhealthy squabs should be culled.

Many breeds are available, but the most satisfactory all-round breeds are:

1. The King, white or silver, produced in the U.S.A. These are of good average weight, 26 to 30 ozs., free breeders producing big squabs of good quality, and of hardy constitution.

2. The Mondain, French and Swiss. In many respects these are like the King, prolific, big squabs, and hardy.

3. The Homer. Small in size but hardy and very prolific.

Housing (to accommodate a unit of twenty pairs for semi-commercial use). A house of 90 square feet area, and a flight enclosure of similar size will be needed. The flight enclosure corresponds to a fowlhouse run.

The building is simple, usually a sloping shed higher in front, with walls of board or corrugated iron or asbestos sheeting, and galvanized iron roof. For ~~the floor,~~ rammed earth or concrete may be used. The house

A suitable housing unit for pigeons being kept either commercially or as a hobby

should be well ventilated, with a 6 inch opening at the back, just below the rafters, protected by mesh wire against rats and cats.

Interior Fittings. The house must include nests, perches, feed hoppers and water troughs. Two nests are necessary for each pair of birds, as a good female commences to lay again before the squabs are ready to be taken from the nest. The male will continue rearing them while the hen sits.

The usual size of a nesting compartment is 28 inches wide × 14 inches deep × 14 inches high. When the nest is divided into two compartments each will be 14 inches square. A 5-inch board should be tacked across the bottom to prevent nesting material or squabs from falling out, and an alighting board should also be fixed, in front of the nest.

A supply of coarse straw, wood shavings and similar material should be kept in a rack in one corner of the house from which the birds can take nesting material. The heap should be sprinkled with agrocide or D.D.T. to control vermin in the nests. Feed troughs similar to those used for chickens may be employed. Allow about 2½ inches feeding space for each pair.

The birds should also be provided with a suitable bath, 3 inches to 4 inches deep and 18 inches to 24 inches wide, to be replenished daily with clean water. Pigeons, unlike poultry, do not use a dust bath but water to keep themselves free from body parasites.

The floor of the house and flight enclosure should be kept covered with sand 3 inches deep to maintain healthy conditions. The sand should be raked over regularly, and removed and renewed every month.

Rearing. The eggs take seventeen days to hatch and nineteen days after the first egg is laid, ~~as there is an~~ interval between the first and the second. If a third appears, it should be removed at once.

Feed. Pigeons are not particular in the matter of their food, eating readily table scraps (vegetable) if chopped small in addition to the usual mixed poultry grain. They should be fed morning and evening, and a few heads of lettuce hung up within easy reach will also attract attention. A supply of salt in suitable receptacles will also be relished.

Turkeys

Turkey-rearing in Jamaica, although profitable, is not as widely practised as it could be. There are two possible reasons to explain this. One is the popular belief that the birds are hard to rear. This, however, is an erroneous belief. It is true that in their infancy the chicks are delicate, but a little careful attention to feeding and protection from wet and night draughts up to the age of ten weeks or so is all that is needed. After that they give no more trouble than other poultry.

The other reason is that the turkey is essentially a free-range bird, subsisting considerably on insects and greenstuff picked up in the course of a day's foraging. But not every poultry breeder has enough open land at his disposal to allow free range for a flock of turkeys.

Making allowance for the foregoing, there is nothing to deter the average farmer from adding to his source of income by keeping a small flock, with the added advantage of ridding the farm of a large number of undesirable grubs and insects.

Breeding Age and Breeding. The hens begin to lay at around twelve months and continue for several years. A single mating fertilizes the batch of eggs. In-breeding should be avoided. For best results the gobblers (sometimes called Toms) should not be allowed to run with the hens. The hens are kept under observation and when they call for mating, introduced, one at a time, into the gobbler's run.

The eggs should be collected and carefully turned every day and preferably set under a broody hen (not more than half-a-dozen to one hen, as allowance must be made for the growth of the chicks). The time of incubation occupies 28 days. The turkey-hen can take twelve to fourteen eggs, but tends to be awkward with the chicks, hence the preference for hens as foster-mothers.

Rearing the Chicks. Strict attention should be paid to the feeding of the chicks, especially for the first few weeks. They should be taught at the earliest opportunity to feed from the commercial chick feed hoppers, and these, as well as drinking-water troughs, should be kept scrupulously clean.

Twenty-four hours after hatching the first feed should be given. This should be small in quantity, repeated at two-hour intervals for two or three days, and consists of hard-boiled yolk of egg, crumbled and dusted with a little black pepper. After this first stage, brown bread crumb very slightly moistened with newly-boiled milk may be added in gradually increasing quantity until at four weeks the egg ration can be discontinued and chick starting mash substituted.

At about three weeks the chicks should be induced to peck at little bunches of clean lettuce leaves or water-cress, hung up within easy reach. This feeding of green stuff should continue regularly until the chicks are old enough to fend for themselves. At the same time a small ration of ground fresh meat may be advantageously introduced into the chick mash when the chicks have reached four or five weeks.

At twelve weeks the chicks should be hardy and sufficiently developed to be self-supporting.

It is estimated that in the earlier stages of growth it takes $3\frac{1}{2}$ lb. of feed for every lb. increase of live-weight.

Control and Housing. While free-ranging by nature, the turkey likes comfortable night quarters, and, especially in the case of the younger

ones, every care should be taken to have the housing ample, warm, comfortable and free from cold-draughts and rain-blown wet. The birds prefer to roost high, and suitable ladders should be provided to allow easy access to the roosts. The perches should be of fair-sized roundwood to allow for a comfortable grip, and at all times everything should be in clean sanitary condition. A weekly dusting with agrocide or other disinfectant should be given.

Until they are eight weeks old the chicks should be confined to their own well enclosed and protected sleeping quarters.

Varieties. For weight and rapid development the American Mammoth Bronze is recommended. Chicks are usually available at the establishments of the day-old chick dealers. A young hen will scale 16 lb. to 18 lb. and an adult 18 lb. to 20 lb., and the gobblers anything between 25 lb. and 36 lb., as against the common cross-bred 10 lb.–12 lb. and 15 lb.–20 lb.

CHAPTER 50

Bees

'The pollination of agricultural crops is the greatest contribution of honey-bees to our national economy. While it is impossible to estimate the value of honey-bees for pollination, it is many times the total value of the crops of both honey and beeswax. Without the services of insects many crops would not set seed or produce fruits.'

The above was written of bees in the United States of America and shows the paramount importance that is attributed to them there.

In Jamaica the honey-bee has the same importance in the development of many of the crops that are grown. In this country, as in most developing agricultural countries, intensive and specialized agriculture is destroying many of the nesting sites of wild beneficial pollinating insects, increasing our dependence on the cultivated honey-bee.

There are many plants that have flowers that will set seed with their own pollen although they are of the normal insect-pollinating type and it is generally believed that insect pollinators are not necessary. These plants, however, will produce better fruit when insect pollination takes place.

There are, of course, many vegetables producing root or leaf crops where no seed-production is involved, but there are many orchard and vegetable crops that need the services of insects for their pollination. Of the orchard fruits the almond, avocado, mango and many varieties of citrus need bees for proper fruit formation. Of vegetables the cucumbers, melons, pumpkins, peppers, tomatoes and many others would produce most inadequate fruit without the pollinating insects.

In the United States of America, honey-bees are employed in the commercial production of many crops. Apiarists supply the bees to growers to pollinate crops and are paid for their services. The importance of honey-bees for pollination is just as great in Jamaica, although largely unrecognized. Every encouragement should be given to farmers to keep alive the industry of bee-farming, emphasising its twofold economic value.

(i) How to start beekeeping

First it is necessary to choose a suitable site, next to buy or make good hives and then to start each colony with a queen and her attendant workers obtained from a reliable source.

A suitable site for a few hives in a city back-yard is sheltered from wind and mid-day sun.

Care must be taken

(1) that there is sufficient nectar to satisfy the bees, and
(2) that the colonies are not in a position where they are a nuisance to neighbours.

To start a commercial apiary in the country, a suitable site is one which

(1) has a good supply of nectar and water nearby,
(2) has shelter from the sun and prevailing wind, having preferably a southern or eastern slope to allow for good air and water drainage,
(3) is of easy access to the beekeeper to save costs of labour and transport,
(4) is far enough away from public roadways to avoid being a nuisance to passers by.

The unwritten law of priority amongst beekeepers is respected, that is, apiaries of seventy-five hives are three to four miles apart.

The hives are set on stands about eighteen inches high to protect the bees from bull frogs. The stands are treated with a persistent insecticide, such as creosote, to protect them against termites. The hives are painted white. The paint protects them from decay, and the whiteness reflects the sun's rays, thus keeping inside temperature more tolerable for the bees.

To ensure ease of manipulation hives in Jamaica are standardized to the Langstroth pattern which is accepted here and in many other parts of the world.

The hive consists of a bottom board, an entrance piece, a hive body or brood chamber, a queen excluder, extracting supers and a hive cover. Within each section of the hive are hung frames, in each of which has been fixed a bees-wax comb foundation.

(ii) Working Equipment

For proper working with bees a bee-veil is desirable. This can be made from mosquito netting and dyed dark for better visibility. A bee-smoker is essential to provide smoke to quicken the bees. A hive tool is necessary to separate the different parts of the hive. A bee brush is useful to brush bees off the combs.

A white overall is valuable while working with bees, it is cool and reduces the number of stings that the worker among bees may get. If the beekeeper is going to extract his honey he will need an extractor, an uncapping pan, a strainer and an uncapping knife.

When one plans to start beekeeping, it is always useful to discuss it with a well-established beekeeper. Personal advice is more valuable to a beginner than all the many books which increase his knowledge and interest. Get your beekeeper friend to advise you on sites, where to get queens, how to install a colony and how to look after it. Advice can also be had from the bee inspectors employed by the Ministry of Agriculture and Lands. As the beekeeper grows in experience he will learn when to feed, when to take the honey, how to deal with pests and diseases and how to sell his honey to the best advantage. He will notice that there are times of heavy nectar flow when the bees amass honey at a great speed. At other times no flowers are blooming and the bees will need feeding with sugar until the next flow. If left to themselves, they will use for food the honey that they have just brought into the hive. If the beekeeper has removed too much honey, some of the bees will die of starvation before the next flow of nectar occurs. Then there will be too few bees to fill the combs for the next crop.

The process of swarming is always liable to happen. It is a completely natural occurence when the queen is getting old or when the colony is thriving well and needs to reproduce. Although it is natural it may leave the hive seriously depleted. The beekeeper must learn how to retrieve the swarm in case of necessity.

(iii) Pests and Diseases of Bees

In Jamaica, fortunately there are not many pests or diseases that trouble bees. Termites may eat away the wood of the hive, red ants and robbing bees sometimes kill the bees and rob the hive of its honey, and bull frogs eat the bees. Careful supervision of the apiary will prevent these losses. There is, however, another pest which sometimes seems uncontrollable, the wax moth, *Galleria melonella*. This usually makes its presence felt in weak colonies, when there is not a strong honey flow. It may also appear in stored combs.

The moth lays its eggs in the wax combs and the caterpillar that hatches out from them bores a tunnel through the comb, weaving a silken lining which gives the comb a most unhealthy appearance. The best agent for its control is the bee. Feed and strengthen the colony, if necessary re-queen it with a vigorous young queen, tidy up the hive so that there are not too many frames for the workers present and there is no loose refuse in the hive. The bees will do the rest. Burn or fumigate any infected combs that are lying about the apiary or the store. Paradichlorobenzene is very effective as a fumigant although it will not kill the eggs of the moth. Stored combs should be fumigated at intervals to prevent the build-up of the wax moth population.

American foul brood disease is a very infectious bacterial disease of the larvae in the brood chamber, in which after they have been covered in their cells they degenerate into a soft glutinous mass. The disease is trans-

mitted by bees brought in from infected apiaries, by robbing bees or casual migrants which are already infected coming into the hives, or by using infected honey or appliances. An outbreak of this disease in 1918 was the reason for the formation of the bee inspection service of the Jamaican Ministry of Agriculture and Lands. The disease broke out again in 1926, 1935 and 1943 but in each case it was promptly stamped out to the great relief of all beekeepers. Inspectors have been appointed to detect any outbreak of the disease in Jamaica, and strict quarantine laws are enforced to prevent its importation into the island. If American foul brood disease should be discovered it must be reported to the Government and no bees, honey or equipment removed from the infected colony. The inspector's treatment will be drastic, involving burning all diseased bees and combs and sterilizing the hives and implements, but the results amply repay the loss.

There are two or three other diseases that occur very occasionally in the brood chamber, but they are not nearly as dangerous or infectious as the American foul brood disease. They are often the result of poor conditions and lack of care. Proper care and cleanliness should bring the colonies back into good condition.

PART FIVE

CHAPTER 51

Weeds and Noxious Plants

We . . . know there is no substitute for good cultural practices, but the advantages of chemical weed control become apparent to more American farmers every year. We have now reached the point where more acres are sprayed for weed control than for the control of insects and diseases combined. Last year, this amounted to over 35,000,000 acres of farm land.

R. H. Beatty: 'Herbicides and the American Farmer,' *Proc. 4th Brit. Weed, Cont. Conf.*, 1960, p. 87.)

Introduction

A weed is a plant growing where it is not wanted. Agriculturally it is a plant which is harmful to a crop. It either interferes with the growth or contaminates it in one way or another.

The standard method of control has been, and to a large extent still is, simply to dig or cut them out with a machete or a hoe or to plough and cultivate them out. Until just over twenty years ago, that was the only method. If you did not weed your fields, your crops were smothered and killed.

It is practically within the last twenty years that weed control by means of chemical spraying has been developed. Before, there was a little weed control spraying in cereal crops using sulphuric acid. It was this discovery that some chemicals would run off the leaves of cereal but settle on the leaves of the broadleafed crops that started research into the whole idea of selective weed control. Different chemicals were used, which although less corrosive than the acid, still had this burning effect on the broadleafed weeds. Weed control was still confined to that in cereals, but as there were so many other crops that needed weed control, work began towards a completely different idea of a substance that would be chemically selective, killing weeds, but not the crop, always striving for the complete list of killers that could be used, one or more for each crop to deal with all the weeds therein. This, still, is virtually an impossibility, but since 1943, amazing progress has been made and in almost every crop there is an opportunity for the use of chemicals in the control of weeds.

The first results of this research are still sometimes called hormone weedkillers because they are absorbed by the plants and, acting in exactly the same way as a plant hormone does, affect the growth of the plant. Since the discovery of 2,4-D (2,4-dichlorophenoxyacetic acid) and MCPA (methylchlorophenoxyacetic acid) in 1943, research has increased beyond all expectation. Work has been done on both the hormone or systemic type of chemical and the contact types.

Both types have their place. Many crop plants are so sensitive, that no plant killing chemical can be sprayed on to them without killing them, so that it may be necessary to try some other device, such as spraying the field before the crop comes above ground. In any case, the crop must be sprayed when it is resistant and the weed when it is susceptible. It is particularly important when systemic weedkillers are used on soft weeds that the plants must be growing well for the chemical to be effective. A plant which, either because of drought, winter or any other reason, is not growing acts as though it is a dead plant. It will recover when conditions improve. Crops can be sprayed before they show above the ground or after. These are called pre- and post-emergent sprayings. The weeds can be sprayed before they have germinated, just as they are germinating or when they are well established. Each crop and weed problem must be considered apart.

Weed Control

From the weed control point of view, weeds can best be divided into three groups. There are the soft broadleafed weeds, the hard, woody types and the true grasses. Razor grass, nut or coco grass and water grass are not true grasses and behave like 'soft' broadleafed weeds. Weedkillers can be either 'burn-off' type or systemic, each type including some that have been used as total weedkillers. Special mention is made of some crops where more work has been done giving some information on methods used.

Chemical weed control is often a very simple job, but it has complications which must be known and avoided. The hormone type of weedkiller is valuable in its right place, but many of the most valuable broadleafed crops such as tobacco, okra, cabbage, tomatoes or lettuce are very susceptible to it and the least trace of it allowed to drift on these crops or the smallest fraction left in a spraying machine which is subsequently used for an insecticidal spray, may well kill the whole crop. For this reason, do not spray when a breeze is blowing and if possible do not use a machine used for weedkillers for any insecticidal spraying. Keep that machine for nothing but weedkilling.

As with insects or with diseases, more often than not it is essential to spray before the weed problem is apparent to prevent its appearance. The farmer must know his problem and be prepared for it.

The descriptions and illustrations of weeds that follow will help a farmer towards identification of his problems. They are, though, only a small proportion of plants that can be classed as weeds. It will probably be possible to fit any weed into a class with one or other of these, and guess the probable treatment. For more detailed study there is unfortunately no book on Jamaica weeds, but there is a very good book written in Spanish published by Editorial Universitaria, Rio Piedras, Puerto Rico for about twenty-five shillings. This is *Plantas indeseables en los cultivos tropicales* by Velez and Van Overbeek. Most of the Puerto Rican weeds are identical with the Jamaican ones, and the book is extremely well illustrated. If a farmer needs further help in weed identification, he should get in touch with the Science Museum of the Institute of Jamaica. The Botanist there will be willing to identify any specimens of the plants. When bringing or sending specimens, the whole plant, including flowers and fruit, should be sent, if possible.

Weed Identification

(*a*) Most of the **soft broad-leafed types** are killed by weedkillers such as 2,4-D. The shallower rooted weeds and very young seedlings can be killed by contact weedkillers, as when their leafy parts are killed there is very little whereon they can survive. The great advantage of the systemic weedkillers is that, having entered the system of the plants they penetrate down into the roots and so kill the whole plant.

Some mention should be made of the different formulations in which 2,4-D is prepared. They are grouped as the sodium salt, an amine salt, high and low volatile esters. The sodium salt and the amine are water-soluble and non-volatile and therefore to be preferred in some respects. Dosages however have to be a good deal higher than the esters. Two pounds of the amine, and two and a half to three pounds of the sodium salt compare with one and a half pounds of the low volatile ester as being necessary for weed control on an acre. In addition, being soluble they are easily washed off the plant by rain. They are cheaper by the gallon than the esters, but as more is needed for the spray this cheapness is lost. The esters are in emulsion form and so are not so readily leached off the plants and are therefore more valuable in the wetter climate general in Jamaica. The high volatile esters have been preferred for their economy, but the risk of drift of vapours from the spray for some days after its application is so great that its use is not now recommended. The low volatile esters have no drift risk and are coming to be the most popular formulation in spite of slightly higher cost.

Mallow (*Urena lobata*) with its showy bright pink flowers is usually only a weed in neglected pastures.

Marigold (*Wedelia trilobata*), a yellow composite flower may become a

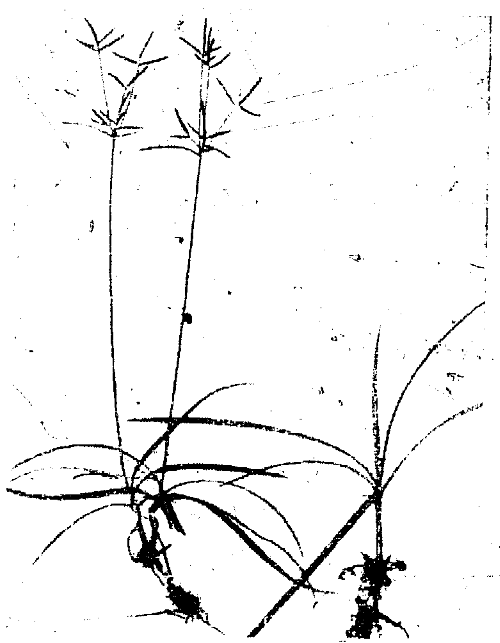
Mallow

Marigold

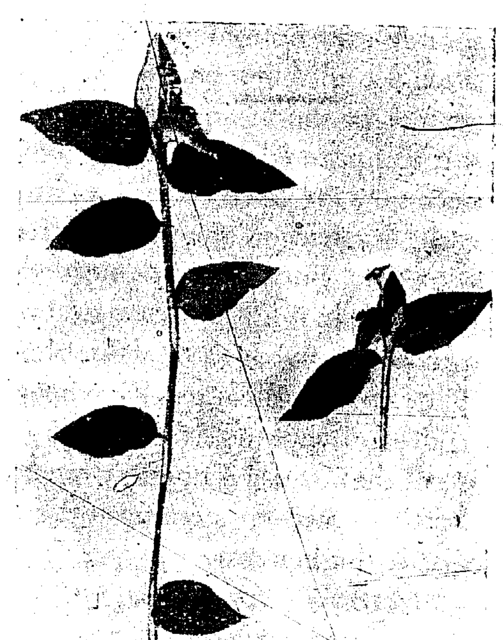
weed on wet, poorly drained soils, where its stems spread across and smother other plants.

Nut Grass (*Cyperus rotundus*) is not a true grass, but a sedge. It can become a very important weed in lawns, where careful use of 2,4-D can be fairly successful in its control.

Water Grass (*Commelina* species) is again not a grass at all, but a broadleafed creeping plant.



Nut Grass



Water Grass

Spanish Needle

Broomweed

Spanish Needle (*Bidens pilosa* and related species) is another composite flowered weed with needle-like seeds with barbed ends which attach themselves irritatingly to clothing and animal fur.

Broomweed (*Sida carpinifolia* and related species) is a fairly woody plant which can sometimes be controlled by spraying with 2,4-D. Normally it is fairly easily controlled by cutting it out when young, but if it is well established and cut in pastures it may need treatment with a brush killer.

Hogmeat or Wild Potato

Cow-itch

Hogmeat, Wild potato or **Morning Glory** (*Ipomea tiliacea* and related species) are perennials with large underground tubers.

Cow-itch (*Mucuna pruriens*) is a pea-like vine whose pods have stinging hairs with possibly the worst sting of any plant hairs in Jamaica.

Wild Onion (*Allium* sp.) is not widespread but where it occurs in pastures (chiefly in the Port Royal and Blue Mountains) it needs to be controlled, as when eaten by cows it gives a bad taste to their milk.

Burr-weed (*Triumfetta semitriloba*) is chiefly a weed in that its seeds are barbed and attach themselves to fur and clothing.

Wild Onion

Burr-weed

Love bush or **dodder** (*Cuscuta* spp. and *Cassythia* spp.) is particularly difficult to control as it is a broadleafed type of plant growing parasitically on broadleafed shrubs and hedges. A chemical method has been used successfully but it involves considerable risk to the hedge. The best method still is meticulous cutting out and burning of every small piece of the parasite, not forgetting the roots within the stem of the hedge plant.

(*b*) The **woody or shrubby weeds** may be small and tough like the shame plant or they may be trees like logwood and the cassia. They all have a woody stem which helps to make them more resistant to the 2,4-D type of weedkiller. 2,4-D very often distorts their growth and a broadleafed crop like citrus will suffer badly, but it will not be killed by the killer and will in due course recover completely. To control these tougher plants research continued on the lines of the systemic chemicals. 2,4,5-Trichlorophenoxyacetic acid was tried and was found to be as systemic as 2,4-D, but much stronger in its effect and capable of killing quite large trees even during their dormant stages, while still being safe to use among grasses.

Love-bush or Dodder

For greater economy and to help kill the softer weeds as well, 2,4-D and 2,4,5-T are mixed to make what is called a brushkiller. There are several inorganic chemicals often used as total weedkillers which can also be used in control of woody plants, but the systemic killers have so many advantages that these others have no place on a farm.

Guinea-hen Weed (*Petiveria alliacea*) has tough wiry stems and sharp pronged seeds. If its leaves are eaten by cows their milk has a foul taste. This usually is too tough for 2,4-D and would need 2,4,5-T.

Guinea-hen Weed

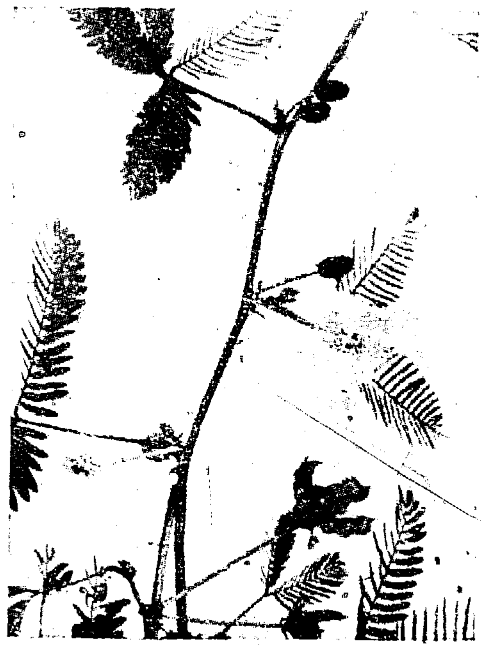
Devil's Horsewhip

Devil's Horsewhip (*Achyranthes indica*) has sharp spined fruits and **Macca Kalalu** (*Amaranthus spinosus*) has sharp spines at the bases of the leaves which make it a pest both to cultivator and stock.

Wild hops or **Jamaica Hops** (*Flemingia strobilifera*) is a fast growing leguminous shrub that is particularly abundant in moister districts. This is easily controlled by spot-spraying.

Shame-bush, Shamer or **Sensitive plant** (*Mimosa pudica*) so called because of the rapid folding of the leaves when touched, has very sharp spines and a very spreading habit making it very difficult to eliminate mechanically. **Guava** (*Psidium guavaja*), **wild coffee** (*Cassia occidentalis*), **cockspur** (*Pisonia oculata*), **logwood** (*Haematoxylon campechianum*), and **cashaw** (*Prosopis juliflora*), are all trees that will rapidly make an area ruinate by the germination of their seeds and quick growth.

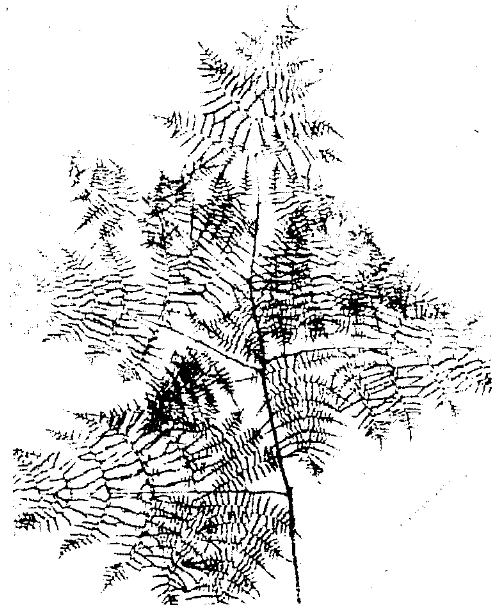
Wild Hops



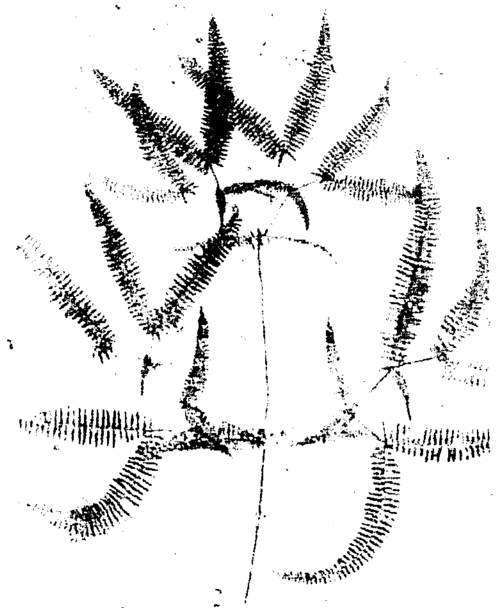
Shame-bush

Bracken (*Pteridium caudatum*), **Boston fern** (*Nephrolepsis bostoniensis*) and **Net-fern** or **Ferril** (*Gleichenia* spp.) are soft in their above ground parts, but have a perennial rhizome that is very difficult to eliminate. Dalapon used more than once will help in their destruction.

Nightshade (*Echites lutea*) is particularly important as a pasture weed in that it is very poisonous to cattle. Whether it is removed by digging or by the use of brushkillers the dead leaves are attractive to animals and still poisonous. The plants should be burned or buried before cattle have a chance to eat them.



Bracken

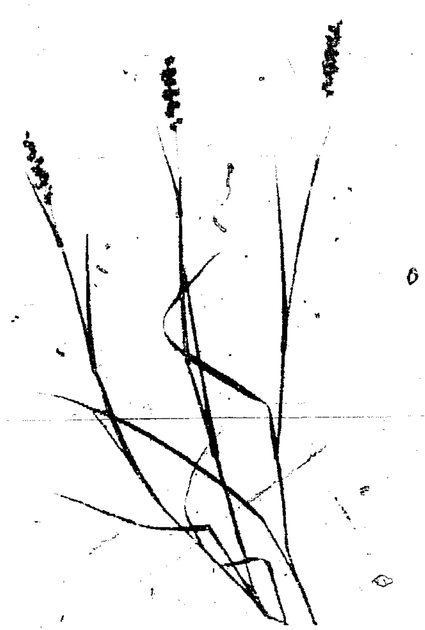


'Bracken' or Net-fern

God-bush and **Scorn-the-earth** (species of *Oryctanthus*, *Dendrophthora*, *Phoradendron* and *Phthirusa*) are tough woody parasites of tree crops such as citrus, cocoa and coffee that cannot be controlled by the use of weedkillers, as if the weedkiller is strong enough it would kill the host plant as well. Cutting out is the farmer's only option.

God-bush or Scorn-the-earth

Bahama Grass



Burr-grass

(*c*) The **grasses** belong to a different section of the plant kingdom. They are resistant to the first developed systemic killers, which is valuable when one is concerned with weed control in cereals. Too often, however, grasses can be a most important pest, both in cereal crops and in broad-leafed crops. Research has been intensive in the search for a selective killer that selects the grasses to kill them, preferring if possible to find a systemic

Razor-grass

one, as so many of the grasses have such well developed root systems. Several chemicals have been used with success on grass seedlings, but it was not until the discovery of dalapon that the nearest approach to the selective systemic killer of grasses was found. The sodium salt of the acid is always used and all grasses are susceptible to it, although some are resistant to lower doses. Most broadleafed plants are resistant to it, but care is advisable for there may be some leaf scorching.

Piano grass (*Themeda arguens*) is fairly resistant. Sodium trichlor-acetate can be used with fair success.

Bamboo (*Bambusa vulgaris*) is very strong, but if it is cut back and sprayed with twenty-five pounds of the dalapon powder in a hundred gallons of water when it is sprouting again, it is killed completely.

(*d*) **General ('total') weedkillers** have been in demand for the complete clearance of industrial sites and railway lines and as such have only limited application within a farm, although there may be a need for clearance round farm buildings wherein they can be useful. Of much greater importance is the fact that some of these chemicals used at lower dosages are selective. The earlier chemicals were inorganic ones like sodium chlorate, which is very soluble and can be damaging if the solution washes on to plants that are wanted. Borates have also been used very successfully, but recently organic chemicals such as simazine, munuron and compounds resembling them have been developed. Many of these are very much less soluble, so that they stay in the position in which they have been sprayed and have a very long residual action.

These are particularly valuable for this persistence. While the crop roots are growing steadily deeper and deeper into the soil, the top layer of the soil containing the weedkiller kills off seedlings of weeds for weeks after the application.

Weed Control in Specific Crops

Sugar Cane covers the largest field area of any single crop in Jamaica and is the crop which has been more mechanized than any other. Although much is grown on small farms and on steep hillsides, there are very large estates where sugar is grown in hundreds or thousands of acres and cultivation, fertilization, variety selection and the like are the subject of acute scientific and economic study within each farm unit. In the old days, (and on small farms still), all weed control was done by hand or by simple mechanical methods. During the last few years economic pressure has made chemical weed control a most important factor in cane farming. Cleaner fields are becoming normal and the savings in cost are very marked.

Climatic conditions vary considerably throughout the island, from the dry plains in South Clarendon, where irrigation is used, to the moist cane-growing areas of Westmoreland. Differences in growing conditions make any routine worked out for one area inapplicable in another. For weed control some farmers still need to use high volume sprayers while others have been able to develop low volume tactics.

Where growing conditions are good, a pre-emergent spray with 2,4-D at a rate of one to two pounds acid equivalent per acre is used. This is valuable in controlling seedlings as they germinate, affecting both grasses and broadleafed weeds. This is followed by one or two post-crop-emergent, but still pre-weed-emergent sprays with 2,4-D at about three weeks intervals. In the irrigated areas this would follow the disturbance of the soil with irrigation. These would affect survivors of the first spray but kill completely any fresh germinating weeds. By this time the crop has grown strong enough to grow over the gaps, preventing growth of weeds. This is probably the cheapest and most complete weedkiller technique in its action, but may not be applicable in all areas.

Another method for the same control has been recommended so as to reduce the number of times that the fields are sprayed. Simazine and monuron are very effective, long-lasting general weedkillers and cane is resistant to them. Economically, they are more expensive and their persistence may be spoilt by dry weather at the time of application or by the human chances in the application. Practically, as they are used as suspensions, there may also be nozzle blockages. PCP has been used as a pre-crop-post-weed-emergent spray, but its burning effects may be poor if the weeds are too well developed. Dalapon may be necessary if seedling grasses have appeared before the cane shoots have come above ground. Five pounds of the wettable powder are used per acre, and care is taken that any cane visible is not sprayed. Dalapon and 2,4-D can be used in a general weed control spray of the canals and ditches. Seven to nine pounds of the dalapon wettable powder and one to two pounds of the 2,4-D will give good control of most weeds.

As PCP may also cause dermatitis of the operator, the farmer should be quite certain of its value before including it in his programme.

Bananas. Until recently, chemicals have been avoided in weed control in bananas as the hormone types of killer can cause serious damage to the plants. It has been the custom to weed right through each plantation every two months, using a machete and, in the opinion of some growers, causing a great deal of damage to the pseudostems and the young suckers.

The chief weeds that cause damage in bananas are the grasses. A ground cover is desirable but the grass roots take so much food out of the soil, that their destruction is of major importance to the farmer. If the grasses can be killed and the more obnoxious broadleafed weeds cut out leaving such light feeders as the watergrass covering the ground, that is all that the farmer needs. With many farmers the use of dalapon has gone

beyond the experimental stage. They get adequate control of the grasses with two sprays with dalapon using up to six pounds of the wettable powder per acre. Further work needs to be done before this can be suggested as a general recommendation, but there is obviously promise in the use of dalapon.

Citrus. A ground cover is valuable in a citrus grove, to keep the soil moist and to help prevent erosion, but grasses can drain a great deal of the food from the soil. In the case of nurseries, they can almost smother the young plants. Dalapon wettable powder has been used at strengths of from four to six pounds per acre with considerable success. Care should be taken to avoid too much of the spray falling on the citrus as the young plants particularly are rather susceptible.

Grassland. The most important crop and the one least cared-for is grass. Apart from poor varieties, no fertilization and little grazing care, which ~~are all very important~~, weeds may easily reduce the value of a field to almost nothing. Trees may spread their seedlings and suckers across the field and reduce it to useless ruinate. In moist areas ferns spread their underground stem systems through acres and acres and their leaves across all growing things above. Even weak annual plants like mallow and marigold set generation after generation of seedlings across fields and the grazing becomes negligible.

Cultural methods help a good deal in keeping weed numbers low, but too often the manual labour costs of the clean up are so high that the fields are left to grow to a useless mass of weed. Chemical control becomes necessary. There are different problems in different types of country, depending on the weed dominance, but as the crop is a grass, there is a fairly wide range of chemicals that could be used with complete safety for the crop.

Woody shrubs and trees can best be killed by using brushkillers, which are usually a mixture of equal parts of 2,4-D and 2,4,5-T. Younger trees and shrubs can be killed by a drenching spray of all leaves and branches with an emulsion of three to four pounds acid equivalent of the mixture in a hundred gallons of water. This should preferably be sprayed when the trees are growing well for better absorption of the chemical. The spray is effective against bigger trees, but as they are much tougher they may need treatment with an oil solution of the brushkiller. Twenty-four pounds acid equivalent of the mixture with ninety-four gallons of diesel oil, fuel oil or kerosene can be used as a drenching spray round the basal part of the trunks up to about a foot high from the ground. This can be done at any time of the year, but the trees should not be cut down within a year of the application. This solution can also be used on cut stumps, preferably soon after cutting. Very large trees may be beyond the scope of these treatments and are best treated by cutting a frill of axe cuts round the base of the tree and treating the injured area with the brushkiller at half the above concentration in oil.

Ferns are mainly a pest in the wetter areas of the Island, such as Portland and St. Ann, where some fields are completely covered with them. Their fronds are weak and short-lived, giving one the impression that 2,4-D would be able to control them. Unfortunately, although it may kill the fronds above ground, it is not strong enough to deal with the rhizome underground. Even if it does kill some of the older rhizome, it cannot get into it and then get back up into the growing point and affect the fronds that are growing rapidly but are as yet still below ground. Some success has been obtained in other countries using 2,4,5-T, triazines and dalapon. There have been commercial recommendations that dalapon can be used at a strength of twelve pounds in forty gallons, but only partial control is achieved. Work is continuing on the control of this weed and is very necessary before making any official recommendations. Until that time, the best method that can be suggested is that the farmer should cut and cut again until the plant is so weak that it dies.

For softer but still woody shrubs like Broomweed, Guinea-hen Weed and Devil's Horsewhip, 2,4-D at a rate of one to one and a half pounds acid equivalent with one gallon of oil emulsified in water to cover an acre is satisfactory.

For all soft weeds like marigold, mallow, Spanish Needle and water-grass control is fairly simple. Spray with 2,4-D at a rate of a pound to a pound and a half to the acre. In all of this spraying care should be taken to spray when the plants are growing well and have plenty of leaf surface to receive the chemical. If the growth is too heavy and it has been necessary to cut the grass it should be left for a week or so to allow the grass to heal and the weeds to grow fresh leaves, and do not cut immediately afterwards or you will remove all the chemical before it has reached the roots.

For the proper clearance of a grass field it may be necessary to spray it twice with one or other of these chemicals, but thereafter good maintenance and controlled grazing with occasional spot spraying should keep the grass in good condition.

Strawberries. Little has been done with the control of weeds in strawberries in Jamaica as yet, but experience in many other countries where they are grown in large areas has shown that 2,4-dichlorophenoxyacetic ethyl sulphonate (2,4-DES) will give a significant reduction in the weeds without any bad effect on the strawberry plants. This is best used pre-emergent to the weeds, starting about ten days after the planting out of the strawberries and following at intervals when the weeds start germinating again.

Rice. Rice has two weed problems, the most important being the growth of other grasses such as rice grass etc. As, of course a grass-killer cannot be

sprayed over a rice field, tricks have to be played to get the true grasses above ground before the rice is planted. One suggestion is that the fields should be irrigated and then allowed to dry, so as to encourage the growth of the grasses. When they are well-developed use seven pounds of the wettable powder of dalapon in forty gallons of water per acre. Within two weeks the grasses should be dead and the rice can be sown or planted as the chemical will have disintegrated by then.

When the rice is well-established and is six inches high or more, broad-leafed weeds can be dealt with by spraying with a 2,4-D amine spray at a dosage of two to three pounds active ingredient per acre. This will control most of the broadleafed weeds, particularly if they are young. If there is a strong regrowth, it may be necessary to spray a second time, but with good pre-cultivation this should not be needed.

Cacao and Coffee. Generally these trees are so interplanted with bananas, vegetables, and other plants that any chemical weed control is impossible. Where pure stands of trees are found and weeds have become a problem, it is possible to use both dalapon and 2,4-D amine preparations for control of grasses and broadleafed weeds. They should not be used in the nurseries and care must be taken not to spray either chemical on the leaves and young branches of the trees.

CHAPTER 52

Pests and Diseases and their Control

To produce good crops on a farm or in a garden, it is necessary to know the various pests, diseases and weeds that affect the plants and how to control them.

What is a pest or disease? What is a weed? Insects and diseases are with us all the time, but they are no trouble until they become numerous enough to affect the quantity or quality of our crops and gardens. The same applies to weeds. A plant is not a weed until it becomes either too numerous or offensive in one way or another in a farm or garden crop. Generally speaking, it is a question of numbers that is the problem. To eliminate completely any insect or disease or weed is impossible. To control any of them means to reduce the population of the offensive organism to a level where it does not have a sufficient economic effect on the crop or garden.

To deal with weeds, as has been seen in Chapter 51, details have to be known of the root system, leaf structure etc., so that the undesirable plant may be killed in amongst a plantation of desirable plants. Treatment must be done at a time when the weed is at its most susceptible state and when the crop is resistant.

Insect Pest Control

To deal with insect pests, it is necessary to know what they look like and also to know something of their life history. On the ability of the farmer to identify the various pests, diseases and weeds and to know what methods to use against them depends a great deal on his success in obtaining good and profitable crops. Armed with that knowledge, the farmer will be better able to know the vulnerable spot against which his preventive measures should be applied.

Most insects during their lifetime pass through four well-marked and different stages:

(1) the egg,
(2) the larva (caterpillar, worm, maggot, grub, etc.),
(3) the pupa or resting stage,
(4) the adult stage.

There is, however, a considerable number of insects, such as the grasshoppers and the bugs, that do not have a resting stage. Their young usually resemble the adult, but are wingless and are called nymphs.

The mites will also be included in this chapter. They are not insects but are 'spiders' with four pairs of legs, having sucking mouth parts. They live on leaves or fruit and can best be linked with the sucking group of insects. There are also some mites that eat other mites, and therefore are beneficial animals.

Insects that become plant pests can be put into two groups—the biting insects and the sucking insects. The biting insects bite off plant tissue and swallow it. They may eat any part of the plant—fruit, flower, leaf, stem or root. The sucking insects may attack any part, but their mouth parts are so shaped that they pierce the skin of the plant and suck out the juices from within. These different feeding methods make a considerable difference in the habits of the insects, which often is important in considering methods of control and what spray chemicals to use.

There are many chemicals which will kill the biting insects by poisoning their food and yet not have any effect on sucking insects. There is one group of insecticides, the systemic insecticides, whose main use is to poison the sap of the plants. Apart from other insecticidal effects that some of these may have this type of chemical can only be used effectively against sucking insects.

When any insect is discovered as a pest, it is usually after it has done a great deal of damage, and indeed after a considerable part of the crop has been lost to its attack. It is not always possible to foresee these attacks, but in many cases, the farmer should know of the possibility of an attack and should be prepared beforehand. He must know something of the life of the insect, its food preferences, whether it also lives on some other crop nearby, whether there are any insects that feed on it, either as parasite or predator. Usually, if the pest has reached the acute stage, the only thing that can be done is to safeguard the remainder of the crop and at that stage the method has to be chemical. Those concerned with the organization of plant protection have to consider that method as the last to be used. Some more natural method must be used if it is possible.

Maximum care must be taken of any beneficial insects that are native. It may also be possible to import some from other countries that will add to the effect of the native population. These insects we call beneficial and regard as our friends. They are the parasites and predators, the insects that eat other insects, particularly those we class as pests. The best known predatory insect is probably the ladybird beetle which throughout its larval and adult life eats aphids, scales and such like insects. Also in this group are the praying mantis, ground beetles, assassin bugs, lace-wing flies and the larvae of some hover flies. Various wasps are also predatory, feeding their larvae with insects. There are a number of species of mite that eat other mites and have no interest in plant tissues. These are all predatory animals. The parasitic insects are all small wasps or flies. They lay their eggs on or in the insect of their choice, and the larvae usually live within the body of their host, coming out to turn into pupae.

Some method of crop rotation or weeding may be all that is needed to bring the insect population down to an economically unimportant level.

It may be possible to introduce a variety of the plant that is resistant to the pest for some reason or other.

It may be possible on smaller fields to control such large insects as the hornworms by hand collection but in larger fields this becomes wearisome and most uneconomic.

There are a number of plant lice, mealy bugs and scales that are dependent on ants for their cleanliness and well-being. In these cases control of ants may be all that is needed.

Most insects have fungal, bacterial or virus diseases, which may completely knock out a pest infestation within a very short time, and these may make artificial control unnecessary.

These are some of the factors that come into the whole question of plant protection against insects and they must all be considered before chemicals are applied.

When a chemical is used for the control of any insect, it almost always is not specific. It will kill the aphid or the mealy bug perfectly, but it will also kill hosts of other insects including parasites and predators of the aphid and mealy bug and of other insects, some of which may not yet be economically important enough to be classed as pests. There are numerous examples of insects or mites that have become pests after spraying has been done without sufficient knowledge of the effects the chemicals used might have on the total insect population. These are always quoted by the protagonists of biological control of insects.

These people almost always refer to the 'balance of nature' being disturbed by the act of spraying. Yet all agriculture is automatically a process of disturbing the so-called balance of nature. All crops are grown in fields, so as to achieve economic methods of growing, fertilizing, harvesting etc. It is this initial disturbance that is often the cause of some insect or disease developing into a harmful agent on the hoped for crop, so that artificial control may become essential.

Types of Insects that have become Pests

Biting insects include the 'worms' of one sort or another, the locust, cricket family and the beetles. These all have jaws which bite off part of the living tissue of the plant for their food. Ants are also biting animals,

but their status as a pest usually depends on their social habit of using the sucking animals as a source of nutriment.

Most of the insects called worms are the larvae of moths and butterflies—their caterpillars. They are variously called cutworms, loopers, hornworms, ear worms, fruitworms, army worms etc. according to their different mode of life.

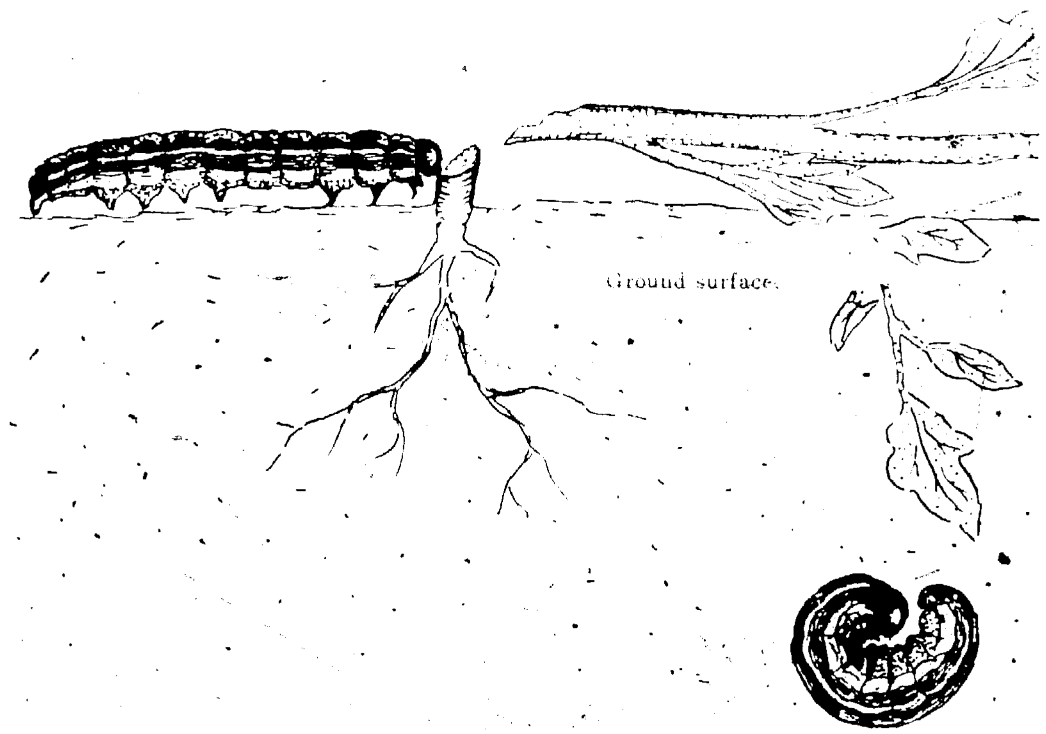


Fig. 1. Cutworms

Cutworms are night-feeding caterpillars which eat the stalks and younger leaves of young plants. They spend the day-time in the soil and the sole evidence of their presence is the death or serious damage of the plants.

Looper worm is the name applied to a caterpillar which moves by stretching out its body to the front, then bringing the hinder part up in a loop to a point just behind the front legs. These are leaf-feeders on many different types of plant.

Hornworms are usually large caterpillars, distinguished by having a horn or tail and diagonal stripes on its sides. When mature these become large hawk moths or humming bird moths which fly about at dusk.

Ear worms are so-called because they eat the ears of corn, they are called fruit worms when they eat the fruit of tomatoes etc. The same insect becomes a cotton boll worm when it attacks the boll of the cotton.

Various worms receive the name of **army worm,** when they appear in large numbers and by reason of this have to move in a swarm from one field to another. They may easily be as devastating to a crop as the locust.

Leaf rollers is the name given to small caterpillars which roll up a leaf, binding it with silk to make a temporary home.

Leaf miners are insects the larvae of which spend their life between the upper and lower surfaces of a leaf. They are moths or two-winged flies, which lay their eggs on the surface of the leaf and whose new born larva immediately burrows into the leaf. Sometimes the larva leaves its burrow to form its pupa, sometimes it pupates within the leaf.

The locust family includes the grasshoppers and the crickets, which as nymphs or adult are biting insects. They have powerful hind legs, by which they jump, their wing cases are leathery and in many cases the males chirrup extremely loudly.

The beetles, as larva or adult have biting jaws. The adults have hard wing cases. The larvae are usually very soft-bodied, with thoracic legs well developed but no abdominal legs, but there are many living either in the soil or within the substance of plants that have almost lost the use of their legs. The less mobile larvae usually look like fat commas with a hard head at the point, the active ones, like the ladybird larva or the tortoise beetle grub, can be very active in their search for food.

White worms are the grubs of beetles such as the May beetle, which live in the ground, feeding on roots.

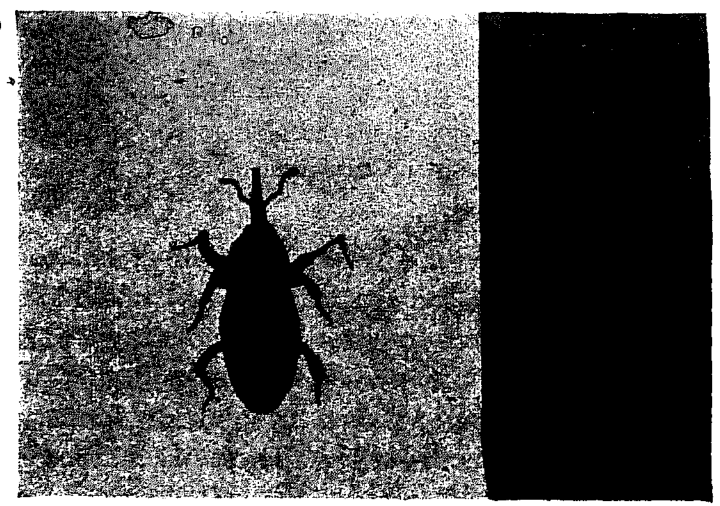


Fig. 2. The Banana Borer Weevil (*Cosmopolites sordidus*)

Weevils are beetles that have a snout in front of their eyes. Their larvae are legless, often living within a stem or root.

Flea beetles are small, shiny beetles with well developed hind legs that hop rather like a flea. As larva or adult, their food is leaves, usually of young plants.

Sucking (or strictly, piercing-sucking) insects as far as plant pests are concerned are principally the so-called bugs, the aphids or plant lice, scales, mealy bugs, white fly, stink bugs, lacewing bugs, leafhoppers,

chinch bugs, cotton stainers etc. The mosquitoes, bedbugs, etc. are also sucking insects, but are not related to plant problems. In a sense of course, the moths, and butterflies are sucking insects, although they do not pierce the plant and as far as their plant visits for their own food are concerned, they are beneficial insects in that they are often valuable pollinators. The other small order of insects that is important as a group of sucking insects is that of the **thrips**. The **aphids** or plant lice are small, fat, usually wingless female bugs that concentrate on sucking plant juices and bringing forth their young alive. Occasionally there are winged females and males that assist in the movement and reproduction of the species. The wingless forms are usually found in dense groups distorting the shape of the plant with their much feeding, excreting 'honeydew' which either acts as a food for ants, or settles on leaves, making them at first shiny and thereafter black with the so-called sooty mould.

White-fly are also minute insects. They include anomalously the Jamaican blackfly. These concentrate on their feeding to the extent that the nymphs become fixed to the leaves by their proboscis or beak and become a scale under the cast skins of their earlier stages.

Mealy bugs are slightly mobile and flattish in shape and are covered with a mealy secretion which gives them their name. The **scales** have taken the formation of a scale to its extreme, so that all the life of the scale after its first movement is lived within a fixed scale formed from its earlier skins.

The leafhoppers and the chinch bugs are fairly small active insects, with wings folded about their abdomen, not usually much more than a quarter of an inch long. The other bugs all have their wings flat on their backs, with the front pair overlapping. The stink bugs or shield bugs are often more than half an inch long, flat and brightly coloured. The lace-wing bugs are usually much smaller, their wing cases having the veins etched in relief. The stainer bugs are usually about half an inch long with red and black patterns on their wings.

Thrips is an entirely different kind of insect, never as much as an eighth of an inch long. Its wings, when seen under magnification are shaped like a feather.

Some sucking insects become far more important as pests in that they carry virus diseases from one plant to another. The damage they do by their feeding is often completely negligible, but the disease may kill the crop. These insects are called **vectors** of the disease and their control or elimination is a vital factor in the survival of the crop.

Plant Diseases

Plant diseases in Jamaica are due mainly to fungi but to a lesser extent viruses and bacteria also attack any part of the plant. For example, fusarium wilt of tomatoes enters via the roots, late blight of potatoes attacks the leaves and also rots the tubers, corn smut attacks the cob producing black boils filled with fungal spores. However, it is only rarely that plant diseases can be controlled by spraying once the plant is affected, since the disease organism is usually inside the plant tissue; exceptions to this include the powdery mildews (e.g. cucumber mildew) which grow on the leaf surface. Spraying in the case of plant disease is therefore preventative and must be carried out before the appearance of the disease so as to cover the plant surface with chemical to kill the fungus before it can enter the plant. It follows that it is preferable whenever possible to avoid the onset of disease. Many diseases are carried on or in planting material, so every effort must be made to ensure that planting material imported is free from disease and accompanied by a phytosanitary certificate from the country of origin, and any local planting material is from the best, healthy plants. If possible, in the early stages of an outbreak, remove and destroy diseased plants to prevent further spread of the disease.

Forms in which Disease may Occur

In general, plant diseases affect specific parts of the plant, producing characteristic forms which give each disease its name. These include the following.

Damping off applies typically to the death of seedlings from fungal attack on the roots and base of the stem.

Wilting describes the quailing, yellowing and drying out of the leaves and stem. Usually this is due to the presence of a parasite inside the stem and producing poisonous substances e.g. Panama Disease of Banana. In other cases it may be due to a root or collar rot, or the presence of eel-worms in the roots. On the other hand it may simply be due to lack of water and in this case if the plant is cut open there will be no discoloured area inside as there would be if a disease were present.

Die-back. Young twigs and branches die-back from the tip either from fungal or insect attack or poor soil conditions.

Canker is an open exuding wound on woody stems, e.g: Gummosis of citrus.

Spot. Many fungi attack the leaves and other young parts of the plant producing spots of varying shape, size and colour. Banana Leaf Spot is probably the best known.

Blight. In wet weather some fungi may kill off all the leaves and also affect the stems, e.g. Late Blight of Potatoes.

Mildew. The common powdery white growth on the leaves of pumpkins is an example of this disease.

Mould is used to describe the dirty growth of fungus on the leaf e.g.

Tomato leaf mould or the common 'Sooty Mould' on the upper leaf surface of citrus.

Rust is an open spot usually covered with a dusty mass of brightly coloured spores, e.g. Pimento Rust.

Mosaic. An irregular pattern of light and dark coloured areas on the leaves and sometimes fruit often accompanied by stunting and off shaped leaves are characteristic of this type of disease usually caused by a virus, e.g. Tobacco Mosaic.

Chlorosis, or the presence of yellowish areas on otherwise normal leaves is often a sign of poor soil conditions or cultivation.

Scab is a raised corky spot on the young growth of plants, e.g. Citrus scab.

Rot. Injuries on ripening fruit are often invaded by fungi which produce a rot and may destroy the entire fruit.

Chemical Control

It should always be remembered when considering the use of pesticides that our object is to kill one living thing (the insect or fungus) on another living thing (the crop plant). It is easy enough to kill both, but some chemical must be found that is selective and kills only the pest. If possible an insecticide must be found which will not kill the parasites and predators, and the spraying must be done at a time when bees are not feeding on the crop or nearby weeds. Generally speaking, insecticides are just as harmful to the good insects as to the bad ones.

Also, one must be found that will not kill either the operator or the person who eats the crop after it has been harvested. It will sometimes be necessary to use chemicals that are dangerous to the spray operator, and on occasions there may be a residue of the chemical in or on the plant which might be harmful to the consumer. As far as it is practicable, in this chapter only the less poisonous chemicals will be recommended, so that there should be little danger for the operator and none for the consumer. On containers of the newer insecticides and fungicides there is always printed information as to the risks to human beings in the use of that chemical and of any precautions that need to be taken.

The farmer should know some details of his spray chemicals, appreciate their method of action, respect them for their variously poisonous nature and learn to use the best in each particular case.

He must know the right time to spray. For fungi, weeds or insects there is a right time and a time when spraying would be useless. For insect control it is of little use spraying when there are more eggs and pupae than larvae. Even attempting to kill off the adult may be useless. Many may escape or may lay enough eggs to start the next generation off before they die. Money may be thrown away by spraying at the wrong time.

Agricultural chemical manufacturers know only too well the complaint 'Your chemical doesn't work', when the fault is simply bad timing of the spray.

Faults are also often attributed to the chemical where inefficient spraying is the true cause. A contact spray on the top of the leaf will have no effect on insects on the underside or on leaves not sprayed. The farmer must know where the insect is, when to spray, what kind of chemical should be used. For this reason information is given on the life history and habits of the insects to help prevent this waste, and details of the type of chemical to be used in each case.

He must also know whether there will be any drift on to another crop, on to drinking water, fish ponds, bee hives, etc. When the droplets are large they tend to fall quickly, so that there is little risk of drift, but with low volume sprayers and particularly with aircraft machines there is considerable risk that the spray mist may drift miles before it finally settles. An insecticide may be valuable on one crop, but may be harmful to another or it may kill bees, stock or fish. A weed-killer may work wonders on a cereal, but may lay waste acres of crops like cabbages or cotton.

Some insects that have had repeated sprayings with a single insecticide have developed a resistance to that chemical. This has happened quite frequently since the introduction of the newer synthetic insecticides. Many insects through selection of that undesirable characteristic, resistance to DDT (or dieldrin or parathion, etc.) have increased their survival rate to such an extent that the spraying of that chemical has virtually no effect on the population. In 1908 the San Jose scale was reported as having a race that was resistant to lime sulphur, which was previously the officially recommended spray. Since then the codling moth has developed resistant races to arsenic; diamondback moth, cabbage white butterfly, tomato hornworm, cotton bollworm and boll weevil, and Colorado beetle among many others have developed resistant races to DDT and/or other insecticidal chemicals. As would be expected, it is always the worse pests that have the most spraying and therefore develop the resistant race, at times depressing one to the feeling that Nature has beaten us. Chemists have had to work hard to find other chemicals in the effort to win, and so far they have managed to keep one step ahead. It is still necessary to be ready for further changes in the insect make up.

Fortunately in Jamaica, in the great variety of crops, there are very few farm pests that have developed any resistance to these chemicals, so that the number of chemicals can be kept small, and newer ones will only find their way on to the market if they prove a markedly improved control of a particular pest.

The following list gives some information about some of the old standard sprays and some of the more generally applicable modern

pesticides. Fortunately many of the newer ones are less toxic than some of the older ones. A few chemicals are mentioned in this list which have not yet found a place on the market in Jamaica but which show promise of great value in the future.

Whatever the chemical, care is needed. Too often old established habit or a false economy persuades people to use really dangerous chemicals with disregard for the safety of their workmen or the consumer. In most countries in the world there have been deaths from the careless use of insecticides. It can only be by taking constant care that sickness and death can be prevented. When you receive a spray chemical, always take precautions.

Precautions

The first thing to do after receiving a container of a chemical is to look at the label. If there is a ☠ sign, be warned and look extra carefully, but don't think that its absence means it is non-poisonous. A death's head sign is also put in the succeeding list against chemicals that are sufficiently poisonous to warrant special safety precautions.

Make a slurry of wettable powders so as to avoid dust risks.

Don't smoke or chew when spraying.

Take off any clothing that has become contaminated.

Have water and soap available for washing.

Keep the chemicals in their original containers and don't lend them.

Do not let them get near foodstuffs.

Use a respirator if the label says so and keep it working efficiently.

Know the first aid treatment for the particular chemical you are using.

Give one man the responsibility for spraying.

Store chemicals away from children, locked away. Don't let children or unauthorized persons get hold of containers or sprays at any time. Get rid of containers, burn, break and bury them three or four feet deep. For a child, any liquid is a drink and any powder something to be eaten. Don't give them a chance to eat or drink your spray chemicals.

Always wash after work. Keep as clean as you can.

Always empty and clean sprayers and dusters after use. Do not leave equipment lying about partly filled with dangerous chemicals.

If you feel ill, lay off, and see a doctor. The feeling may not be due to the chemical, but don't run risks.

Read the label again.

The old-fashioned Pesticides

This title is used, not meaning to put them in disrepute, but referring simple to the fact that these chemicals have been in use since before the development of the modern agricultural chemical industry. In their specific lines they are often as effective as the modern ones, but these have had to be developed to compensate for shortcomings such as poisonousness to mammals, corrosion to machines, expense and difficulty of manufacture.

Paris green is a copper arsenic compound of high human toxicity. It was one of the first chemicals to be used in the modern age of insect control, being used on Colorado beetle in 1867. It is not used for spraying plants as it tends to burn plant foliage when it is in water solution. It can be used as a stomach poison in the control of termites, or mixed in a bait for control of crickets, grasshoppers, cutworms and millipedes. Its cost is usually more than twice that of the more persistent modern insecticides, which are also much less poisonous to man.

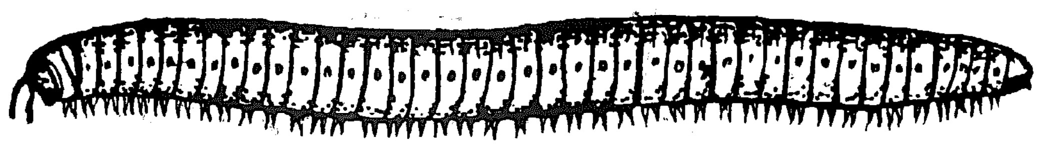


Fig. 3. A Millipede

Nicotine sulphate is a very old established preparation from tobacco used against sucking insects. It does not burn plants but it is very poisonous to man. It is a non-persistent contact insecticide, which can also be used as a fumigant in closed spaces.

Pyrethrum is derived from the flower head of a species of Chrysanthemum. It is a rapid acting non-persistent contact insecticide with some action as a stomach poison. It is claimed that no insect has developed a resistance to it. It is mainly used nowadays for the control of warehouse and household insect pests.

Derris is a powder ground from the roots of *Derris elliptica*, a plant cultivated in tropical Asia and Africa, containing the active ingredient rotenone. Its first use was as a fish poison. It is not toxic, or poisonous to mammals or plants. It is a slow acting and non persistent contact poison mostly used for caterpillars, although it also has some mite killing action. Dosage rates would be about two pounds of a 2% rotenone dust with a spreader in a hundred gallons of water. It is mostly used nowadays in control of insect parasites of pets.

Sodium fluoride can be very useful as a household insecticide, but it is very poisonous to man and domestic animals.

Lead Arsenate is the arsenic compound that has been used since 1892 and is still much in favour as a stomach poison. It is liable to burn plants a little, but usually lime is added to reduce the chances of that. It is poisonous to man and domestic animals. It can be used as a

dust or a spray. For dusting add five pounds of slaked lime to two pounds of the wettable powder in a hundred gallons of water. **Because of its poisonous nature do not use it on any parts of plants that are to be eaten.**

Modern Pesticides

Chlorinated Hydrocarbons is the general term given to that type of insecticide discovered by Dr. Paul Müller when he found the insecticidal powers of DDT in 1939. Their main importance is that they kill by contact. They also act as stomach poisons and many are volatile enough to act as fumigants. Although there are many insects that have since developed resistance to these chemicals, there can be no doubt that that initial discovery has led to the most outstanding development of pest and disease control the world has ever known. Research has spread in many directions since then, but DDT and its chemical cousins remain as the most important of them all.

DDT (Dichlorodiphenyltrichloroethane) is sold in innumerable different forms and concentrations as a dust, a wettable powder or an emulsion. It is insoluble in water and slightly poisonous to human beings, being cumulative because of this insolubility. Also because of this and its stability as a chemical compound it persists on the surfaces that have been sprayed and special care must be taken of its effect on beneficial insects such as bees and parasites and any residue that may be left on the plant parts that are used as food. This has to be used at the dosage stated on the proprietary product being used, which is usually at the rate of one pound of the active ingredient per acre.

TDE, otherwise known as Rhothane, dichlorodiphenyldichloroethane or DDD is a close relative chemically of DDT that has been developed because it is far less toxic to human beings and so can be used almost until a crop is harvested.

BHC or **Benzene Hexachloride** (or Lindane which is a purified form of the gamma isomer), is another of the earliest chemicals developed in this group. It has had very wide use and has been used in numerous forms. Its chief snag is that it may give a musty flavour to food plants, in particular root crops. The purified lindane is much less liable to taint, but is still to some extent suspect. It is insoluble in water, slightly toxic to human beings. It is an excellent stomach and contact poison and is very persistent. It has some fumigant action. It does no harm to plants, with one or two minor exceptions, which are noted on the labels. Because of its possible tainting effect, its use on a large scale is now much less than it used to be, but it still is used in considerable quantity on smaller holdings, very often as a dust.

Dieldrin was developed in 1948 and is one of the most stable of this group of insecticides. It is markedly more toxic to man than DDT, but it can be used safely if the user is strict in his cleanliness and careful not to work for too long periods with this one chemical. It is a very powerful contact and stomach poison to most insects and is very persistent. It does no harm to plants and does not enter their sap system. Being insoluble in water, it is sold in the form of the wettable powder or the emulsifiable concentrate. Its most important use is for persistent insecticidal work in the soil being used at a concentration of one gallon of the emulsifiable concentrate or two pounds of the wettable powder in a hundred gallons of water. It is also used with gypsum as a dust, where water supplies are difficult, four pounds of the wettable powder being mixed with ninety-six pounds of gypsum.

Chemically, **endrin** ☠ is almost identical with dieldrin. It is more volatile and more potent against some caterpillars but also nearly ten times as poisonous to man and should only be used when other chemicals are ineffective, and then only by experienced operators. A quarter to a half pound of the active ingredient per acre is usually effective against most insects.

Aldrin is also very persistent, excellent as a contact or stomach poison, volatile enough to act as a fumigant, almost non-poisonous to man. It can be used for what is termed 'soil sterilization' at a rate of ten pounds per acre. It is also used for control of household pests at a strength of one in two hundred. Insoluble in water, it is usually sold as an emulsifiable concentrate.

The phosphorus insecticides are known and to some extent feared because some of them are extremely poisonous to man. Their first development was by the Germans in their search for poison gases during the second world war. Schradan started in that category and some of those that followed are even more poisonous. Parathion, demeton and dimefox are excellent insecticides but there is considerable human risk in their use. The great value of these insecticides impelled chemists in their researches to try to find a phosphorus compound that had the same insecticidal activity and less human toxicity. In that search they have been successful and chemicals like diazinon, malathion, and dimethoate have been developed to the satisfaction of farmers and householders alike. Some of them are more expensive initially, but their excellent control of many insects and their persistence make them exceedingly valuable additions to the farmer's equipment.

Diazinon and **malathion** are used as contact insecticides, although they may sometimes have effect through the tissue of the leaf and kill leaf-miner larvae. **Dimethoate** is also a contact insecticide, but its chief value is that it is systemic and also virtually non-poisonous to man. Diazinon and to some extent malathion, have fairly long persistence in the field and in household use and have the great advantage that insects which have

already developed a resistance to DDT and the like are still susceptible to it. For household use, diazinon is used at one part in five hundred. For field use they should be used at a quarter of this concentration. Malathion is used in the field at a strength of from one to four parts per thousand. Dimethoate can be used at dosages of as low as one in two thousand five hundred.

Sevin belongs to another group of chemicals that have been found very useful in other countries but as yet has hardly been tried in Jamaica. It is a long-lasting contact insecticide that has the advantage that DDT-resistant insects are susceptible to it. It is virtually non-poisonous to man. It is sold as a dust or as a wettable powder and from a half to two pounds of the active ingredient is all that is needed to spray or dust an acre.

There are numerous chemicals used for fumigation, many of which are both poisonous and inflammable. In making recommendations, the less inflammable types are preferred. As is mentioned in Chapter 53 that most recommended to farmers for fumigation of their stored vegetable products is a mixture of ethylene dichloride and carbon tetrachloride. Others are available for the fumigation of soil of seed beds and vegetable fields.

Paradichlorbenzene is crystalline and is used mainly for mothproofing clothing and carpets, but it has value as a fumigant for keeping stored honey comb free of wax moth and for killing borer beetle larvae within their burrows. The dosage recommended for hive chambers is half an ounce for a brood chamber and a quarter of an ounce for each super or shallow chamber.

Metaldehyde is a chemical which attracts and kills slugs and snails. It can also be fairly dangerous to farm animals and poultry if bait is eaten. Care must be taken to keep it away from all irresponsible types and animals that might eat any quantity of the bait.

It is sold in various different proprietary forms, as a liquid, a powder or ready mixed as a bait. It can be sprayed on, dusted on or baits may be laid. The bait can be prepared from the active material by mixing two ounces in three pounds of wheat or other meal. This should either be scattered over the infected soil at about twenty-five pounds per acre or set in small heaps under small pieces of board to protect it from animals and birds and weather conditions. Under good conditions bait will remain active for several weeks, but rain and wet conditions cause a rapid break-down. It can also be made into a slurry and painted around the trunks of affected trees to trap the slugs on their nightly journey up the trunk. There are difficulties in both these methods and spraying has often been recommended in Jamaica. Between one and two and a half pounds of metaldehyde in enough water to give an overall spray of an acre gives an excellent control. Its persistence is much less, but its initial control may well outweigh this disadvantage.

Fungicides

The old-fashioned types of chemical used for killing fungi are still much in favour as some of them are as efficient as the new synthetic types and appear cheaper. In most cases, however, they suffer from being very corrosive to the machinery and are unpleasant to use. The new chemicals may seem to be more expensive, but they often work out in the end at being cheaper and more effective.

Most of the fungicides used in this country have the advantage that they kill both insects and mites. They are often used with that in mind. It may become a disadvantage, however, as in the case of coffee planted under bananas. The secondary effect of the Bordeaux spray, when it is used on the banana, is to kill off parasites of the leaf-miner on the coffee, in effect encouraging a pest which had been under reasonable biological control before.

Lime sulphur shares with Bordeaux mixture antiquity of use. Lime sulphur, along with the wettable sulphurs, is still widely used on orchard crops, where it has the additional advantage that it kills mites, scale insects and thrips. Its pesticidal value is in the free sulphur that is released in its decomposition. Its snags include its corrosive nature, the fact that a number of trees are 'sulphur-shy' and are badly scorched by it and the fact that it is incompatible with a great many other pesticides, in particular the mineral oils. If these are sprayed on to sulphur-sprayed plants within a fortnight, there may be serious scorching. It also tends to burn human skin if the operator allows it to come into contact. It is usually used at a strength of one in a hundred.

Bordeaux mixture is still widely used against leaf spot on banana and blight on potato and tomato. It is prepared by adding a solution of copper sulphate (bluestone) to a suspension of slaked lime. Its strength is stated as say 4-4-50, stating the ratio of pounds of copper sulphate and quick lime to the number of gallons of the total spray fluid. Wooden vessels should be used to avoid chemical interaction.

Cheshunt mixture was developed earlier in the century for use on seed beds against damping off. It also has the value that it is useful against other diseases whose spores may be present and it helps as a deterrent against insects and millipedes. With the advent of orthocide and dieldrin, which are both more efficient, its use may decrease. To make it, mix finely ground ammonium carbonate and copper sulphate in a ratio of eleven to two and leave in a sealed container for twenty four hours. Dissolve this in water at a rate of one pound in thirty gallons.

The thiocarbamate section of fungicides, which include **zineb** and **maneb,** has been found very effective against blight, anthracnose, downy mildew, rust and damping off in many plants and is also very effective

against the citrus rust mite. The chemicals are used as a spray at a rate of one and a half to two pounds per hundred gallons of water.

Spraying Machines

The object of a spraying machine is to spread a very small amount of chemical over a very large area. The old-fashioned method was to dissolve or mix the chemical in a hundred gallons of water or mix it with half a hundredweight of a dust and spray or dust that over an acre. The diluent was cheap, but the labour of carrying it was excessive, so a great deal of work has been done to find if air or a very much smaller amount of water could be used to dilute the chemical. Nowadays the majority of spraying is done with the chemical in a much more concentrated form. Economically, of course, the machines tend to be more expensive, but the advantages are so great, that many very poor people have them to get through their work so much more quickly and effectively.

The types of spraying machines and dusters are legion, but the following gives a general idea of the forms into which they come.

To deal first with the types of machine that a small farmer or gardener would need they can be grouped roughly into three sections. First the simplest types, hand dusters, flit gun, garden syringe and solo sprayers, second the high volume knapsack sprayer, third the power-driven low volume sprayer being successively more expensive and more effective.

The **dusters** are simple boxes of various design wherein the dust is puffed out in a cloud by a puff of air. Their chief advantage is that they are cheap and easy to use fairly effectively. The snags include the fact that dust is never as efficient as a spray, it may wash off with rain or dew, and to spread the insecticide reasonably effectively, not less than half a hundredweight of the dust must be used per acre, thereby adding to the labour costs.

The flit gun is a simple tin-can with a piston-type air pump crossing a tube leading from the can. The current of air propels the chemical in a fog of small droplets, in a primitive version of the mechanical low volume sprayers.

In the **solo gun** the spray fluid is propelled by a small hand pump through a simple spray nozzle.

The **high volume knapsacks** can be divided into two sections. The cheaper machine has a hand pump by which a pressure can be kept up as the man is carrying the machine across the field. He carries a lance with spray nozzles to direct the spray at the plants, with a simple tap attached to the lance.

The more expensive type consists of a brass or galvanised steel cylinder containing a plastic bag wherein the spray chemical is put and from which it is expelled by air pressure. This also has a hand lance with nozzles and a grip tap to switch on or off the flow of the chemical. This machine is sometimes fitted with special nozzles which will reduce the volume of water sprayed to as low as ten gallons per acre.

The **low volume air blast machine** (*see* Fig. 4) has a motor engine revolving a fan, which propels air at high speed through a wide mouthed tube into which the spray liquid is released. This is broken up into very

Photo: Esso Standard Oil

Fig. 4. Low volume air blast sprayer

small droplets and forced out of the aperture on to the crop in the form of a mist. This machine most frequently is used for spraying at from two to ten gallons per acre. Because of the pressure and turbulence of the air blast and the smallness of the drops the coverage obtained by this machine is usually better than that obtained by the high volume spraying machines. There is not the overall wetting that is visible when a high volume spray is put on to foliage, but the chemical is distributed just as well on all sides of the leaves.

Some of these machines may also be useful for farmers with large acreages, where there is hilly land, interplanting, etc. Generally speaking however, such farmers either use tractor-drawn machines or machines that are carried by tractor. They may call in contractors with even more expensive machines, which do the work as efficiently and more quickly.

Groves are often still sprayed with a high volume of spray where a stationary or mobile motor pump and spray tank supplies the liquid at high pressure through long hoses to spray lances.

Photo: Esso Standard Oil

Fig. 5. Aircraft spraying bananas

Low growing crops, such as peppers, cucumbers, cabbage etc. when they are grown on reasonably level ground can be sprayed either at high or low volume with machines working from the power drive of a tractor. They may be carried by the tractor or drawn behind it. There are different models, either spraying through horizontal booms across the crop or propelling the spray fluid by air blast into the air for orchard pest control. These can be regarded as large scale models of the hand machines adapted for dealing mechanically with larger areas.

In addition to these machines, spraying machines have been designed to work in aeroplanes, both helicopter and fixed wing types (see Fig. 5). The helicopter has the great advantage in that it can land in a small area, it can spray at a much slower speed and that it can turn much more sharply at the end of each run of spraying, but its capital cost and heavy running expenses tend to make it uneconomic. Fixed wing aircraft are much cheaper to buy and fly so that in most cases other disadvantages are outweighed. There are two general types of sprayer used. One is the simple hydraulic low volume sprayer as used on tractor drawn machines and the other is a rotary 'atomiser' in which four nozzles cover a swathe of twenty yards with fairly uniform sized droplets.

Pests and Diseases

Seed beds are open to attack from all sorts of pests and diseases. Particularly important are millipedes, crickets, cutworms, ants, slugs and the disease known as damping off. Damping off is usually worse in overcrowded or heavily shaded and wet seed beds or boxes. Good management should reduce these to a minimum. Nematodes which are pests at any stage of growth of the plant are particularly harmful when the plant is young. For full protection, the soil should first be sterilized, either by heat or by chemicals such as sodium methyl dithiocarbamate or ethylene dibromide to kill off the nematodes. After the seeds have been sown the ground should be soaked with a fungicide. Cheshunt mixture is effective and it also acts as a deterrent to insects and kills off many of the weed seedlings. Cuprous oxide and orthocide have been developed since and are reputed to be more effective. If sodium methyl dithiocarbamate has been used as a nematode killer, it is also an efficient fungicide and kills weed seedlings. These fungicides prevent the development of the damping off disease fungus. If cutworms or crickets are a problem, DDT should be sprayed or BHC used as a dust. This will also kill ants and millipedes which may often kill seedling plants. A BHC bait in corn meal can also be used for the control of cutworms and millipedes. The fire ant is very fond of gathering seeds from a seed bed. If it is possible to find the nest, the pest can be completely controlled by putting dieldrin dust in it or laying a trail of dieldrin close to it, by which means the workers will transport the dieldrin into the nest and kill the queen whose death will mean the end of the ant colony. The persistence of dieldrin when sprayed on to the ground quite a distance away from the nest means that it may be carried into the nest by the workers and have effect from a long distance.

Also attacking many plants before they have managed to grow enough leaves are the flea beetles, which though very small may do a great deal of damage biting holes in the leaves. An overall spray with DDT or dieldrin will control these during the crucial growing period.

Slugs are a pest on full grown crops, but when they attack a seed bed, their meals may easily halve the number of plants within a night or two. The usual method of control has been for the farmer to search for them under leaves and stones where they hide during daylight, or to go out after

dark, and look for them at work. Metaldehyde baits can be scattered near the seed bed to attract and kill the slugs.

Almond

This crop is not much troubled by pests, but on occasion thrips may become very numerous, shrivelling up the leaves. It is mostly on the under side of the leaves. A thorough spray with DDT will give a very good control. A small beetle known locally as Popeye sometimes cuts up leaves to feed its young, but rarely is important.

Avocado

Mealy bug and the fire ant can almost kill young avocado plants. The mealy bugs suck juices from the plant and the ants protect them, removing the sweet honeydew which they excrete, and moving them from plant to plant. The ants may even kill off the beneficial ladybirds in their defence of the mealy bug. The mealy bug can best be controlled by controlling the ant with Dieldrin or Chlordane, spraying the trunks and the ground around the trees. When the ant is controlled, the mealy bug dies as a result of the dirty conditions left in the absence of the ant. The ants themselves are a direct pest in that they carry away soil particles from the root exposing them and sometimes causing their death, doubling the reason for their control.

Scales also infest the avocado and they are attended by the black ant. They can be controlled with a white oil spray, but it is again simpler to kill off their attendants with Dieldrin or Chlordane.

Occasionally thrips becomes very numerous on young plants, shrivelling up the leaves, so that it may be necessary to spray with DDT. On older plants, branches may be eaten out by a beetle stem borer, which can be controlled by drastic pruning, destroying the prunings and putting paradichlorbenzene in the exit holes and blocking the opening with mud.

Bananas

When bananas topple over at ground level leaving the head in the soil it is usually a sign of borer damage. Inside the plants, diffused discoloured patches containing well-defined borer tunnels often extend to the centre of the plant.

The **banana borer weevil** (see Fig. 2, p. 790) lives in the trash round banana plants and lays it eggs in the bulb near ground level. These hatch after about a week and the grubs spend their life of up to three months tunnelling through the leaf bases.

After a short chrysalis stage, the adult comes out and may live two years laying eggs to continue the devastation.

Cleanliness and hygiene help to kill off the adult. Java beetles, which have been introduced into the island are of little use in reducing the numbers. Chemical action is necessary for proper control of the pest.

The recommended treatment is to use a four per cent mixture of dieldrin fifty per cent wettable powder in gypsum. Four ounces of this dust is scattered over each mat or placed in and around each planting hole. This has been found to be effective over a period of two years.

Thrips. This is a minute insect which occurs erratically and causes minute, raised spots on the fruit. As yet, nothing is done to control it.

Red Spider. A very small, red mite occurs frequently on the banana and is of no economic importance, but there have been two or three occasions recently when it has developed into pest proportions and some degree of control has been achieved by spraying with one or other of the new miticides such as chlorobenside.

Leaf spot is a very important fungus disease in Jamaica. The spots first appear as minute, yellowish streaks which gradually enlarge to form well defined brown spots up to half an inch long. On very young plants the spots are much rounder than on older ones. The time taken for spots to develop depends on the amount of infection. When this is heavy, spots can be fully formed in 25 days and so start appearing on the younger, upper leaves of a plant, but when infection is very light, spots may take three months to appear. Where leaf spot is being very well controlled the spots are only found on the oldest, lower leaves. Leaf spot on young plants reduces the number of hands per bunch; on older plants it reduces the size of a finger and can induce ripening in the field.

The routine treatment has been a regular spray of 8-10-100 Bordeaux with four ounces of a wetting agent in each hundred gallons every three weeks.

Bordeaux spray must reach the back of the younger leaves of Lacatan and Robusta bananas to prevent leaf spot infection. Unless this is done the disease can become serious despite all the time, trouble and material expended in this form of spraying because once the fungus has infected a leaf no amount of Bordeaux mixture can stop the spots developing. This is one reason for so much ineffective Bordeaux spraying, ~~and for~~ its almost complete abandonment in most farmers' ~~spray~~ programmes. With the ~~development of low volume~~ methods of spraying, petroleum oil has been applied at the rate of half to one and a half gallons per acre. This is put on either by aircraft or with a low volume air blast machine, care being taken not to drench the leaves as this will cause burning. The oil is able to stop the fungus developing inside infected leaves even if it settles on their upper surface, hence the effectiveness of mist spraying with oil both from the ground and from above the tops of tall coconut palms. Much less fruit is rejected from fields poorly sprayed with oil than from those poorly sprayed with Bordeaux.

Panama disease has become so well known because it is so devas-

tating. It is a wilt caused by a soil fungus which is virtually impossible to control. The Gros Michel variety of bananas, which is regarded as the best banana in all respects, is so susceptible to the Panama disease that it has largely been replaced by the resistant Cavendish varieties, particularly Lacatan. Intensive breeding experiments are continuing to try and find a better substitute for Gros Michel.

Blackhead is caused by an eelworm known as the burrowing nematode. This can cause a serious setback to banana production. This nematode attacks the roots and outside of the head. In both cases the infested portions rot and turn black. Near roots may die back an inch or so, to their point of origin within the head. Cavities left inside the head by the rotted roots are similar in size to borer tunnels with which they have been mistaken in the past. A sure sign of infestation by the burrowing nematode is the presence of a narrow, dark purple discoloration where the black rot adjoins the healthy part of a root or head. The plant is weakened with the loss of its feeding and anchoring roots. Uprooting due to nematodes is easily distinguished from that due to borer because the whole plant, head and broken roots included, is dislodged from the soil. The disease is spread from one plantation to another on infected suckers.

All suckers should be trimmed heavily with a cutlass before planting until all signs of discoloration in the head are removed and then a final paring with a knife should be continued for at least a further half inch. Very heavily diseased suckers and those showing deep wounds should be discarded. No cleaned sucker should be planted if less than six inches wide, the cabbage being cut back to four inches high and the head to two inches deep. The new growth comes away quickly from the heart and plants with healthy roots can make full use of fertilizers which should be applied regularly from the time of planting. The burrowing nematode cannot exist long in soil free of living banana growth. Fresh land or land on which there have been no bananas for at least six months should be free of this eelworm. There is little use in planting clean suckers in recently cleared plantations.

Speckle formerly known as Swamp Spot, causes minute, smooth black spots on fruit and can be sufficiently disfiguring to cause rejections at buying stations. In the past this well-known disease was considered to be physiological and no method of checking it was known but recent research in Jamaica has shown that it is due to a fungus that grows on trash. The incidence of the disease varies considerably in different localities, being worst on the irrigated plains after heavy rains but there is a tendency for it to appear regularly in certain parts of hillside estates. Wherever speckle is known to cause rejection of fruit the removal of hanging trash is recommended just before an expected wet season. Work on the disease is still in progress.

There are a number of other diseases in the field, but they are generally of minor importance. Much more important are the fruit and stalk rots in storage that affect the banana industry after the harvest.

Beans and Peas

Beans and peas are attacked by a leaf roller, a leaf-eating beetle and a moth worm. These all are controlled by spraying with DDT Sometimes the pea aphid can be numerous enough to be a pest. This should be controlled by spraying with malathion or dimethoate. Congo peas, being longer in the ground can also be attacked by a stem borer, the larva of a beetle which must be controlled as in the case of avocado.

They are often attacked by **mosaic,** which is caused by a virus. Leaves of infected ones become highly mottled and crinkled. This type of disease on beans is carried in the seed, therefore seeds from disease free plants must be used. Pulling out affected plants and affected leguminous weeds is advisable.

Rust which is due to a fungus is sometimes seen on beans. This disease appears as small yellow to brown spots or pustules on leaves and can be controlled by spraying with zineb at two pounds per hundred gallons. **Powdery** and **downy mildews** and **leaf spots** are commonly found on peas and beans but control measures against these are hardly profitable. Spraying with a copper fungicide or zineb might be carried out to prevent serious damage to the crop.

Beetroot

Beet leaf-eating beetle (flea beetle) and the beet leaf roller are the most important pests of beetroot. They can both be controlled with a thorough spray of DDT

Cabbage

Cabbage leaves are eaten by various caterpillars and may at times be so perforated as to appear like lace. A very small green grub, belonging to the diamond back moth, lives in a silken tent on the underside of the leaves, eating small holes in them. When it has finished eating it spins a pale coloured cocoon on the leaf and turns into a chrysalis from which the moth comes in a few days. This moth when it is at rest has a diamond-shaped mark on its back giving it its name. Also often seen about cabbage fields are large white butterflies, which lay groups of yellow eggs on the leaves. These hatch after four or five days into yellow and black spiny caterpillars which eat larger holes in the leaf. After about fourteen days these turn into beautiful spiny chrysalises each tied with a silken thread to the leaf or whatever support they have found. These spend a week in this condition, before coming out as the adult. There is also a 'heart worm' which is more

difficult to see and to control as it spends most of its time eating away at the leaves at the heart of the cabbage. This turns into a brownish coloured moth about an inch and a half across the wings.

When the crop is attacked by any of these worms it will be found that their generations are fairly marked and it is often fairly easy to attack at the right time for one of them. It will be found that spraying with DDT,

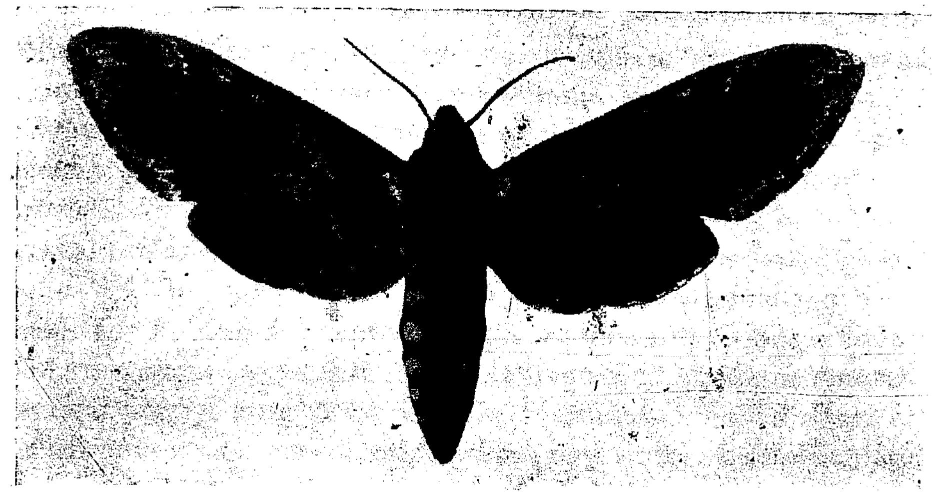


Fig. 6. The Hawk Moth (Tomato Hornworm)
(Protoparce Sexta Jamaicensis)

dieldrin or BHC in the early stages will control each of them very well, but that after a week or so, the eggs that had been laid before the spray will have hatched and a further spray will be necessary. To achieve really clean cabbages it will often be necessary to spray at intervals of a week or so to catch succeeding generations of the moths. Within three weeks of harvesting, these more poisonous chemicals should not be used. Malathion or TDE are much safer from the consumer's point of view and can be used very much closer to the date of harvesting.

There are usually plant lice on cabbage, but their numbers are not great enough to be of any importance. Occasionally, they become a real infestation just before the plants begin to head up. They should then be sprayed with malathion or dimethoate to clear them before they infest the head.

Seedling cabbages suffer severely from a fungal disease known as **mildew.** Leaves of affected plants are covered with a downy white growth and the plants ultimately go yellow and die. Spraying with a copper fungicide or with Zineb gives some sontrol.

Black rot is a condition in which the veins of affected leaves become black. This is due to bacteria. Affected plants should be pulled out and burnt and the land rotated with non-susceptible crops for four years. Resistant varieties are known.

Carrots

Carrots are generally affected by a **leaf spot** which produces brown spots and shrivelling of leaves and stalks. Cleaning up affected crop residues before replanting and not planting beside affected beds or fields are more helpful than spraying to control the condition.

Cucumbers, pumpkins and water-melons

Cucumbers, pumpkins and water-melons are subject to a **mildew** which causes the leaves of plants to wither and die. Bordeaux mixture, zineb, may be used to control this condition.

The undersides of leaves and young shoots are often attacked by small plant lice or aphids of yellowish, greenish or black colour. The leaves become distorted and may even wilt and die if the infestation is serious. They are particularly noticeable during the dryness of the summer. Malathion is effective in control. Dimethoate is valuable in that because of its systemic method of killing, it can be used against lice that are impossible to reach with the direct spray of the spray gun. Melon worms are small pale coloured worms that feed on the flowers and young fruit and may burrow into the stem. Their worst attacks occur towards the end of the summer. The moth is a delicate white moth with a black border round the wings measuring about an inch across. If the attack is serious, it is as well to prune off the worst affected branches before spraying with malathion or lindane.

Cacao

The chief pests of the cacao are the fiddler beetle, the rat and the woodpecker.

The fiddler beetle is dealt with more fully as a pest of citrus. Conditions are slightly different in the case of cacao, the leaves being too tough for the adult beetle, There is however, nearly always shade as part of the normal cultural process for the growing of cacao and it is on the leaves of such 'permanent' shade trees as quick stick (*Gliricidia*) and Cocoa Oak (*Inga vera*) that it can live and lay its eggs. When the young grubs hatch and drop to the ground, they have the choice of shade tree or cacao root and may be harmful to both, but they can be especially bad to the cacao in that they seem to prefer the main roots so that a small number of grubs may easily kill a young tree.

All cacao plants are treated in the nursery with dieldrin to help prevent the attack of the fiddler during the first two years of growth in the field. The value of this is increased by the fact that the temporary shade used for the first two or three years is often bananas and the fiddler beetle does not eat banana leaves. The 'permanent' shade may be planted at the

same time, but is often too small to be of much interest to the beetles. In the third and fifth years of the plant in the field, the drip circle area of the tree is sprayed with dieldrin to continue the control after this initial stage. After this, any attack by the beetle should be overcome by the number of roots that are available to feed the plant. In the nursery, leaf rollers, leaf-hoppers, leaf-eating beetles and thrips may become pests in that the plants are so close together. These are usually controlled with BHC.

Rats will be dealt with in Chapter 54, but reference should also be made here as they may easily halve the crop by their attacks. They climb trees as readily as a squirrel and spoil a great many more fruit than they actually eat. Every method from mongoose to poison has been used with only partial success. Nowadays, chemicals of the warfarin type are used in baits put into bamboo pots tied to the branches of the tree. With continued treatment over a considerable area it should be possible to eliminate the rat.

In some plantations, the woodpecker may damage a large number of the pods. Generally it is undesirable to kill off birds, particularly such useful insect-eating types as the woodpecker, but it may be necessary to shoot them if they become a pest as no deterrent chemical has been found that is economic.

Black Pod. In wet areas cacao pods often become infected with a fungus which causes the pods to become first dark brown in colour and then black. During wet weather whitish growths of the fungus can be seen on the pods. Reducing shade in the plantations will help to control the disease, but it is important to take all diseased pods off the trees and either bury them or take them from the field. There have been few attempts so far in Jamaica to control the disease by spraying, but in other countries control has been obtained by applying a copper or zinc spray.

Cassava

Hornworms may eat the leaves and cause a considerable amount of damage in a short time. Occasionally the fall army worm may add to these losses. These attacks often occur with the sudden flush of growth when rains follow the dry period of the summer. Hand picking will reduce the effect, but usually it is after most of the loss has happened. The best policy is to spray when the larvae are still small with a DDT spray. Red spider and thrips also attack cassava. They generally are most noticeable during the drought and can be controlled with a sulphur spray, but chlorobenside has been found very successful against the spider. Barnacle and red mussel scale may attack the tubers and the sweet potato weevil may transfer from its normal host. As these are all underground, practically the only method of control is by careful selection of clean tubers for planting. It is possible by watering with dieldrin an eight inch strip along the rows to protect the tubers from a re-infestation of the weevil, but this is only supplementary to the initial planting of clean tubers.

Citrus

Fiddler Beetle. There are a number of different species of weevil known as fiddler beetle, which feed on various trees in the normal forest habitat and are of little importance until they turn their attentions to

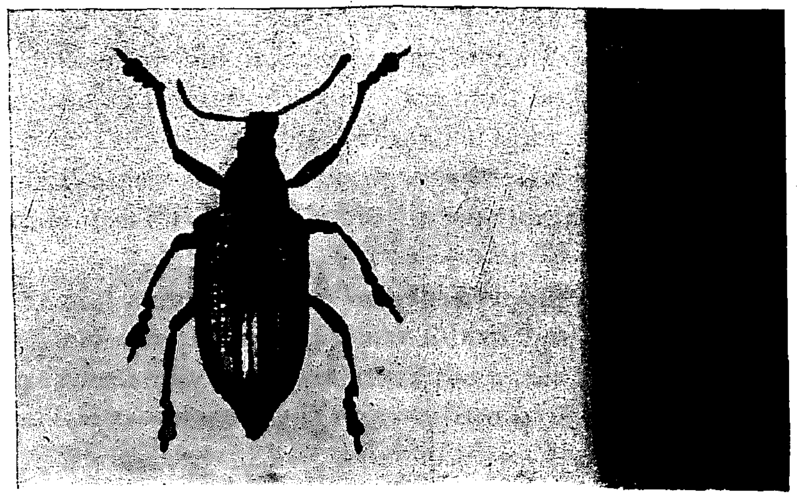


Fig. 7. The 'Striped Fiddler Beetle' (*Prepodes vittatus*)

citrus or cacao. The adult weevils, the largest of which may be about an inch long, feed on the leaves of trees and lay their eggs between two leaves that they stick together. The damage done to leaves is insignificant compared with the damage done by the grubs to the roots of the fruit trees. The newly born grubs although they are only as large as two pin heads, drop from their birth-place to the ground, and burrow into the soil until they find a suitable root, when they start to eat away the soft growing tissue until the root is killed. If too many roots are killed, this may cause great reduction in the strength of the tree or it may die. Control of the adult or elimination of the egg batches and encouragement of egg parasites will help in controlling this pest, but with the development of such long-persisting soil insecticides as dieldrin, the main brunt of the defence has come to be routine treatment in alternate years until the tree is large enough to resist any further attack. The whole area covered by the tree should be sprayed with dieldrin.

An insect that can occasionally eat an economic amount of citrus leaf is the **Orange Dog.** This is a grotesquely shaped caterpillar, dark brown and white in colour, which throws out pale tentacles when it is alarmed. When it becomes adult it is the beautiful swallow tail butterfly, that flies about so indolently. It is rarely numerous enough to warrant more than hand-picking as a means of control.

Fig. 8. The Orange Dog (*Papilio andraemon*)

At times the **bagworm** may be a pest of citrus. The worm never comes out of the pointed silken bag which it spins round itself as soon as it hatches. Even as an adult, the female never leaves her bag, but the male is winged and flies around during his short life. They feed on a considerable variety of tree plants, but are most important as a pest of citrus. The most usual method of control of small numbers is by hand-picking, but if their numbers are too high a DDT or malathion spray is completely effective.

Another pest that seriously reduces the crop, makes the fruit smaller and badly discoloured is the **Citrus rust mite.** This is an exceedingly small mite with a life cycle of a week. Its name derives from the rusty colour of infected fruit, which so become unsaleable on the export market. Because of the small size of the mite it is important to keep a close watch for the discoloration and prevent its building into a serious infestation. Where the mite is prevalent citrus growers have a routine spray with lime sulphur or wettable sulphur during the 'dormant' period. This can be followed after blossom with another similar spray. Zineb may be used as this can be combined with the oil spray which will control scales and black fly. It may be necessary to spray twice during the summer.

An uncared for citrus grove may often have a large population of scales. They may be on fruit, leaf or stem sucking at the plant and reducing its crop-carrying capacity. The most frequent scales seen are the Florida Red Scale and the Purple Scale. They are kept in control to some extent by ladybirds and other predatory insects but the routine spray with oil gives very effective control. An alternative spray which may also help with other pests is half strength oil with malathion. Another caterpillar which until 1959 has never been regarded as a pest is a beautiful furry green slugworm less than half an inch long. This eats small holes in the leaves, then spins a spherical cocoon like a small pea, before coming out as a delicate white moth less than half an inch across the wings. When this is very numerous, it may seriously damage the leaves of a grove and spraying with malathion may be necessary. The life cycle is about five to six weeks long and the spraying should be done before too many of the larvae have turned into their cocoons.

Black fly can be a most important pest of citrus, although generally speaking, it is not important owing to control by the so-called Eddy wasp, which comes into its interesting history. Before the days of the Plant Quarantine section of the Government, mangoes were imported into the country from the Far East. They were infested with black fly, and when they arrived about fifty years ago, they found a marvellous field of good food in the citrus groves and within a short time they became a very serious pest. They sucked the life out of the plants and excreted their 'honey dew' over the rest of the plant. A sooty mould developed on the honey dew giving the trees a completely black appearance and reducing the amount of light available to the leaves. They became a pest both here, in Cuba and in the Southern United States. Research workers went to Malaya and found that there the black fly had an orange coloured parasitic wasp which kept its numbers within bounds. They brought this wasp back to Cuba and under the influence of Mr. W. H. Edwards of the Plant Protection Division it was brought on to Jamaica. Within a very short time it took control of the situation and the numbers of black fly were reduced practically to nothing. As with all cases of biological control, there is a tendency for the control to be uneven. There have since been occasions when the black fly has increased so that chemical control has become necessary. A spray of malathion with white oil gives an almost complete control of black fly, and in addition the oil clears off the sooty mould which is such an important secondary effect of the black fly. It may be necessary to repeat this spray after about three weeks, which is the length of the life cycle of the black fly. It is unwise to spray with oil after the fruit has begun to fill but usually the summer sprays can complete the control.

The **Mediterranean fruit fly** is a fruit fly rather smaller than a house fly ~~that exists~~ in a number of countries but as yet does not exist in Jamaica. It lays its eggs in the skin of any attractive fruit and the maggots burrow through the pulp into the flesh and make the fruit completely unsaleable. Strict plant quarantine regulations are in force to prevent this insect being brought into the country either ~~by ship or~~ by aircraft. It is possible to control it or even eliminate it by careful picking, spraying and trapping, but the cost and the great loss of fruit is something to be avoided if at all possible.

Fruit piercing moths are night flying moths whose sucking trunks have developed strength enough to pierce the skin of citrus fruit. Several

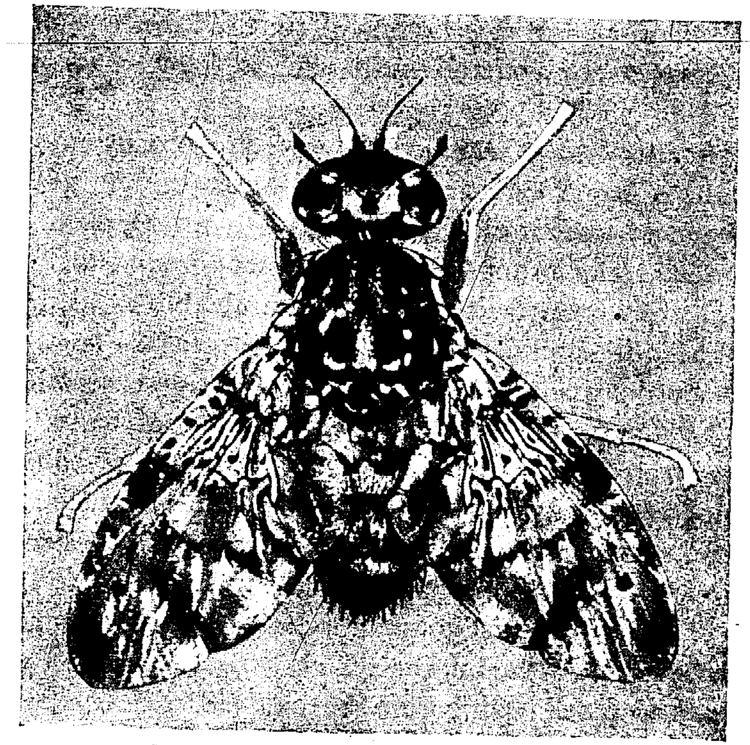


Fig. 9. The Mediterranean Fruit Fly
(*Ceratitis Capitata*)
(Photo by courtesy Shell Oil Co.)

different types have been observed attacking fruit, but little is known of their other habits. Apparently, the moth is attracted to ripe or nearly ripe fruit and makes one or more punctures in the skin to suck the juices. After a short time, a circle of decaying tissue develops round the puncture and the fruit becomes unsaleable. The distribution of the moths is not general and the attacks are uncertain, but there have been occasions when a

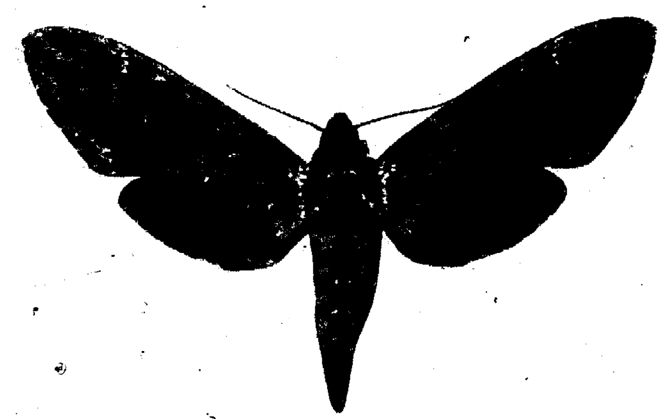


Fig. 10. Hawk Moth (*Protoparce sexta jamaicensis*)

considerable proportion of a crop has been spoilt. The pest is receiving a great deal of attention, but any means of controlling the moth either by the use of deterrents or control of the larval stages have so far been unavailing.

Scab is a fungus disease which produces raised corky spots on leaves, stems and fruits of some varieties of citrus. Sour orange, grapefruit and lemons are the most susceptible. The fungus only attacks young tissues, so that it often makes sour orange seedlings grown for rootstocks unsuitable for budding. Scabby grapefruits are made unsaleable as fresh fruit by its disfigurement. Light shading of nursery beds and the spraying of the seedlings with Bordeaux or a similar copper fungicide is recommended for its control. The standard Bordeaux would be 3 : 3 : 100 mixture. Grapefruit can be protected by spraying with Bordeaux to fifty gallons of which half a gallon of petroleum oil has been added. This is the standard high volume dosage, where a hundred and fifty gallons would cover an acre. Low volume mist spraying is also effective, the mixture would be 3 : 3 : 12½ with ½ gallon of oil, using about 30 gallons of the spray for each acre.

Gummosis is due to a fungus which attacks the base of the stem causing the bark to crack oozing gum. If the dead bark is removed a dark brown stain is seen in the wood below and if the disease goes unchecked it will girdle the tree and kill it. Grapefruit and sweet orange rootstocks are more susceptible to this disease than lemon and sour orange. If they must be used the budding should be done as high up on the rootstock as possible and the base of the citrus plants should be kept clean and protected from cutlass wounds. Very low branches should be removed to reduce dampness round the trunk. Any sections of the trunk showing gumming should be cut back to clean wood and painted with white lead paint or Bordeaux paste.

Melanose is a disease of citrus caused by a fungus which produces dark brown slightly raised pin point spots on the fruit. It first appears on the young leaves as minute dark circular depressions with yellowish margins. These later become raised and the leaf has a surface rather like sand paper. This disease can be controlled by using a copper fungicide within one to three weeks after the fruit has set. It may be necessary to spray again three or four weeks after the fruit has set, and again three or four weeks after that if the attack is bad.

Greasy spots are slightly raised dark brown spots on the undersides of orange or grapefruit leaves. These cause premature leaf fall and a reduction in yield. This disease is supposed to be due to a fungus, but is apparently also associated with the presence of mites on the trees. Two or three applications of a zineb, white oil mixture soon after the young flushes have hardened, should control the disease. One and a half pounds of zineb and a gallon of white oil should be used in a hundred gallons of water for high volume or in twenty-five for low volume application.

Virus diseases recently confirmed in this country include tristeza and psorosis. Neither is of great importance at present, but having heard how the citrus industry in South America has suffered from them every care must be taken to prevent their spread.

The main symptoms of **tristeza** are stunting and poor development in trees that are fifteen years or older and a curious pitting of the inside of the bark of the root stock (see Fig. 11). The disease is transmitted from

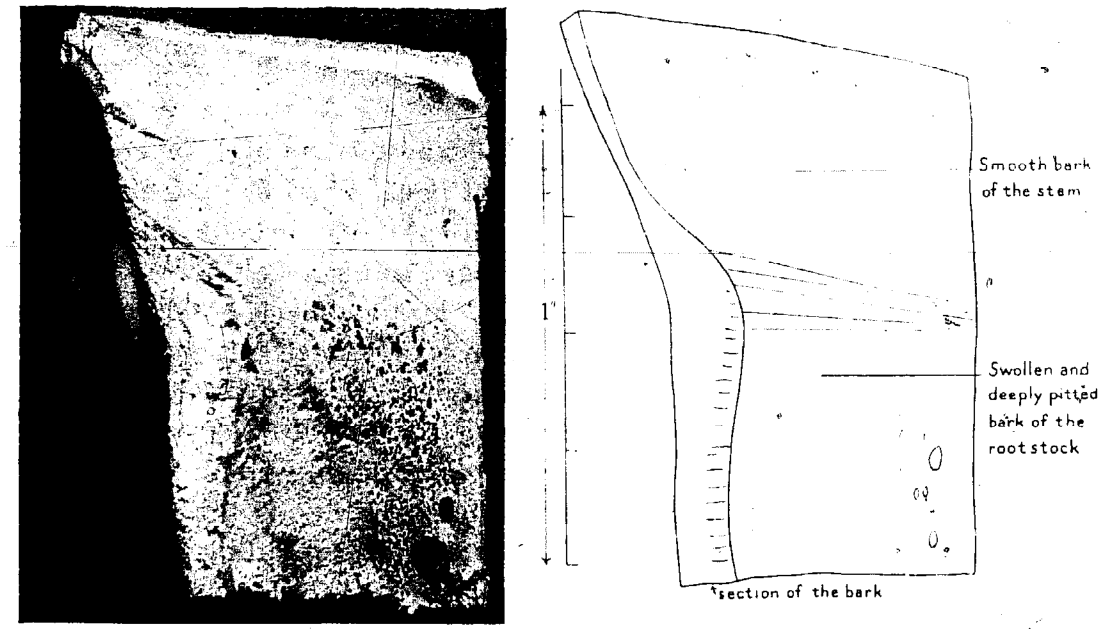


Fig. 11. Inside view of a piece of bark from a citrus tree affected by the Tristeza virus disease

plant to plant either by the process of budding from an infected tree or by the feeding of plant lice. Fortunately for Jamaica the tropical citrus aphid, which is apparently the insect mainly concerned, does not seem to exist here. To prevent the spread of this disease, several things should be done. No buds should be taken from any suspected trees and rough lemon rootstocks should be used. To ensure that such disease as we have is not transmitted within our groves (most of which are budded on sour orange rootstock) the plant and human quarantine restrictions at the ports have been strengthened to prevent the accidental import of this plant louse. It is being recommended that any trees that have the disease should be rooted out and burnt.

Psorosis can be confused with gummosis but there is no exudation of gum. Parts of the bark on the stems and branches of some types of citrus such as grapefruit, orange and ortanique tend to form dry scales with their edges raised and slightly curved. These symptoms do not appear until the trees are at least twelve years old. Since indiscriminate use of budwood is the most common way of spreading psorosis, buds should not be taken from trees showing signs of scaly bark but from trees which are apparently healthy and at least fifteen years old.

Stem knot of limes is a serious disease especially along the north, west and southwest coastal regions of the island where a large percentage of the branches of limes are killed. The fungus causing this disease attacks young or injured tissues producing enlarged knots or galls out of which several shoots emerge. The stem above the knot ultimately dies and the entire plant may be killed. Pruning off branches 18 inches below the galls and burning them helps to control the infection.

Coconut

There are many insects which eat the leaves or stem of the coconut, but few achieve much importance as real pests. There is only one scale insect that ever endangers the life of the trees, the 'destructor' scale. The Florida red, the Star and the Coconut fringed scales can also be numerous and the plant is better without them. Fortunately, considering the difficulty of spraying trees thirty or forty feet high, there are a number of ladybirds which can, if necessary, be brought in to keep the scales at an economic level. Another most important fact is that the scales are tended by ants, which can almost invariably be seen running up and down the trunks of coconut palms. If these are killed by spraying the trunk with dieldrin, the scales will die from lack of care and the insanitary conditions that follow. This is an excellent example of combining chemical with biological methods of controlling an insect, without actually spraying the insect itself. On young trees in gardens, a plant louse may attack the trees, reducing its strength. A spray with malathion or dimethoate will control this adequately.

An impressive-looking beetle, the **rhinoceros** beetle may occasionally be a pest. Its normal home is decaying vegetable matter like rotting coconut stumps being of no agricultural importance. But after a storm its numbers may increase so much that the adults may be attracted to the cabbage of the living palm. Hygienic clearing up of damaged plants is the only practicable way to reduce its damage to the palms.

The **shot-hole borer** is a minute beetle that occasionally completely perforates the trunk and the tree may die after this. It is usually only a secondary infection after the tree has already been infected by fungus to a fairly considerable extent, and to which the death should rightly be attributed. If it is desired to control this beetle, something can be done by clearing the trash away from the trunks and spraying the trunks with a persistent spray like dieldrin. This would prevent the spread of the beetle, but little can be done to kill the beetles or grubs within the tree trunk.

Rats can be of considerable importance even on tall coconut palms as they have skill enough to climb even those to reach the nuts through the husks of which they bite a hole to reach the food. Metal collars twelve inches wide may be used to protect the trees, or warfarin baits may be used in bamboo pots laid on the ground. They will be attracted to these as much as to any nuts that may have fallen.

There have been cases where **rat bats** have been reported as cutting open coconuts. They cut a hole in the husk exactly like the hole cut by rats and may seriously reduce the crop. The only means possible in this case is to find the home of the rat bats, which is usually a cave and seal it off with rocks and soil or cover the openings with a fine wire mesh so that the rat bats are unable to come out and will die within the cave.

By far the most important disease of coconuts in the island is **lethal yellowing.** It is still called the unknown disease although it has recently been attributed to a virus as its cause still is not known. The first symptoms are falling of the younger nuts and the opening of the spathe nut brown in colour. Growth of the palm ceases very soon and the heart leaves begin to rot with a most unpleasant smell. Some of the nuts may hang on for two or three months, but towards the end the leaves of the plant turn bright yellow. There seems to be no method of control at present, but to prevent its spreading too far, regulations have been made so that all infected trees are cut down and burnt and no material from an infected coconut plantation may be taken from the infected Western area to the uninfected areas. The Malayan and Fiji dwarf varieties seem to be very resistant to this disease, so their planting has been encouraged in the infected area.

Frond drop is a condition (the cause of which is also unknown) in which the lower leaves droop and hang around the stem leaving a small tuft of leaves standing. Growth and nut-production is greatly reduced and the nuts become elongated. The plant may die within six months or remain unthrifty for several years. It looks like drought wilt or that caused by impeded drainage but it is often found on properly drained areas with adequate water. There is no known control of this disease but it is recommended that the trees should be cut down and burnt.

Bud rot is attributed to a fungus. The bud rots and finally dies but the crown leaves and nuts may remain healthy for some time. Usually the palm dies after a variable length of time although sometimes if the weather is dry there is a chance that a slightly affected tree may recover. Dusting the heart leaves with ~~about~~ a pound of a 1 : 3 : 5 mixture of bluestone, whitelime and common salt is recommended to prevent or control early infection.

Other diseases such as yellowing, leaf blight, leaf spot and other minor ailments can often be corrected by proper drainage, cultivation and application of fertilizer to the crop.

Coffee

Coffee in Jamaica is not seriously attacked by pests as it is mostly planted scattered among other crops.

Green scale followed by a sooty mould sometimes develops in the drier parts. In moist conditions a fungus parasite develops, so that it is no problem in the hills. Where it does occur, spray with white oil.

Leaf miner generally is not a pest, as the miner has a parasite that keeps its population at an economic level. Where however, bananas are grown as a shade crop and they are regularly sprayed with Bordeaux, this parasite is killed and the number of leaf miners increases to pest proportions. It has been controlled during the non-fruiting season by spraying with endrin. DDT or TDE are also suitable.

Coffee stem borer can be controlled by putting crystals of paradichlorbenzene in the tunnels and stopping up the opening with mud. It is important to prevent it developing into large numbers, so early care is necessary.

Leaf spot diseases sometimes attack coffee, producing small holes in the leaves and causing early leaf fall and in some cases a brown blotch on the berry. Bordeaux (3 : 3 : 50) or other copper spray is recommended for its control.

Black rot occurs on the roots of coffee. Infected plants almost invariably wilt and die. There is practically no control of this disease, but its spread must be stopped and all bushes must be cut down and burnt. The infected areas must be trenched around and the earth thrown towards the plants. Dusting the roots of healthy plants near the infected area with sulphur will help in preventing the spread of the disease.

Corn

Corn suffers chiefly from the attacks of various caterpillars, mainly the fall army worm, the sugar cane looper cutworm and the ear worm. In bad years they may even eliminate the whole crop. It appears that the attack is usually far worse on the autumn sown crop, but whenever the crop is sown it is necessary to keep a close eye on it from the time it comes out of the ground. Very soon after the plant has grown a single leaf, the fall army worm may find it and creep down into the leaf funnel and eat away at the relatively protected part of the plant. This continues throughout its growth.

The sugar cane looper cutworm may attack at about the same time, but its eating is more on the outside of the plant. When either of these are present in any number it is as well to spray with DDT or to put DDT granules in the leaf funnel. It may be necessary to do this twice as the generations of each moth, which vary from a month to six weeks are apt to overlap, and almost always there seem to be insects of all stages present.

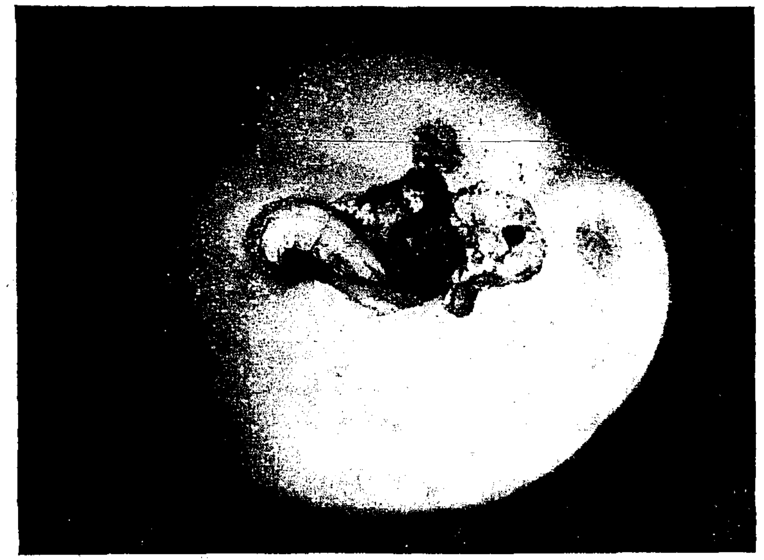


Fig. 12. Fruit Worm

When the young ears are just beginning to form the ear worm appears. For each of these worms DDT sprays will help in the control, but it should be mentioned that complete control of either the fall army worm or the ear worm is very difficult and several sprays may be necessary. To distinguish these worms, it is better to give general descriptions. The **fall army worm** is up to an inch and a quarter long, a varying grey brown colour. The most distinguishing factor is the marking of the head, which has a very definite inverted Y shaped mark between the eyes. The **looper** may be as much as an inch and a half long with longitudinal stripes and greenish-brown in colour. It has only three pairs of 'legs' on the abdomen and it progresses by pulling these legs up behind the front legs to form a loop, then stretching out the front legs to the next point of attachment. The ear worm is about an inch or so long and of very varied colour of green or brown. It is usually found in the ear, which gives it its name without further description.

Occasionally corn is attacked by plant lice. These are best controlled by spraying with dimethoate or malathion, as DDT will not kill more than a fraction.

When the ears are beginning to mature, weevils will appear. The normal DDT spraying will help to kill off new arrivals, but it is necessary not to open the ears on the plant, and to be very clean in the drying process.

Egg Plant

The egg plant may be attacked by plant lice at any time. These can be treated with malathion or dimethoate. Scales are also often a trouble throughout the life of the plant. They can be controlled with malathion or with an oil spray. Especially when the weather is hot, a lace wing bug

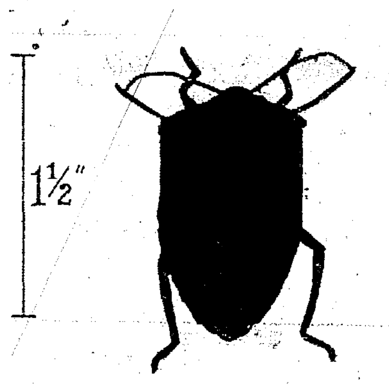


Fig. 13. 'Mary Grudgeful' (*Nezara viriduta*)

may suck the juices of the egg plant. This can best be controlled with a DDT spray. The green **Mary Grudgeful** (see illustration) may occur just about fruiting time and may be very harmful to the fruit that are practically ready to harvest. If there are not too many, the adults can be hand-picked. The clusters of young nymphs should be sprayed. Malathion, TDE or Sevin are all suitable. A beetle stem borer attacks older and damaged plants. Damaged branches must be removed and destroyed.

Grape

The most important pests of grape are plant lice, mites and the beetle stem borer. The **plant lice** are most important on the young flush of growth that comes immediately after the annual pruning. They should be sprayed if they are becoming too numerous with dimethoate or malathion. Mites do not often appear in sufficient number but occasionally during the drier periods of the summer, it may be necessary to spray with a sulphur spray or one of the new mite killers. The beetle stem borer may be pruned off at the annual pruning, but if holes still remain, drop some crystals of paradichlorbenzene into them and block the opening with mud.

Rust is sometimes severe on grape leaves causing small yellow pustules and clusters of yellow powdery spots that come off easily on the fingers. This also damages the leaves and fruits and ultimately reduces yield. Zineb will reduce its intensity if applied before infection is high.

Grapes are often affected by a mildew which affects young leaves and fruits. It destroys the part affected and greatly reduces yield. To prevent its development the vines should be sprayed fortnightly with a copper fungicide or one of the newer fungicides.

Grass

Grass is a most important crop, which, because of its commonness, too often gets little or no attention. At times it may be attacked by both the fall army worm and the sugar cane looper cutworm. Usually this happens

during the flush of growth during the rains immediately after the long summer drought. These are easily controlled with any insecticide, but care should be taken if stock are feeding, and at present malathion is the only chemical which can be recommended and the cattle should be kept out of the field for a week.

A yellow plant louse may sometimes become numerous enough to be a pest. This usually is kept in trim by ladybirds, so that even if the insect has actually become a pest, care should be taken of these. If spraying is necessary, malathion or dimethoate should be used.

Froghoppers and a chinch bug may occasionally become a pest on lawns. They can easily be controlled with a DDT, BHC, chlordane or similar spray.

Lettuce

Lettuce is attacked by most of the usual pests as seedlings. Its chief pest when it is well grown is the white worm, grub of the **May beetle.** As this is underground, this has to be controlled by watering the soil with dieldrin.

Mango

The **mango** is very rarely sprayed even though it may be badly affected by blackfly and fruit fly and be fairly heavily diseased. Often thrips may be found on young leaves, shrivelling them up. With young plants it may be necessary to spray with DDT or BHC which gives an excellent control.

On occasions, farmers and gardeners are much troubled by the **West Indian fruit fly,** which attacks their mangoes. A degree of control has been obtained by using insect fly traps with a sweetened bait, but this is too time consuming and expensive for general recommendation. In America, wide acreages of fruit have been sprayed with a bait spray every ten to fourteen days and all infected material destroyed. Some similar method may become necessary in Jamaica. Spraying the tree is ineffective, as it must be done several times and in any case the immigration of flies to the trees is so considerable that the newcomers may have laid another lot of eggs before they die, so keeping up the infestation of the fruit.

Powdery mildew which appears as a grey or whitish growth on young inflorescences and leaves does a large amount of damage to the mango crop especially during rainy periods. This disease destroys the flowers, young fruits and leaves causing them to fall prematurely and leads to a poor crop in years of heavy infection.

Spraying with one of the copper fungicides or with Karathane at one pound in a hundred gallons of water will give control and encourage setting of a fair crop.

Anthracnose causes small blackish spots on fruits or dark brown spots on leaves and is sometimes serious on mangoes. This is caused by a fungus which is particularly bad in wet conditions which can be controlled by two or three two-weekly sprayings when there are young fruits on the trees using one of the copper fungicides or orthocide at two and a half pounds in a hundred gallons of water. The East Indian variety suffers badly from this disease.

Peanuts

Peanuts are sometimes attacked by the velvet bean caterpillar, which may almost defoliate them. DDT as a spray or dust will control them, but it may be necessary to repeat the spray in ten days to kill off those that may have hatched in the interval.

Papaw

This crop is very badly affected by a mosaic which is supposedly caused by a virus. This disease is either carried by affected seeds or by certain insects and is very difficult to control. Affected plants show a mottling or water soaked condition of the young stem. The leaves ultimately become yellow and crinkled and the plant dies.

Cutting back of the plant below the point of active latex flow may encourage healthy growth but this also is affected before long.

Pimento

Rust is a very serious disease of pimento, especially in upland areas. It may reduce the crop to a fraction of what it should be. This fungus attacks young leaves, flowers and stems, producing masses of yellow powdery spores. The affected tissues become dark brown and die. Low volume spraying with zineb has shown some promise for its control, but further trials are being made to find the best control.

Die back is a disease sometimes affecting pimento, where a branch wilts and its dead leaves remain on it. This can spread throughout the tree and kill it, so that when these branches are seen they should be cut off well below the damage and the cut ends painted over.

Pineapple

Mealy bug is an important pest of pineapple, and one which is difficult to control. It settles mainly at the bases of the leaves beyond the reach of a normal contact spray. The adults are not very mobile, but the young ones are fairly active and move from plant to plant. During the summer they need only two months to mature. They suck the juices from the plant and may cause a wilt through toxins which they inject when feeding. They are attended by ants which feed on the honeydew which they

excrete, and generally help them in their feeding. Unfortunately, there are many other plants on which this mealy bug feeds, so that planting in any area cannot be done in freedom from it. Resistant varieties such as Spanish Red which can be planted are not so much desired for canning or fresh fruit. As far as possible, planting material should be clean. If necessary it can be fumigated or dipped in insecticides. One useful method that can be used in small plantations is action against the ant. The ground should be sprayed with dieldrin before planting, and if necessary the young suckers sprayed soon after planting if it is found that the control has been incomplete. Without the attention of the ant the mealy bug continues to excrete until the results go mouldy and the bug dies as a consequence. Chemical control of the mealy bug itself has been done with the phosphorous chemicals, which seem able to penetrate further into the plant than do the normal contact-insecticides. Parathion is very good, but is too poisonous to recommend, but malathion and diazinon are also quite successful. Trials are also being made with systemic chemicals so as to reach those insects which are beyond the reach of the other chemicals.

Potato (Irish potato)

Late and early blights also affect potatoes in the same way as they do tomatoes. The symptoms are much the same with shrivelled leaves showing up in late blight and with circular leaf spots occurring with early blight.

Late blight may attack potato tubers in the ground and these spoil quickly in storage. A black discoloration under the skin of tubers is indicative of the presence of this disease. Spraying with either Bordeaux mixture, (8 : 8 : 100), cuprous oxide, zineb or maneb at the strengths recommended will give control if properly applied every seven to ten days.

Fusarium wilt similar to that on tomato attacks potatoes and affected plants should be taken out. Efforts are being made to obtain varieties resistant to this disease.

Viruses attack potatoes causing the leaves to crinkle or the plants to become dwarfed and mottled. The use of clean certified seeds from abroad helps to prevent this disease. Affected plants should be pulled out and burnt.

Root knot eelworms attack potato tubers causing them to produce raised bumpy growths on the skin. If an affected tuber is cut, small cyst-like pockets can be seen just under the skin. If the crop is infected, great care should be taken to cull all diseased potatoes or the whole crop may be rejected by the buyer. Control of this disease is best obtained by planting healthy seed in clean land which has not had an Irish potato, vegetable or tobacco crop on it during the previous year. If it is necessary to grow potatoes on contaminated land, the nematodes can be suppressed by fumigating the soil prior to planting. Directions for this can be obtained from the Ministry of Agriculture and Lands.

Spinach

Spinach (**Kalalu**) may be attacked by a **leaf roller caterpillar.** As this habit protects the worms very well from spray it is usually necessary to hand pick them from the plant. If aphids are numerous enough to reduce the crop, it may be necessary to spray with dimethoate. Flea beetles may occur even when the plant is well grown. Spray with DDT.

Sugar cane

The **borer moth** is noticeable, but in Jamaica it is rarely numerous enough to be a pest of sugar cane. The caterpillar which may be as much as an inch long, lives within the cane and may cause loss in bad cases by causing the stalks to break off and the quality and weight of the crop to be reduced. Its numbers are kept low principally by climatic factors and the vigour of the cane, but egg and larval parasites are a very important agent of control.

Cane fly at times is a very serious pest, particularly with young cane, its growth being affected both by loss of juice by the fly and by the sooty mould that develops on its honey dew excretions on the leaves. Normally it is kept in control by various parasites and predators and general climatic conditions in the country. Outbreaks occur when one or other of these factors changes and they may achieve dangerous proportions. When the adults are flying they will migrate from old fields to young ones. Parasites and predators catch up with them a generation or so later. When it is necessary to spray against the cane fly, it is important not to break down the pest parasite balance more than is absolutely necessary. Non-persistent insecticides such as malathion should be used and the spray timed very carefully so that the majority of the nymphs are in the second or third stage. It is necessary to keep a close look out for undue increase in numbers, so that as small an area as possible need be sprayed.

Sweet potato

The most important pest of the sweet potato is the **sweet potato weevil.** This is a slender beautifully-coloured ant-like beetle. Both larva and adult can feed on any part of the plant, but they are particularly fond of the tubers. They also live on various wild plants, and can be a serious pest of cassava. Usually the larvae burrow into the tuber and become apparent just as the crop is reaped. Its control is difficult because most of its life is spent inside the tuber. Fields known to be infested should be ploughed well. Any sweet potato tubers and vines should be fed to pigs. The beetles can be trapped in buried tubers and these then fed to pigs.

As far as possible only clean slips (cuttings) should be used for planting. Nowadays the plants can be protected by watering an eight inch band along the rows with dieldrin. This will kill any invading beetles that may come into the field.

Hornworms may eat almost all the leaves of the sweet potato. They often are particularly prevalent in the summer if wet weather follows a drought. These worms may be as long as three inches, being variously green or brown with diagonal stripes on its sides. The moths, called hawk moths or humming bird moths are about four and a half inches across the wings and are of a general grey colour with pink marking on the body. Generations of this moth often overlap a fair amount and their attack may be almost continuous. These worms can be partially controlled by hand-picking. Natural control by encouraging the cling-cling and other insectivorous birds helps a great deal. If spraying becomes necessary, it should be done when most of the grubs are small. Use DDT and make sure to spray both sides of the leaves.

Occasionally a beautiful golden-coloured **tortoise beetle** may become a serious pest on the leaves of the sweet potato. The grub of this beetle is particularly remarkable in that it carries its cast skins and excrement stuck on spines on its back, making it look like a moving heap of dirt. When this appears, it may be controlled by spraying with DDT. If it is practicable the other plants that are found to be its hosts in or near the field should be removed.

Tobacco

The most important insect pests of tobacco are caterpillars. The most distinctive is the **hornworm.** This is the same worm that eats tomato leaves and it often almost defoliates a plant. There are also cutworms and a heart worm which is the same one that eats tomato fruit. The seed beds should be sprayed with chlordane, endrin or dieldrin at weekly or ten daily intervals. TDE has also been recommended as being a very safe and effective insecticide. When planted out hand picking of the young hornworms may be possible if there are no other worms eating other parts of the plant. It is important to see the small hole and look on the underside of the leaf where the young worm will be feeding. It may be necessary to spray again.

Tobacco is often badly affected by virus diseases which cause various types of leaf mottling, dwarfing and malformation of stems. Affected leaves are poor in quality and diseased plants should be taken out of the field.

Leaf spot also affects this crop but it is usually not serious if cultural operations are satisfactory.

Black shank, which is caused by a fungus, attacks the collar of the plant with fatal results. Pulling out affected plants and rotating the crop are advised.

Root knot eelworm also attacks tobacco and should be prevented by planting in clean land which has not had an Irish potato, vegetable or tobacco crop on it during the previous year. If it is necessary to grow on contaminated land, it is possible to fumigate the soil against the nematodes prior to planting. Directions for this can be obtained from the Ministry of Agriculture and Lands.

Tomatoes

Wherever tomatoes are grown, it is necessary to spray against blight so that all insecticidal sprays need to be fitted in with the fungicidal ones.

Aphids may at times be exceedingly damaging, although usually their numbers do not warrant spray control methods. If the infestation is becoming bad it may be necessary to spray with malathion or dimethoate, both of which are particularly good in the control of aphids.

The **tomato hornworm.** This is very similar to the other hornworms that attack many plants in Jamaica and its adult is a hawk moth with brownish-grey wings. When full grown the hornworm consumes a great deal of food and control must be done before too many larvae grow too large. In small plantations hand-picking will reduce the effect of the attack. There are also some parasitic insects which attack the caterpillars which are fairly useful where they appear, but their control is only partial. When the infestation is bad it may be necessary to spray with DDT, care being taken to spray both sides of the leaf.

The **green bug** or **Mary Grudgeful** may be an important local pest. The adult is a bright green and its young are reddish, later becoming mottled. The young usually feed in clusters, sucking the sap from the plant and injecting toxic substances which cause the shoots and leaves to wilt and drop off. Fruit is deformed and scarred, becoming useless for export. Where possible hand-picking will eliminate the adults, but it may be necessary to spray the clusters of young with DDT or TDE.

The **Tomato fruit worm** is one of the most important pests of this crop, often attacking the crop when the grower thinks he has dealt with all the pests satisfactorily. The fruits are eaten into by the plump green or brown worms and become useless. It may move from fruit to fruit, and if brought into the packing house it will continue its depredations. The worm is about one and three-quarter inches long when full grown. It attacks the fruit of many different plants so it may come from other crops or wild plants nearby. The moth is greyish and measures about an inch and a half across the wings. It lays up to a thousand eggs, of which a considerable proportion may be killed by natural enemies. Such grubs

as survive feed at first on leaves and flowers before turning their attention to the fruit.

Where this pest is expected, preventive spraying should be done with a residual spray which should be applied before the damage has got too far, so that it will kill the caterpillars before they start attacking the fruit. DDT or TDE are both effective.

Collar Rot. This fungus attacks the stem or roots usually at the soil surface, causing the plants to wilt. It is distinguished from Fusarium wilt by the absence of brown strands in the stem and by the presence of a white growth around the stem and roots on which small brown seeds may be seen. It is apparently worse on moulded up plants.

Root Knot eelworm also attacks tomatoes. The best prevention is using clean land which has not had an Irish potato, vegetable or tobacco crop on it during the last year. If it is necessary to grow tomatoes on contaminated land, it is possible to fumigate the soil before planting. Directions for this can be obtained from the Ministry of Agriculture and Lands.

Mosaic. This is a disease due to a virus which is characterised by dwarfing of plants and a curling of their leaves often accompanied by mottling on young plants. Fruit set is greatly reduced. Some varieties are more susceptible than others. Badly affected plants and seedlings should be rogued out to prevent the spread of the disease.

Before touching healthy plants after pruning or, indeed, touching virus-affected plants, it is necessary to wash the hands thoroughly.

Late blight is caused by a fungus which produces water soaked or light brown patches on leaves that quickly become shrivelled and dry up. During damp or rainy weather the fungus can be seen as a whitish growth on the under side of affected leaves. This fungus grows and spreads quickly killing large areas of leaf and affecting the fruits causing a dark brown discoloration by the stem end.

Early blight is caused by another fungus. This produces circular spots on the leaves and stem.

Leaf mould is due to a fungus during cool, damp weather which produces a greyish growth on the undersides of leaves causing the affected areas to become yellow and die.

Other leaf spots sometimes occur but these can be controlled with the same fungicides.

Fusarium wilt caused by a soil fungus is often encountered and affected plants should be pulled out, taken off the field and burnt. Affected areas should not be used for tomato or potato for two years.

Blossom End rot locally known as black bottom, produces a dark leathery discoloration at the bottom end of affected fruits, oftentimes causing them to become unmarketable. The condition is associated with uneven supplies of water, unbalanced fertilizer mixtures and with lack of calcium in the plant.

Yam

Yam as a rule is not attacked by insect pests, but on occasions there are outbreaks of the Yam weevil and the yam scale, both of which attack the tuber. The yam weevil is a small black beetle with reddish brown legs and its grubs are white legless grubs which tunnel in the tubers. The damaged parts rot, and often the yam head which is to be used for planting is completely destroyed. The control of this insect is difficult as it spends most of its life in the tubers, so that cultural methods must be used. Rotation of crops must be done where there is a risk of infestation and any infested material should be destroyed. As far as possible only weevil-free tubers should be planted.

The yam scale occurs both on the tuber and the vine and when it becomes really numerous it may kill the plant. It is a small circular scale, the females being dull brownish-grey in colour. Chemical control can be uneconomic, but tubers should be scrubbed clean with soap and water. Stored yams from infested fields can be fumigated with ethylene dibromide.

Yams and cocoes have their diseases that are mostly caused by soil fungi which attack the roots and tubers. The entire tuber may rot and the plant dies but there is little that can be done to prevent this, other than planting in clean land and using healthy planting material.

Latin names of pests and diseases of crops in Jamaica

Seed beds	fire ant	*Solenopsis geminata*
	cutworms	*Prodenia ornithogalli*
		Xylomiges sunia
	crickets	inc. *Gryllus assimilis*
	flea beetles	*Epitrix parvula*
		Haltica spp.
		Disonycha laevigata
Almond	red-banded thrips	*Selenothrips rubrocinctus*
	'Pop eye'	*Attelabus bipustulosus*
	beetle stem borer	*Apate terebrans* et spp.
Banana	banana borer	*Cosmopolites sordidus*
	banana thrips	*Frankliniella parvula*
	red spider	*Tetranychus* sp.
	leaf spot	*Mycosphaerella musicola*
	Panama disease	*Fusarium oxysporium* var. *cubense*

Beans	Leaf eating beetles	*Epilachne* and *Ceratoma* spp.
	moth worm	*Anticarsia gemmatilis*
	pea aphid	*Macrosiphum pisi*
	bean rust	*Uromyces appendiculatus*
Beetroot	leaf roller	*Psara* sp.
Cabbage	diamond back moth	*Plutella cruciferarum*
	cabbage white butterfly	*Pontia monuste*
	heart worm	*Hellula* sp.
	cabbage mildew	*Peronospora parasitica*
	black rot (bacterium)	*Xanthomonas campestris*
Carrot	leaf spot	*Macrosporium carotae*
Cassava	Hornworm	*Erinnyis ello*
	red spider	*Tetranychus* sp.
	thrips	*Corynothrips stenopterus*
	barnacle scale	*Ceroplastes* sp.
	white mussel scale	*Lepidosaphes alba*
	Sweet potato weevil	*Cycas formicarius* var. *elegantulus*
Citrus	fiddler beetle	*Prepodes vittatus* et spp. and *Pachnaeus citri* et spp.
	orange dog	*Papilio pelaus*, *P. andrena* etc.
	bag worm	*Oiketicus abbottii*
	rust mite	*Phyllocoptruta oleivorus*
	florida red scale	*Chrysomphalus aonidum*
	purple scale	*Lepidosaphes beckii*
	green scale	*Coccus viridis*
	slug worm	*Alarodia nana*
	black fly	*Aleurocanthus woglumi*
	(Eddy wasp)	(*Eretmocerus serius*)
	Mediterranean fruit fly	*Ceratitis capitata*
	piercing moths	*Gonodonta* spp. (and *Mocis* spp.)
	scab	*Elsinoe fawcetti*
	gummosis	*Phytophthora parasitica*
	melanose	*Diaporthe citri*
	tropical citrus aphid	*Toxoptera citricidus*
	psorosis and tristeza	viruses
	stem knot	*Sphaeropsis tumefaciens*
Coconut	star scale	*Vinsonia stellifera*
	rhinoceros beetle	*Strategus titanus*
	destructor scale	*Aspidiotus destructor*

Coconut	shot hole borer	*Xyleborus perforans*
	bud rot	*Phytophthora palmivora*
Coffee	green scale	*Coccus viridis*
	leaf miner	*Leucoptera coffeella*
	stem borer	*Apate terebrans*
	leaf spot	*Cercospora coffeicola*
	black rot	*Rosellinia* sp.
Corn	fall army worm	*Laphygma frugiperda*
	sugar cane looper cutworm	*Mocis repanda*
	ear worm	*Chloridea obsoleta*
	weevil	*Sitrophilus* spp.
Egg Plant	lace wing bug	*Corythuca gossypii*
	Mary Grudgeful	*Nezara viridula*
Grape	Aphid	*Aphis illinoisensis*
	stem borer	*Apate terebrans*
	powdery mildew	*Uncinula necator*
	downy mildew	*Plasmopara viticola*
	black rot	*Guignardia bidwellii*
	rust	*Phakopsora vitis*
Grass	sugar cane looper cutworm	*Mocis repanda*
	chinch bug	*Blissus leucopterus insularis*
Lettuce	June beetle	*Lachnosterna jamaicensis*
Mango	West Indian fruit fly	*Anastrepha mombinpraeoptans*
	black fly	*Aleurocanthus woglumi*
	red-banded thrips	*Selenothrips rubrocinctus*
	powdery mildew	*Oidium mangiferae*
	anthracnose	*Glomerella cingulata*
Peanut	peanut velvet bean moth	*Anticarsia gemmatilis*
Pimento	pimento rust	*Puccinia psidii*
Pineapple	mealy bug	*Pseudococcus brevipes*
Potato (Irish)	late blight	*Phytophthora infestans*
	early blight	*Alternaria solani*
	Fusarium wilt	*Fusarium oxysporium*
Sugar Cane	sugar cane borer moth	*Diatraea saccharalis*
	cane fly	*Saccharosydne saccharivora*
Sweet Potato	sweet potato weevil	*Cylas formicarius elegantulus*
	scarabee weevil	*Euscepes batatae*
	tortoise beetle	*Metriona* et *Chirida* sp.
	hornworm	*Herse cingulata*
Tobacco	hornworm	*Protoparce sexta jamaicensis*

Tobacco	leaf spot	*Cercospora nicotinae* et *Alternaria longipes*
	black shank	*Phytophthora parasitica* var. *nicotinae*
Tomato	fruit worm	*Chloridea obsoleta*
	black shank	*Phytophthora parasitica* var. *nicotinae*
	late blight	*Phytophthora infestans*
	early blight	*Alternaria solani*
	fruit worm	*Chloridea obsoleta*
	hornworm	*Protoparce sexta jamaicensis*
	Mary Grudgeful	*Nezara viridula*
	collar rot	*Sclerotium rolfsii*
	leaf mould	*Cladosporium fulvum*
	Fusarium wilt	*Fusarium oxysporium*
Yam	yam weevil	*Paleopus* sp.
	yam scale	*Aspidiotus hartii*

Active ingredients of some commercial products

Agrocide	BHC
Basudin	diazinon
Blitane	zineb and copper oxychloride
Captan	orthocide
DD	dichloropropene and dichloropropane
Didimac	DDT
Dithane M-22	maneb
Dithane Z-78	zineb
Fosferno	parathion
Fumazone	1,2,dibromo-3-chloropropane
Gammalin	BHC
Gammexane	BHC
Karathane	2-(1-methylheptyl)-4,6-dinitrophenyl crotonate
Katakilla	derris
Kelthane	4,4,-dichloro-a-(trichloromethyl) benzhydrol
Metasystox	demeton-methyl
Nankor	ronnel
Nemagon	1,2,dibromo-3-chloropropane
Perenox	cuprous oxide
Perthane	diethyl diphenyl dichloroethane
Pybuthrin	pyrethrins with piperonyl butoxide
Rhothane	TDE, DDD, dichloro diphenyl dichloroethane

Rogor	dimethoate
Sevin	1, naphthyl N-methylcarbamate
Vapam	Sodium nitro-methyl dithiocarbamate

Indiscriminate use of Insecticide

The use of insecticides for controlling insect pests in the home and on the farm has become quite widespread in recent years.

Control. It is all well and good to attempt to control these insect pests. There are, however, a number of important things that should be known about insecticides to avoid their indiscriminate use.

What must primarily be appreciated is that insecticides are chemicals which differ in degree of toxicity to humans, animals and plants. Some are virtually harmless. If enough of the toxic insecticides were allowed to get into the system by mouth, with or without food—through the nose, by breathing vapours, particles of dust or liquids; or through the skin by absorption, almost certainly there would be ill effects. Similarly before applying an insecticide, the user should become thoroughly acquainted with its uses and characteristics.

Use of Insecticides. Some insecticides are specific, that is to say they are formulated and recommended by the manufacturers to kill only certain kinds of insects, hence it would be pointless applying such an insecticide to kill insects which it was not designed to destroy.

One of the most important sources of information concerning an insecticide and its safe use is the label on the container. If for any reason the label becomes obliterated, it is advisable that all details concerning the proper use of the insecticide be obtained from the firm or agency from which it was purchased. Before attempting to use an insecticide everyone should therefore read and understand all the directions and warnings on the container because they relate specifically to the material in the container, and failure to follow directions could have serious consequences.

Types of Insecticides. Five types of insecticide formulations are employed to control insect pests. These are:

(1) Dusts
(2) Wettable powders
(3) Emulsions
(4) Solutions
(5) Aerosols.

Dusts may be applied by hand dusters, power driven devices or by improvised means such as perforated containers.

Wettable powders, emulsions and *solutions* are applied as sprays. There are various kinds of spray equipment on the market which may be used for this.

An aerosol insecticide is an assemblage of insecticidal particles suspended in air, and, in the most common form, is dispersed in fine mist form through a small opening from a pressurized container. Sometimes referred to as 'aerosal bombs', these containers are available on the market and have become quite popular among housewives, for controlling household insect pests. Many of these aerosol dispensers are marked as suitable for use in the presence of foodstuff, and contain chiefly a pyrethrum base accepted as being virtually non-toxic to mammals. It should not be assumed however that *all* aerosol dispensers may be used in this way, and, once again, the directions on the label must be read and followed.

Precautionary Measures. Users of toxic insecticides sometimes do not exercise sufficient care in storing away these chemicals. There are records of many serious ailments and deaths occurring among children because of carelessness on the part of users of insecticides. Every user is therefore urged to keep these chemicals out of the reach of children and pets.

The direct application of toxic insecticides to foodstuffs in storage should be avoided unless such foodstuff is intended to be used as planting material. In many cases infestation can be prevented, or sufficiently reduced, by improved storage-hygiene and by the use of insect-proof containers. Food already infested can be disinfested by heat or by fumigation. The need for attention to clean and intelligent storage methods, and the value of these, cannot be over-emphasized. There are, however, certain approved toxic insecticides which have been accepted as safe to use on certain kinds of foodstuff, for example, DDT, lindane and malathion have been widely approved for the treatment of raw grains and peas.

While these insecticides are considered safe for use on certain types of foodstuff it must be emphasized that they are only safe if properly used and if the concentration level is kept below certain limits. Lindane for example, has been approved for use on raw unprocessed grains provided the contamination does not exceed 2·5 parts lindane per million parts grain. This is a very low level of contamination, but it is sufficient to kill insects in the grain.

Pyrethrum insecticides have already been referred to as virtually non-toxic to mammals and can be used quite safely on a wider range of foodstuffs.

It is not unusual for some farmers to apply insecticides such as 'Agrocide' liberally to grain and pulses intended for human and/or animal consumption. There appears to exist confusion among some farmers and other users of insecticides as to the difference between 'Agrocide' and the 'weevil powder'. The latter is a low concentrated preparation, containing 0·25% lindane, and is intended for use for the treatment of grains and pulses. Agrocide on the other hand is a high concentrated preparation of an impure form of lindane, containing 0·65% and is intended for treatment of seed, and of certain crops before harvest.

It is generally believed that toxic insecticides can be easily washed off, and that if they are washed off, all will be well. Some of the chemical is removed by washing but a residue usually remains which might have ill effects if sufficient quantities get into the blood stream. If the food is to be cooked this *is* a safeguard as most insecticides are not stable to heat.

If toxic insecticides are to be employed in the dustings or spraying of crops, or in buildings where foodstuffs are in storage, the following precautionary measures should be adhered to:

1. Where dusts are used, a respirator should be worn to prevent inhalation of the dust. Goggles should be worn to prevent particles of dust entering the eyes and a headgear—for example, hat or cap—to protect the head.

2. Where sprays are used, a hat or cap, as well as a full-view face shield, should be worn to prevent splashed spray contacting the skin or eyes.

3. Elbow length rubber gloves should be worn when mixing insecticides and on no account should the exposed hand be allowed to come in contact with the insecticide. Should this happen, the affected parts should be immediately washed to remove the chemical.

4. Extra clothing for changing should be available to avoid a prolonged contact of the insecticide with the skin if splashing occurs. Immediately a spraying operation is concluded, the clothing worn during the operation should be removed.

Because of the toxic qualities of insecticides, uninformed persons should on no account use them other than for such purposes as are specified by the manufacturer and provided that adequate directions are given. Where doubt may exist, persons should consult the firm or agency from which it was obtained for proper advice.

Insecticides have a great part to play in the control of insect pests in housekeeping, agriculture and industry. It would be unfortunate to allow wrong usage to lessen the chance of making economic gains which undoubtedly can accrue from their proper use.

CHAPTER 53

Controlling Insect Pests of Stored Crops

Although there is no extensive farm storage of infestable crops such as grain and peas in Jamaica it is known that considerable losses due to insect infestation in store do occur.

Many farmers store small quantities of these crops for use as foodstuff or for seed, and even although the storage period may not exceed 3–4 months for seed, and a maximum of 6 months for grain stored for food, serious damage can and does occur in many instances. Such losses may be almost insignificant when taken singly, but in aggregate they represent a serious wastage of foodstuff. This wastage can be prevented.

The first and essential step in preventing this wastage is that all people concerned, whether they have to store for seed or for food—whether one bushel or more, must recognize the following facts.

(1) Insects are not inherent in any of the foodstuffs in which they may be found. These things do not 'breed' weevils—the weevils breed themselves and merely feed in or on the foodstuff.

(2) When an adult weevil crawls out of a hole in a grain or pea with no visible entry hole, or when a grub is found in the grain or pea with no visible holes on the outside at all, it is either because an egg was laid by an adult female on or below the surface or because a young grub, which was small enough to make a hole which is not readily visible to the naked eye, has eaten its way into the grain.

(3) All of the insects which occur as pests in foodstuffs pass through the following stages in development.

1. Egg.
2. Larva or grub (the main feeding stage which does most of the actual damage).
3. Pupa (resting stage).
4. Adult (the winged moth or beetle; which is the stage mainly responsible for spreading infestation, and the stage in which mating occurs. After mating the fertilized female lays eggs—in numbers which may total several hundred—thereby bringing about the multiplication of the pest. The adults of some species will also do damage by feeding).

Hygiene. A great deal can be done to reduce insect infestation of stored crops simply by good hygiene. A storeroom which is dirty, or already contains infested commodities, will serve as a breeding ground for insects. These will spread to other commodities in the same store, and to other people's storerooms, and at times when grain crops or peas are ripening in the field they will also spread to the growing crop, and from there to other growing crops and other stores.

Every individual farmer should, therefore, ensure that his storeroom and his fields are not breeding-grounds for these insects. All infested materials must be disinfested or destroyed. It is no use merely to throw out infested materials, it must be seen that they are disposed of in some way which will prevent the spread of infestation. Cracks and crevices in storerooms also harbour insects, and if grains and trash are allowed to accumulate in these places they also may become active breeding grounds. The store itself must be kept free from infestation.

Some methods which may be used to disinfect commodities and prevent reinfestation are outlined below. But before these methods are employed good management and good hygiene must be adopted. By these measures alone is it possible to create an environment in which insect pests of foodstuff are not able to become permanently and well established. And that must be the first aim. These pests are not welcome, so why let them be 'at home'?

Invader Insects. Despite the value of good hygiene and good store management it must be recognized that insects may come into the storeroom with harvested crops. Grain and peas are typically infested to a greater or lesser extent at harvest, and although hygiene alone can reduce the likelihood of serious field infestation it will not ensure complete freedom from infestation. So generally it is wise to treat crops intended for storage immediately after harvest, or if this is not done a close watch must be kept and disinfestation carried out *as soon* as weevils first begin to appear.

Methods of Controlling Infestation

1. **Good drying.** The drier the grain the more resistant it is to insect infestation and the more slowly does the infestation multiply. This is also true of peas and other foodstuffs.

Grain especially is susceptible to infestation by several different insects. Some of these can be eliminated completely by thorough drying. The major pests cannot be eliminated by drying alone but the degree of infestation is considerably reduced. Thorough drying is therefore a very useful beginning to the control of infestation, and more than that, it is also very necessary because many of the insecticide treatments suitable for use in stored grains are made less effective, and less lasting, if the grain is not well-dried.

The following figures should give some guide to the amount of sunning which is necessary for thorough barbecue drying.

MINIMUM DRYING TIMES FOR SUN-DRYING OF SHELLED MAIZE

Depth of grain	*Time of exposure necessary (in strong sunshine)*
2 inch or less	10 hours (2 days 9.30 a.m.–3.30 p.m.)
4 inch	25 hours (5 days 9.30 a.m.–3.30 p.m.)

2. **Use of Insecticides in the Storeroom.** Insecticidal treatments, if applied after cleaning the storeroom, will help to prevent the spread of infestation into and out of the store. All insecticides must be regarded as toxic chemicals, and must be handled with care by the user. In particular the manufacturers' advice on precautions in use must be read and complied with and these chemicals must be kept out of the way of children and animals.

Spraying the walls and floor. A small knapsack pump, or bucket pump, is the best thing to use for applying the spray. An ordinary 'flit-gun' is *not* satisfactory.

There are three insecticides which are suitable for this purpose, either as wettable powders or as emulsifiable concentrates, and they should be mixed at the rates indicated below and applied at a rate of approximately 1 gallon for every 1000 sq. ft. of wall or floor surface.

Malathion:

25% Wettable powder:	7–14 ozs. per gallon of water.
Emulsifiable concentrates:	Dilute with water to 2–3% by volume.

This treatment should remain reasonably effective for 3–4 months.

DDT:

50% Wettable powder:	14 ozs. per gallon of water.
Emulsifiable concentrates:	Dilute with water to 5–6% by volume.

This treatment should remain reasonably effective for up to one year.

Lindane:

50% Wettable powder:	4–7 ozs. per gallon of water.
Emulsifiable concentrates:	Dilute with water to 2–3% by volume.

This treatment should remain reasonably effective for 2–3 months.

The maximum rates given above should not be exceeded and care must be taken to ensure that foodstuffs are not exposed to the spray.

Use of smoke generators. Smoke generators containing lindane, DDT, or malathion, *but no other insecticide* may be used as an alternative to spraying in storerooms. This treatment may be more convenient in practice *provided that the storerooms can be closed up tightly to prevent the 'smoke' escaping* *and being wasted*, but it is not otherwise preferable to spraying. Treatment every 4–6 weeks will be necessary to maintain a reasonably effective insecticidal deposit. Smoke generators may be used in the presence of foodstuffs in bags or other containers but exposed foodstuff must be removed or protected.

The manufacturers' directions and recommendations must be followed. This treatment is **not** a fumigation, and infested foodstuff will not be disinfested by it. It is a surface treatment only.

Treatment of foodstuffs. The insecticide sprays referred to above should not be allowed to contaminate foodstuffs. Under certain conditions these sprays may be used to protect bagged grain or peas, but they should not be used for this purpose unless specific advice and instruction has been given by a reliable authority.

The only insecticides which may be generally used for the treatment of bagged commodities, or for spraying in stores containing exposed commodities, are insecticides containing pyrethrins, or, so-called 'synergized' pyrethrins, without any other insecticides. These may be used for surface spraying, as described earlier, of walls and of bagged commodities, or as a fine spray for 'misting' the whole storeroom, but frequent use is necessary because these insecticides do not have long-lasting effects. Surface spraying with pyrethrins needs to be done every 1–2 weeks if good effects are to be obtained, and misting at least once a week, and preferably more frequently. At these rates the treatment can become rather costly.

Disinfesting foodstuffs. Infested commodities may be disinfested by heating thoroughly at moderately high temperatures, but this is not usually a practical method if large quantities are involved. The alternative is to use a suitable fumigant. At present the only suitable safe fumigant readily available to the farmer is a liquid grain fumigant containing ethylene dichloride and carbon tetrachloride in a 3 : 1 mixture. This fumigant may be marketed under various trade names (e.g. **Killoptera** and **Dowfume 75**). These fumigants, unlike many others, are quite safe to use. There are no harmful effects on the treated commodity. The fumes evolved are not dangerously inflammable, so the liquid can be stored quite safely in ordinary containers such as screw-capped or well-stoppered bottles. The fumes do have an anaesthetic effect and are toxic if inhaled in sufficient quantity, so the obvious precautions in handling must be observed. However, the fumes have a recognizable smell, and one cannot inhale them without knowing it. Nevertheless, containers should be labelled clearly with the contents and must be kept out of the way of children.

In order to use **Killoptera** the infested material must be put in a reasonably air-tight box or bin, (a 45-gallon oil drum is ideal) and a tight-fitting lid or gas-proof cover must be available. If the drum is of the type

which has a metal lid and gasket held in place by a clamp this should be satisfactory so long as the drum is not bent or buckled. Otherwise, the best method of sealing the drum is to cover it over with a piece of polythene film tied down tightly all round. Polythene is a plastic which is quite commonly available nowadays and polythene film and bags are made locally so it is not too difficult to obtain a piece.

The liquid fumigant is applied by spraying or pouring a measured quantity on to the infested material in the drum, and the drum is then covered over and left for *at least 48 hours*. The dosage to use is 5 fluid ounces per 10 cubic feet. A 45-gallon drum has a volume of approximately 8 cubic feet.

This treatment can be used quite safely for all foodstuffs and for grain and peas, including material required for seed.

Preventing reinfestation by mechanical protection. The simplest method of preventing reinfestation is to store the disinfested commodity in an insect-proof container. Fumigated commodities can be kept quite safely in a metal bin, provided that the bin is tightly sealed and that the grain is properly dry. Alternatively, a plastic lining in a jute sack may be used. Large plastic bags can sometimes be obtained second hand nowadays, and provided that these are intact and free from holes, and are tightly fastened at the neck, they make an effective shield against the entry of insects unless exposed continuously to heavy infestation.

Protection by insecticides (grain and peas). Grain and peas can be protected from reinfestation very effectively by mixing with them a very dilute insecticidal dust. Lindane and malathion have been approved for use in this way, but only special low concentration formulations are suitable, and *unless an insecticide is reliably labelled as being suitable for this purpose, with clear directions for use given on the label, it should not be used.* A suitable low concentration lindane formulation (0·025% lindane)* has been available to the farmer for some time and is still very effective. It should be used at the rate of 8 ozs. per 100 lbs. for 3–6 months protection, or 1 lb. per 100 lbs. for longer storage. The powder must be mixed thoroughly with the grain and the dosage rate must not be exceeded. This treatment may also be relied upon to eliminate a light infestation but unlike fumigation it will not kill the grubs which may be present in the grains. These will not be affected by the insecticide until they emerge as adults, so some slight damage will occur in the early stages.

Seed for planting may be treated safely with this insecticide, and if there is no chance of the seed grain being required for food higher dosages, or higher concentration formulations, may be used if necessary. DDT 5% dust or malathion dust may also be used to treat seed grain. Germination will not be adversely affected.

* J.A.S. 'weevil powder'.

There are many methods which have been used successfully for controlling those domestic insect pests dealt with here. Of these many methods only those which are available and suitable for general use will be mentioned.

All of these pests can be controlled effectively. If a method does not work it may be—as with some insecticide treatments—that resistance to the insecticide has developed in the insect. More often it is because the treatment has not been carried out with sufficient care and thoroughness. In either case it is almost always possible to get good results by modifying or improving the method, but any person who tries methods suggested below and does not get good results is advised to obtain proper advice before using other methods *and before losing faith in the method itself.*

All the insecticides mentioned here—although quite safe if used as recommended, are *poisons* and must be treated as such. Bottles of insecticide *must* be kept out of the reach of children and sprays and dusts must not be allowed to contaminate foodstuffs or kitchen utensils. They are best applied by means of a *suitable* spray pump but they can also be applied effectively with a paint brush *which should be thoroughly cleaned after use* unless kept safely for this purpose alone. Spray pumps designed to give a fairly coarse wetting spray are suitable for applying the treatments mentioned in the following sections. The flit-gun type of pump *is not suitable.* The fine spray produced by these pumps cannot be directed effectively so that a proper treatment cannot be given and, what is more, *there is greater risk of contamination by drifting spray particles and greater personal risk to the user.*

The use of various insecticidal sprays is mentioned at several points. Insecticides are sold at various concentrations, and where dilution is necessary before use directions for dilution should be given on the label. If dilution is not necessary then this should be stated. If the appropriate information is not given it is advisable NOT to buy the insecticide. In general 1%, 2%, 3% or 5% sprays are used, depending on the insecticide and the purpose for which it is used. An insecticide concentrate as sold might, for example, contain 24% of the active ingredient. To obtain a 3% solution it would therefore be necessary to measure out one volume of the insecticide and add seven volumes of water or kerosene, (making eight volumes in all so that the final concentration is $\frac{1}{8}$ of the original concentration; thus:

$$\frac{24\%}{8} = 3\%).$$

Insecticide concentrates suitable for dilution with water are called 'emulsifiable concentrates'. These concentrates can also be diluted with kerosene. The words 'emulsifiable concentrate' may be marked on the container or it may simply say that the concentrate can be diluted with water or kerosene. Some concentrates can only be diluted with kerosene,

and you must make sure that you know which kind you are buying.

Emulsifiable concentrates diluted with water should be used as soon as possible, because their effectiveness may decline quite quickly after dilution.

With insecticidal dusts dilution is not necessary but you must make sure that you purchase the dust at the recommended concentration. (E.g. for 5% DDT or 0·5% lindane: these are the concentrations for which you must ask when you purchase the dust.)

Some very effective insecticides which have been specially prepared for immediate use (i.e. without dilution) and which are particularly suitable for brush application are available from the various farmers' supply stores. These are quite cheap to buy in small quantity and should be preferred to concentrates which are not only more dangerous but also more troublesome to handle. These ready-for-use insecticides should have their contents described on the label, so that you can still look out for those containing the insecticides specifically recommended on the following sections.

These ready-for-use insecticides *must still be used carefully* and all the precautions mentioned earlier must still be taken.

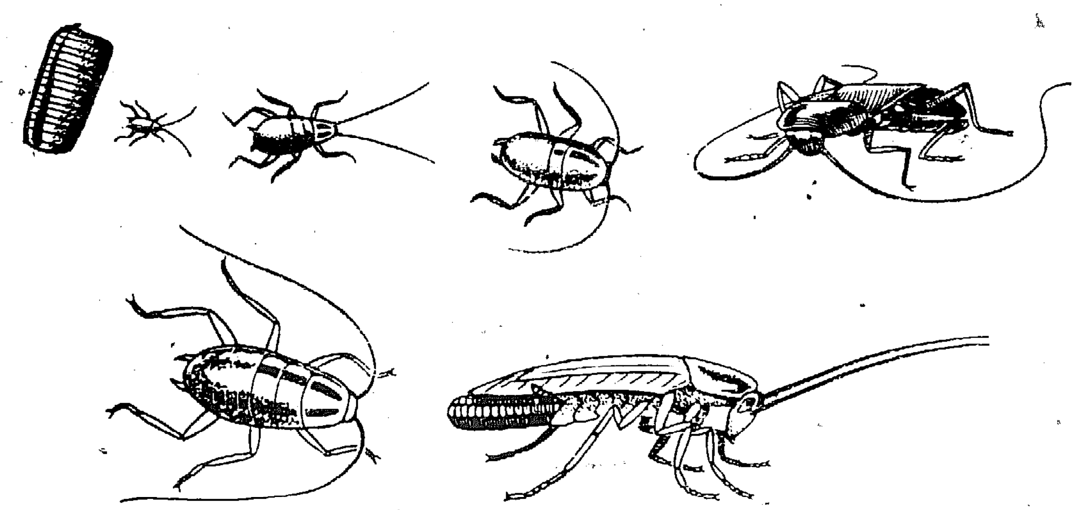
Prevention and control

Cleanliness is vital. Kitchens and cupboards must be kept clean and small particles of foodstuff must not be allowed to accumulate in cupboards, on shelves, or behind furniture and kitchen fixtures. Old wallpaper which is peeling is also a good breeding ground since it provides hiding places and food. (Cockroaches will feed quite happily on paste or any similar gummy material.)

Spray treatments should be applied to wall surfaces where the insects are seen to run or congregate, to the inside surfaces of cupboards, and behind and beneath cupboards and fixtures if possible. (It may be easier to apply dusts in these places.) Cupboards where unpackaged foodstuffs are kept, or where foodstuffs such as sugar and flour may be spilled and collected up for use should not be sprayed. Such foodstuffs should be kept in one cupboard with a tight fitting door, with all other openings covered by *fine* mesh gauze or wire netting, and cleanliness alone should be relied upon in this cupboard. Cupboards and drawers used for pots, pans, cutlery, tinned foodstuffs, and foodstuffs in cartons, may be sprayed but they must be emptied before spraying, allowed to dry, and lined (shelves and bottoms of drawers) with greaseproof paper, or brown paper, before replacing the cupboard contents.

Insecticidal paints and lacquers have been developed for cockroach control. Many of these contain dieldrin and may not be effective against the German ('teenager') cockroach. Any of these preparations which become available locally must be treated as insecticides and not as harmless 'magic paints' and the usual precautions must be observed in their use.

They are not suitable for indiscriminate application, and it is best to avoid altogether those which do not give on the label a clear statement of the precautions which should be observed in use.



Cockroaches
(Courtesy Canadian Department of Agriculture)

Cockroaches *

Characteristics and Habits. No insect is the cause of more troubles to the pest control operator than the cockroach. And, of more than 3,500 species still surviving in the world, the one that brings the most complaints is the resistant German roach. There is a good reason for this.

Sanitation. As with most pest problems, the best control begins with cleaning up; sanitation must be a part of every roach control job.

From the start, eliminate the food and water supply which roaches must have to live. Excess moisture should be reduced or eliminated.

Any crack one-eighth of an inch or more wide, is an entrance to a hiding place, and should be sealed up with cement or any other suitable material. This is especially important around pipes, between window sills and the wall, around loose door frames, between food cases and uneven floors, etc. Roaches breed in cracks and crevices of all kinds.

If you have a powerful vacuum cleaner, use it in the initial clean-out to draw up dust, debris, food and scraps, all of which help to keep roach populations alive.

Do not let food scraps fall or remain in places where roaches can get them.

Garbage must be kept in cans with the cover fitted securely, particularly in basements.

* Matter on cockroaches taken from *Pest Control Magazine*, 1900 Euclid Ave., Cleveland, Ohio.

Where possible, install metal fixtures instead of those made of wood. If you can, remove all unnecessary trim behind which roaches can hide.

In short, an exhaustive programme of cleaning up and sanitation must be inaugurated if your control efforts are to have lasting effectiveness.

Where to Look for Roaches. Often as not you know where the roaches have been seen, but that does not mean that that is where they are, or where they come from. You should have a good strong flashlight and a mirror to search for their hideouts. For those places you cannot easily see, flash your light into the mirror and you will be able to peer deep into dark, hidden places.

You may find empty or full, brown or black, cross-ridged, pocket-book-like egg capsules. If full, you may see as many as 40 eggs neatly lined up, half on one side, half on the other, inside the case when you open it up.

There may be excrement stains that look like either drops of greasy water or large grains of soil.

Roach droppings usually have six horizontal ridges along the pellets and that is how you tell them from small mouse droppings.

Frequently there is a characteristic offensive 'roach' odour, but it is indescribable and is one you will have to learn to recognize only through experience. The smell is due largely to an oily liquid secreted by roach scent glands and by their excrement.

One trick old-timers use for discovering hidden infestations is to blow, with a rubber bulb or bellows-type duster, some pyrethrum powder into likely hiding places. Fresh pyrethrum is known for its quick knockdown and thus irritates the roaches, causing them to run about or 'come out for air'.

Where to Put the Chemicals. No one can give you instructions that will fit every roach job you will run into, but here are some practical suggestions.

The first task is to do a 'clean-out' which is a complete cleaning up and application of chemical, more thorough than should be necessary on subsequent calls. In a clean-out, the person amply dusts or sprays every crack or crevice behind stoves, under iceboxes or refrigerators, in and around pipes, in all wooden joints and fixtures, around stacks of boxes or other debris that cannot be moved, under the sink, behind shelving, and wherever else there is evidence roaches might be hiding or coming from. Use a vacuum cleaner and/or a broom to get rid of loose food particles on the floor, under cabinets, refrigerators and stoves, between cracks, etc.

For household spraying, an oil-base formulation is generally used rather than a water-base solution, since the possibility of staining is much less likely to occur with an oil-base material. In other places staining may be less important and the odour frequently associated with oil-base

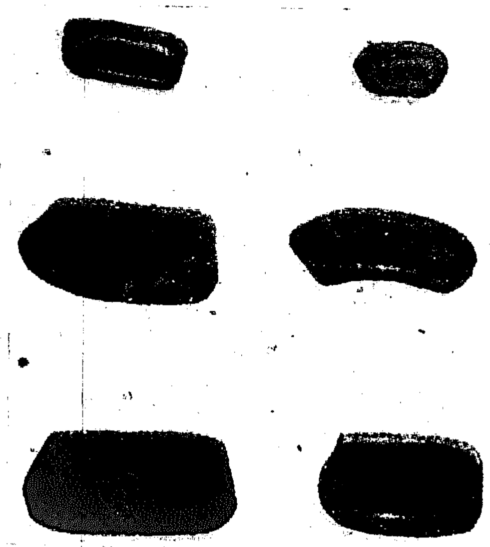


Fig. 2. Egg capsules of cockroaches
(Reading left to right)
Top row: German and Brown-Banded
Second row: Oriental and Woods
Third row: Smoky Brown and American
(*Courtesy Professor Gould, Purdue University*)

insecticides may be objectionable, so many people prefer to use water emulsions. Here are some 'don'ts' to observe whichever type you use:

Do not get water-base sprays into electric outlets or on fabrics or papers that will run or stain.

Do not use oil-base sprays on asphalt tiles or other surfaces that will be damaged by them.

Do not be careless about applying chemicals in television sets, radios, hi-fi sets, air conditioners, electric washers and driers, stoves, sewing machines, refrigerators, etc. You may cause serious damage to such appliances if you are careless. Use a paint brush to apply cautiously any chemicals in these appliances.

Where roaches are not resistant to chlordane, a 2% formulation of this chemical is the one preferred by most. But German roach resistance to chlordane and other chlorinated hydrocarbon insecticides is almost nationwide, so the industry has turned to the organic phosphates. But these newer chemicals do not give the long-lasting residual control chlordane once did of non-resistant roaches, hence many people use a sodium fluoride-pyrethrum powder mixture. It is most effective against the German roach. Phosphorus paste baits are more effective controls of the American, Oriental, and Brown-Banded roach. A common roach powder consists of (by weight) 1 part pyrethrum powder, and 3 parts sodium fluoride, coloured Nile blue.

To reduce the dustiness of this sodium-fluoride mixture, add a small quantity of highly refined kerosene: $\frac{2}{3}$ of a teaspoonful to each pound of mixture, or approximately 1 pt. of base oil to 50 lbs. of powder.

It is not necessary to add food baits to roach powder since roaches pick up the poison by merely wandering through it.

Dust can be distributed by using either a small hand plunger, bulb, or bellows-type duster. Long, small metal tube extensions, pinched at one end, enable high or out-of-the-way places to be more easily reached.

Blow the powder into hiding places or underneath and behind objects and on to surfaces where roaches run. A light uniform film is sufficient. Repeat when excessive moisture causes the powder to cake and become useless. It is best to apply dust where it will be protected from moisture, grease, and ordinary cleaning operations.

Some people drill small holes in baseboards, walls, etc., to get the dust to roaches between wall partitions.

Never put dusts in places where they can be contacted by children, pets or unreliable persons, or where the dust can sift down on to food, dishes, utensils, food processing equipment, etc.

Placing a band of roach powder on the floor around the edges of an unused room may kill many of the roaches, but it is not an adequate treatment. Many roaches are able to go from their hiding places to sources of food and water without crossing the band of powder.

The main preference of sprays over dusts is that the powder is conspicuous and unattractive, whereas the toxicant in sprays is not noticeable once the oil or water carrier evaporates.

Using sprays and dusts in the same building is sometimes advantageous, the residual sprays being used on all surfaces readily accessible and the dust blown into cracks and hidden crevices. Dust can also be applied safely in places where use of an oil-base spray would create a fire hazard, providing there is no chance of food contamination and water-base sprays cannot be used.

For use in the home a liquid insecticide is often more suitable than powder. It can be sprayed into cracks and other hiding places. It can also be applied on exposed surfaces, such as baseboards, where the roaches will crawl over the residue when they come out of hiding. A liquid spray should be used on vertical surfaces and on the underside of objects, where a dust would not adhere or would leave an undesirable visible deposit.

In basements, spray your chemical on walls 12 inches up from the floor, and 12 inches down from the ceiling. Upstairs, spray above baseboards, as well as on them, all around rooms suspected of having a roach infestation.

Liquids can be applied with a hand sprayer in small areas. A compressed-air or power sprayer is recommended for larger areas. The sprayer should deliver a fairly coarse spray which will wet the surface being treated. If the mist is too fine, it will float away in the air. Use just enough sprayer pressure to moisten the surfaces thoroughly, but not so much that the liquid runs or drips, or washes dirt out of cracks. Thus, you will also avoid misting and splattering the chemical in your face.

Pin sprays from long wands are useful for reaching high or low places without wasting or splashing chemical.

If there is any spilling or dripping, be sure to wipe it up with your rag. And wash off any chemical that gets on your face, arms and hands.

Sewers, a Special Problem. Many sewers in cities afford shelter for cockroaches. They will migrate in search of food from manholes into private homes, bakeries, restaurants, and similar buildings. A 2% chlordane emulsion applied as a fog has proved effective for sewer-line treatment. An emulsion containing 1% dieldrin is also effective. The fog should be applied in one manhole until it can be seen escaping from the next. Spot treatments of manholes should be made by spraying the sides.

Special precautions must be observed when using this method to treat 'sewer roaches'. All operators should wear protective clothing to prevent skin absorption of the insecticide and be equipped with suitable respiratory protection equipment.

Roach control techniques do not come easy, but if you follow principles and suggestions given here, you will do a better job in less time. Just be sure you know the species of roach you are after, otherwise much of your efforts may be misdirected.

Which Chemicals to Use. The chemical you will find most effective depends upon your skill and the degree of resistance in your area, as well as upon sanitation conditions, and limitations established by the presence or absence of food and food machinery.

Places to look for Roaches

A

unused air conditioning units
air ducts

B

boxes
bars
baseboards
basement walls
baskets of fruit
bedroom furniture
insulating boards
soiled books
bread around breadboards
brooms

C

cabinets
in and behind utility cabinets
behind calendars
behind cartons and similar packages
cases
ceilings of pantries, kitchens, restaurants
under chairs and tables
around cheese
chests
abandoned cisterns
closets
construction materials

couches
cracks between window sills and wall
cracks between uneven flooring
orange crates
crevices in wood, plaster, concrete, or metal
cupboards

D

around and under debris
desks
dishwashing machines
over door frames
door hinges
under door trims
dressers
clothes driers
in dumps

F

double floors
ends of floor joists
uneven floors under counters and cabinets
floor alongside foundations in sod areas
on top of foundation sills
over door frames
over window frames
in living-room furniture

G

garages
glue
grease traps

H

entrance halls
wicker clothes hampers
behind hinges

I

under iceboxes
under ironing boards

J

junk yards

K

in kitchens
in and behind kitchen closets

L

gummed labels
lavatories
dirty laundry
in commercial or home laundries
around leather
piles of leaves
under linoleum

M

magazine racks
on and underneath meat cutting blocks
behind and over mouldings
mortar joints

P

behind packages
accumulations of papers
behind picture frames
in and around water pipes
pipe tunnels
plants
bags of potatoes
produce racks and tables

R

in radios
refrigerator motors
row houses

S

inside scales
sewers
sewer outlets
sewing machine cabinets
sideboards
bookshelves
pantry shelves
under shingles
old shoes
under kitchen sinks
kitchen sink drawers
food storerooms
non-food storerooms
behind stoves
in pan drawer of stoves

T

in and under tables
flush tanks

behind toilets
trash

V

vegetation coin-vending machines
ventilators

W

between walls
double walls
behind wall ornaments
wallpaper
over window frames
in all-wood joints and fixtures

Chemicals used for Roach Control

Baits

Phosphorus Paste. Phosphorus paste is still commonly used for controlling Oriental, American, and Brown-Banded roaches. Can be applied with a spatula or a flexible knife blade on basement walls, at the end of floor joists, on top of foundation sills and uprights, and in out-of-the-way places, or the paste can be spread on paper butter chips, paper souffle cups with the word 'Poison' imprinted on them, or coated cardboard and placed or thrown into areas that cannot be reached. If phosphorus paste is applied to very porous surfaces, it will dry out rather rapidly. If applied to relatively non-porous surfaces, it is said to remain soft, attractive, and effective for over two weeks. Do not apply on wet surfaces. It acts as a stomach poison. As supplied by reliable concerns, phosphorus paste is not a fire hazard provided directions on the label are followed. Paste should never be cut or diluted with water, syrup, or any liquid. It is highly toxic to man. It should not be used around inflammable materials. Odour of phosphorus paste and its fumes act as warning agents to adults. Never use where it is accessible to children or pets, or in such a way that it will drip.

Other Baits. Baits do not seem to be effective against German roaches, but against American, Australian, and Brown roaches. The U.S. Department of Agriculture found satisfactory baits that could be made of cornmeal, plus syrup, or powdered sugar, or dextrin, or syrup mixed with either 1% Dipterex, 0·5% dieldrin, or 2% chlordane. A half-pound of bait was put in an average home, spooned out and put in places where children and pets would not get it. 'Oddly enough these roaches seem to be able to find it,' even if baits are put in out-of-the-way places.

Dusts

Pyrethrum. Pyrethrum dust formulations are effective for flushing out roaches. It is safe and is a contact botanical insecticide with good knockdown qualities. Often added to sodium fluoride to combine knockdown with faster initial kill. The extra expense of pyrethrum, or pyrethrum plus synergist, is justified, many feel, to get a quick reduction of roaches and

because of its low mammalian toxicity can be used liberally. A more toxic, longer-lasting pesticide can then be used for spot treatments later to give lasting control. Fresh formulations must be used because 'stale' pyrethrum deteriorates and loses its effectiveness. Often used as a spray.

Ryania. Ryania is a botanical dust said to be toxic to both German and American roaches. It is said to be non-toxic to man, non-volatile, and to have residual action. A new formulation combines pyrethrum plus ryania, with or without sodium fluoride, to kill resistant roaches. Should be applied only in dry places.

Sodium Fluoride. Sodium fluoride is an effective, very toxic dust against both resistant and non-resistant German roaches. It must be very finely ground to be effective. It is a contact poison, so roaches must run through it. This chemical is frequently mixed with pyrethrum in a 1 part pyrethrum to 2, 3, or 4 parts of sodium fluoride, depending upon the user's preference. One standard mixture today is (by weight) 65% sodium fluoride and 35% pyrethrum powder. Dust gently and evenly to keep dust from fluffing into the air and getting into operator's nose. It should never be applied where food or food utensils are exposed. Has high toxicity to man. Keep away from children, pets and irresponsible persons.

Chlorinated Hydrocarbons

Chlordane. Chlordane is the best residual insecticide for non-resistant roaches. A 2% coarse spray of oil solution, or water emulsion, or a 5% dust gives good control for 60 to 90 days, depending upon the surface upon which this is applied and upon subsequent cleaning methods. Apply thoroughly to infested cracks, baseboards, and other hiding places. Apply locally on exposed surfaces where roaches will crawl when they come out of hiding. Usually 1 gallon of 2% spray can be used per 1,000 linear feet of crevice spraying, or 1 pint per 125 linear feet. Should be applied wet, with minimum fogging. In dust formulations 5 or 10% chlordane is especially useful. Use with care.

DDT. A 10% oil-base or emulsion spray has produced high kill of both non-resistant German and American roaches, but apparently this chemical has short-lived residual action against roaches. A 50% DDT dust is reported to be an excellent tool for control of American and Oriental roaches where it will not contaminate food. Some use from 20 to 50% dust for blowing between walls with a hand or electric duster. Employ ordinary safe-use precautions.

Dieldrin. Use a 0·5% solution in the same way you would use chlordane as described in section above. A 1% emulsion or solution is reported to give longer residual control of American roaches. A $1\frac{1}{2}$ to $2\frac{1}{2}$% dieldrin dust can be used to control American roaches where there is no danger of food contamination. Effective against most non-resistant species. Use common sense safety precautions.

Lindane. Against several non-resistant roach species a 0·5 to 1% lindane spray is said to be useful, but it does not have the residual killing power of chlordane. Use with care.

Organic Phosphates

Diazinon. Diazinon is effective against resistant German roaches in either 0·5 or 1% sprays. The higher concentration is used in the initial clean-up, while the lower concentration is used for subsequent service. Over 7 weeks control in homes has been experienced in U.S. Department of Agriculture tests. The residual activity is longer on pervious surfaces such as wood and wallboard than on impervious materials including glass, ceramic tile, stainless steel, etc. It is available in both water emulsifiable and oil-base concentrates. It can be used safely if normal precautions are observed and is approved for use by the public.

Dicapthon. Dicapthon is a new fast-acting, long-lasting insecticide effective against resistant German roaches. Apply 1% dicapthon emulsion wet spray to places where roaches are seen or hide. In homes treatments should not be made more than once a month. Some odour and staining problems exist in present-day formulations, but these may be eliminated as formulations are improved. It is available in both water emulsifiable and oil-base concentrates. It is one of the relatively safe organic phosphate insecticides, but operators should avoid prolonged breathing of spray mist, and repeated contact with skin. Do not apply near animals or poultry, near food, or in dairy barns.

Ronnel. One of the newest organic phosphates is ronnel which at 1% emulsion was 92 to 96% effective against resistant German roaches for 60 days on masonite test panels.

Malathion. Malathion has low mammalian toxicity and has given good control of non-resistant roaches throughout at least 7 weeks with a 2% oil-base spray. In dusts or oil-base sprays, concentrations of 1 to 3% are effective. It usually gives over 1 week control of resistant species. Former unpleasant odour has been overcome in premium grade sprays. Oil-base spray said to be more effective than water emulsions. Observe personal precautions.

Malrin. A 5% malrin dust is said to be effective for resistant German roach control. A 4% oil-base formulation spray of this chemical is also recommended. As a spray, 10 ounces of 55% malrin oil soluble concentrate per gallon of oil carrier, applied in the usual wet procedure, is said to be effective against German, Brown-Banded and Oriental roaches. Relatively safe when used according to directions.

Desiccant Dusts

In the 1940's the desiccant effect on roaches of certain sorptive dusts was observed. More recently, entomologists at the University of California, Los Angeles, have instigated new investigations into this method of control. Roaches have protective lipoid film and wax. Their abundant body oil is readily absorbed and thus roaches are amenable to control by use of sorptive dusts.

In the laboratory, the American cockroach can be killed in about 5 hours with such silica aerogels as Santocel C and Hi-Sil. The German roach, being much smaller, can be killed in about 1 hour with these dusts. If this method of control is practical in the field, the rapid and complete dessication of roaches would eliminate the bad odours that usually occur after the poisoned insects crawl to inaccessible places before they die.

Repellents

Roach repellents, employed in a relatively new control technique, may be applied on beverage dispensers, wood beverage cases, to certain areas in kitchens, warehouses, in basements, on beams, posts and pipes, etc. Two such repellents are 1% MGK Repellent 11 with pyrethrum spray, and Tabutrex which is formulated as an oil spray or in emulsifiable form. Repellents drive roaches to other areas where poisons can be used to kill insects.

Fumigation

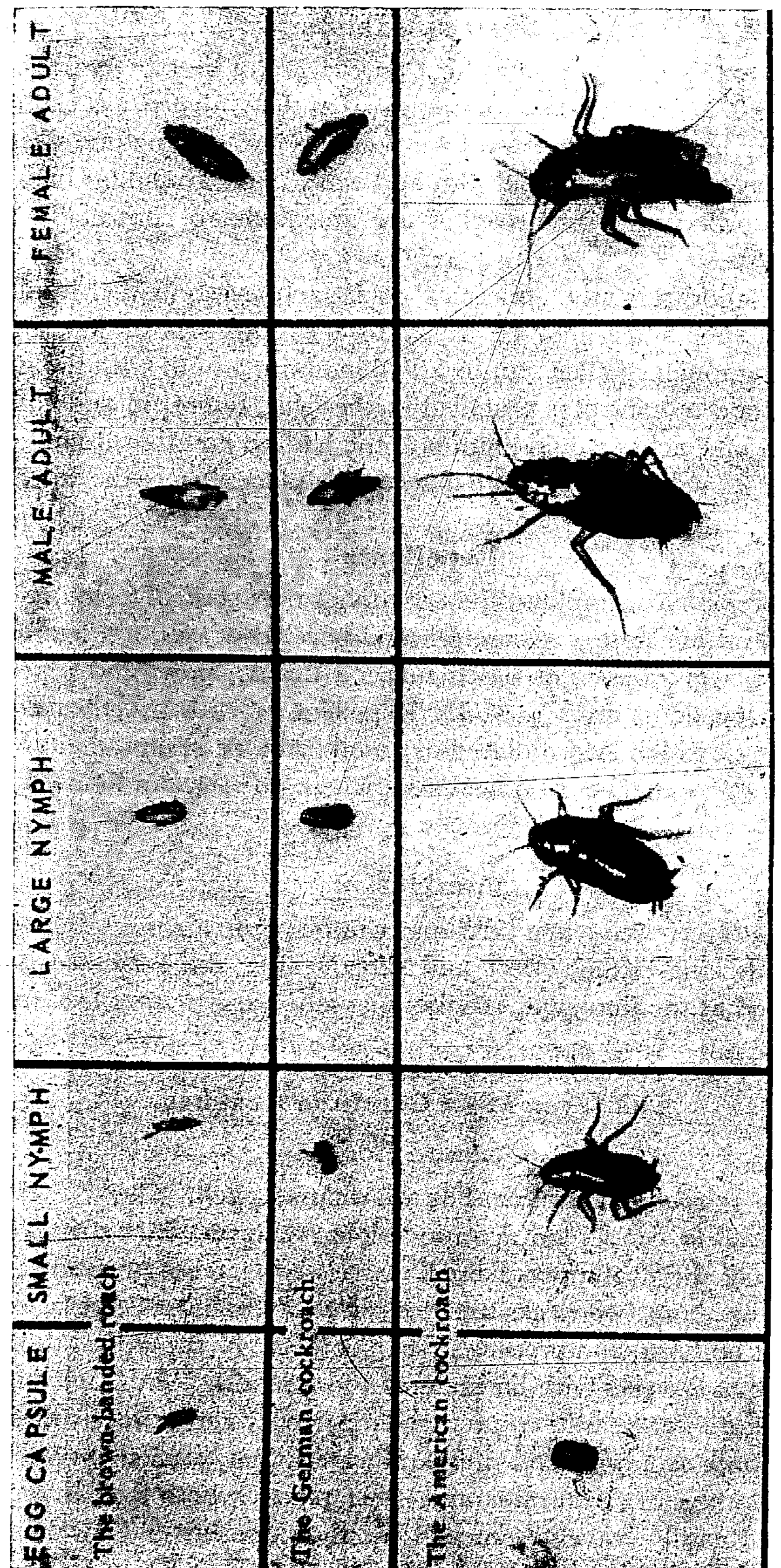
Fumigation is used when buildings can be made air tight, but there is no residual, long-lasting effect and shortly after the structure is completely aired of the fumigant, roaches may once again enter from outside sources.

The Seven Most Common Roaches

German Roach

Blatella germanica (Linne). The German Roach. The Water Bug. The Croton Bug. Small, tan, ½ an inch long, with two dark stripes on the upper side of the prothorax. Female carries egg packet protruding from abdomen for about two weeks until nearly ready to hatch. Averages 25 to 30 eggs per ootheca, and produces 1 to 7 ootheca. Nymphs pass through 7 moults in 6 to 8 weeks with life span of 2 to 5 months, with an average of 2 or 3 generations a year in an average house. Very active, rarely flies.

Commonly occurs around sinks and water pipes, in kitchens and bathrooms of homes, in restaurants and other places where food is prepared or stored. Readily travels from one room to another over walls, along water and heat pipes, and through incinerators. Not normally found in



Actual size, life cycle pictures of three common roaches
(U.S. Department of Agriculture)

bedrooms. Recent reports of them in living-rooms, bedrooms, clothes closets, bedroom furniture, lobbies, entrance halls, checkrooms, non-food storerooms, coin-vending machines, in food packages, laundry and similar material, behind radiators, in hotels. Many places similar to those usually inhabited by Brown-Banded roach. Also sometimes found out-of-doors near buildings, in soil under basementless buildings.

Oriental Roach

Blatta orientalis (Linne). Large Black Oriental Roach. Oriental Roach. Is about 1 inch long, uniformly black, females almost wingless, males much shorter in abdomen. Life cycle about 13 months. Female produces 14 to 15 capsules of 12 to 16 eggs each.

Travels through sewer pipes, lives in filth, and is found in dark, damp basements, or under damp houses without basements. Lives in debris, such as leaves, construction materials, etc., around buildings, in offices and apartments several stories above the ground, in garbage and trash dumps, or sidewalks, in any part of the house from the basement to the attic, in abandoned cisterns. Now more frequently found out-of-doors, too, in bare soil, in sod alongside foundations, in vegetation. Not so much of a pioneer. Colonies tend to stay together as long as food and moisture are sufficient.

Brown-Banded Roach

Supella supellectilium (Seville). Brown-Banded Roach. Smaller than German roach, being less than ½ an inch long. There is a crossband at the base of the wings and another about $\frac{1}{16}$ of an inch farther back and the dark stripes on the thorax are much broader than those of the German roach. Female is broad bodied; male more slender and lighter coloured. Life cycle is about 200 days. May be two generations a year. Egg capsules contain 18 eggs.

Invades areas of the home, including bedrooms. Seems to appear about everywhere in the home: baseboards, mouldings, closets, behind pictures, clocks, under furniture, davenports, under tables, ironing boards, radios, TV sets, dressers, etc., in fruit stands.

American Roach

Periplaneta americana (Linne). American Roach. Shad Roach. Flying Water Bug. 1½ inches or more in length. Female drops capsule, or glues it in a sheltered place with excretions from her mouth the day after it is formed. Will produce a capsule a week until 15 to 90 are formed. Each will contain 14 to 16 eggs. Nymphs hatch in 25 to 100 days and require 10 to 16 months and 13 moults to become an adult. Total life span as long as 2½ years. Pronotum has yellowish posterior border.

A pioneer that frequently is found in sewers, grease traps, air ducts, ventilators, plumbing, etc. A pest of homes and store buildings. Eggs often hidden in some porous substances such as insulating board or mortar joints. Prefers damp, warm places and usually develops in basements, storerooms, steam tunnels, etc. Common in food establishments. Attacks book bindings, wallpaper, other items containing starch.

Australian Roach

Periplaneta australasiae (Fabricus). Australian Cockroach. Shad Roach. Large Flying Water Bug. Australian cockroach similar to American roach but only about 1¼ inches long and has prominent yellow stripe about ⅓ of front wing along costal margin and distinct dark spot in the centre of the pronotum.

Found in many greenhouses, is apparently more vegetarian than other species. In homes it may eat holes in clothing, feed on book covers. More common in warm, southern states.

Woods Roach

Parcoblatta pennsylvanica (DeGreer). Woods Cockroach. ⅔ of an inch long. Males fly long distances. Life cycle about 1 year. Capsules have maximum of 32 eggs.

Lives under loose bark of dead trees, fallen logs or stumps. Will wander throughout entire house, cabin, or cottage built in wooded areas. Firewood is another source for this roach. Seldom develops in homes.

Smoky Brown Roach

Periplaneta fuliginosa (Seville). Smoky Brown Cockroach. Completes life cycle in about 1 year. Capsule contains about 24 eggs.

Destructive in homes. Also seen in greenhouses, heated basements, chicken processing plants. Mostly an outdoor species associated with woods and shrubbery from which it gets into homes.

Ants

(**Termites**—'duckants'—are not true ants and their control poses different problems. They are dealt with elsewhere.)

The small ants which sometimes invade houses, walls and floors are usually foraging for food or migrating from one nest to another. Although they often appear out of cracks in walls they are not responsible for damage to the fabric of the building. Scraps of foodstuff or any edible matter such as dead insects encourage these pests, so, once again, cleanliness goes a long way towards preventing trouble. These ants can be controlled by the same insecticides recommended for cockroach control, but application can

be restricted to the treatment of the cracks and crevices from which they emerge, and the areas immediately around these. Insecticidal lacquers or paints containing dieldrin should also give very good results but should not be used on any surface with which foodstuffs, packaged or otherwise, may come into contact. Another insecticide which is particularly good for ant control is chlordane. A 2% kerosene solution, applied as a 'spot treatment' to cracks and crevices from which the ants emerge should give good results.

All ants live in colonies and whenever the nest itself can be found it is best to attack this rather than the 'ant trails'. 2% chlordane, or 2% dieldrin, in water or kerosene, can be used to eradicate the nest. The nest should be broken open and a sufficient quantity of the insecticide sprayed or poured into and around the nest so as to saturate the nest and the ground around it. Liquid fumigants of the type suitable for use by the farmer (and petrol) can also be used to destroy the nests in the same way. Nest treatment is probably the only satisfactory method for dealing with the large red ants which also invade buildings from time to time. These however are not usually very troublesome except when the ants are 'swarming' and flying ants can be controlled fairly easily by using an ordinary aerosol fly spray since they tend to congregate around lights and can be slaughtered in fair numbers at this stage—provided that the fly-spray is handy!

Bedbugs

Good hygiene is essential in controlling these pests. That is not to say that the presence of bedbugs indicates bad hygiene; sometimes infestation can develop in the cleanest home. However, in a clean home it can be eradicated fairly easily.

Infested bedding must be disinfested. The easiest way is probably to saturate mattress and bedding with really hot water and then leave out in the sun to dry off. While this is being done the infested rooms must also be treated. All cracks and crevices in walls and floors, and the bed frame itself, should be treated. The use of a strong disinfectant solution in kerosene may be sufficient but it is best if possible to use a suitable insecticide. These can be used in kerosene solution or as emulsions in water. 5% DDT should be effective unless DDT has been used extensively in the house to control other pests, when the bedbugs may be resistant to it. 1–2% malathion, or 1–2% ronnel are more certain (at present) to give good results. Whatever is used it is most important that all possible hiding places in cracks and crevices, and in the bed frame and springs should be treated. Spray or brush application can be used but in either case the treatment must be thorough and careful.

Bedding can also be disinfested by fumigation with one of the liquid fumigants available for use by the farmer, if a heavy tarpaulin, or large piece of polythene (plastic) sheet is available. The tarpaulin or plastic sheet should be spread on the ground. The mattress is placed on this, and any other bedding spread out on the mattress. This is then sprayed with about ½ pint of the liquid fumigant and the whole lot rolled-up quickly into a bale which must be made as gas tight as possible by tucking in the end of the tarpaulin or plastic sheet at the outside of roll and tying up the ends. The bale should be left for at least 24 hours and preferably for 48 hours, and then aired thoroughly.

If it is not convenient to sterilize or fumigate the whole mattress, it can also be effectively disinfested by spraying the outside of the mattress *lightly* but *uniformly* with the same insecticide as was used to treat the bed frame and the walls and floor. Mattresses used by young children should not be so treated, or if it is the mattress should not be used by them for several days.

Fleas

Similar treatment of cracks and crevices, especially in floor boards, to that recommended for bedbug control should control infestation in the fabric of the building. Personal infestation will have to be dealt with in the good old-fashioned way. A heavy infestation by fleas which appear to originate from under the floor boards may necessitate overall floor spraying with particular attention to cracks and joints in the floor boards or spraying of the ground beneath where possible. Rat infestation may be the cause of flea infestation, so rat control, as described elsewhere, may also be necessary.

Ticks

Tick infestation of homes is usually associated with the presence of dogs infested by the common brown dog tick. The best method of control is to keep the dogs themselves free of ticks by *regular* treatment with any of the sprays or powders sold for that purpose. Once tick infestation is allowed to get out of hand inside the house eradication may be extremely difficult, particularly if the dogs are allowed free access to all rooms. Treatment of the dog's sleeping quarters (both inside and outside the house) by monthly spraying with 2% malathion, 2% ronnel, or 5% DDT (emulsion or kerosene solution) should kill off ticks in those areas. If very young puppies are concerned it is wisest to avoid the use of insecticides but otherwise those suggested above can be used safely. Malathion or DDT dusts may also be used where convenient, and may have a longer residual effect.

Clothes Moths and Beetles

These pests usually only give cause for worry when clothing is left unused for any length of time. One of the best and most effective simple

preventive treatments is to sprinkle the clothing liberally with para-dichlorbenzene ('moth crystals') and then store them away in a box or chest with a tight fitting lid, so that the fumes evolved from the crystals are retained.

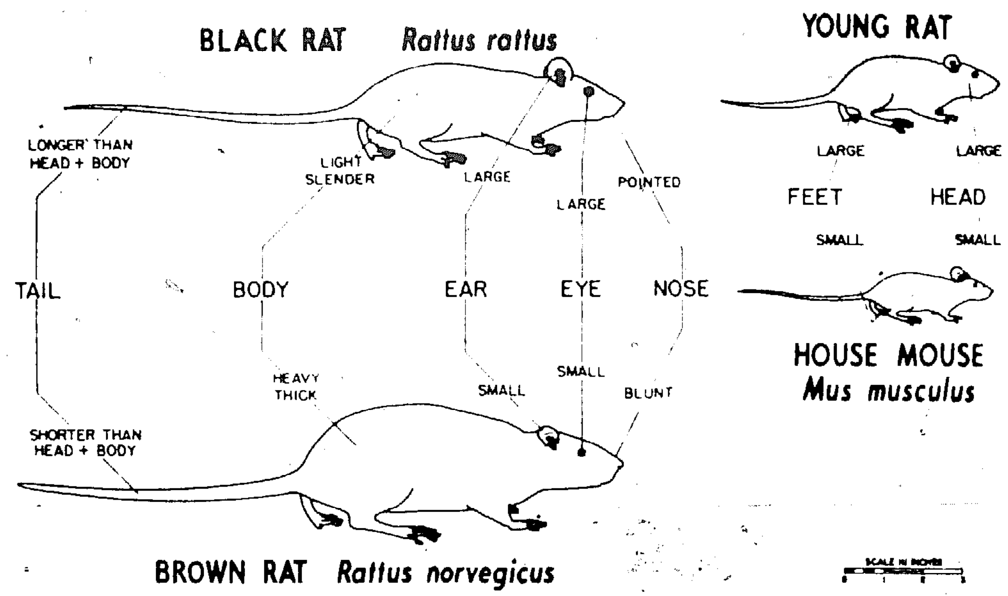
As an alternative, polythene sheets, or polythene bags which are often obtainable second hand, may be used to bale up the clothing after treatment with para-di-chlorbenzene.

Carpets in use can be protected by spraying or dusting the underside of the carpet with 0·5–1·0% lindane or 5% DDT. If sprays are used it may be possible to treat the upper surface as an extra precaution.

CHAPTER 54

*Rodent Control in the Field and Storehouse**

Rats and mice cause serious losses of farm produce which too often are overlooked by farmers. When the harvest time comes and the farmer begins to hope for monetary gains he finds that rats have already caused him financial loss. Rats do extensive damage to all kinds of field crops, cocoa, coffee, sugar cane, rice, coconuts, yams, citrus while they are still in the field. In addition, of course, they cause very serious losses in barns and storerooms.



Field identification of domestic rodents

(i) Kinds of rat

There are two kinds of rat common in Jamaica, the black rat, otherwise known as the ship rat, grey rat, tree rat or the roof rat, (technically known as *Rattus rattus*) and the brown rat, otherwise known as the common rat or the sewer rat, (technically called *Rattus norvegicus*).

The black rat has no fur on its ears, its tail is long and slender, its muzzle is pointed. Its colour varies but it is usually dark grey or grey-brown with a pale greyish or yellowish belly. It weighs from six to eight ounces.

* By courtesy of Public Health Service, Communicable Disease Center, Atlanta, Georgia.

The brown rat differs in being larger and heavier (about twelve ounces) its ears are smaller and furry, the tail is thicker and relatively shorter (never longer than the body), and its muzzle is more blunt. It is less variable in colour, usually brown on the back with a pale belly.

The house mouse is a much smaller animal weighing from an ounce to an ounce and a half. It is generally brownish grey and has a long thin tail, larger and furry ears and a pointed muzzle. It is known technically as *Mus musculus*.

Rats and mice multiply rapidly having six to nine litters each year, each litter having between four and ten young ones. They start breeding at about three to four months old and have a gestation period of twenty-one to twenty-eight days, so that a single pair can become an important problem within a short time.

(ii) Control

Rats have been a pest since the early seafarers brought them in their ships across the Atlantic. They have been trapped and shot, and all sorts of protective devices have been tried with only partial success. Biological control was tried back in 1762 by importing ants that preyed on the rats. These were more trouble than they were worth. In 1872 in despair a few mongooses were imported from India. They helped a good deal, but many rats learnt how to avoid a mongoose. A much worse factor, however, was that the mongoose took a liking to other animals that are useful in one way or another.

Buildings have been rat-proofed, hygienic disposal of waste has been improved, poisons have been developed. With all methods the rats often find how to defeat them, but we are gradually getting better control, and are looking forward to the time where complete elimination may be possible.

Control by trapping. This method is not likely to give good enough control of large numbers of rodents, but is useful for dealing with a small number, especially of mice.

For most purposes the best type of trap is the 'break-back', set-off by a treadle. Treadle release traps are generally more 'fool-proof' than the type actuated by a baited hook.

Traps should be placed in runways which are actually being used by the rodents. Make sure about these when you are pre-baiting, because every hole you find is not necessarily in use. It should be set at right angles across the runway with the treadle end closest to the wall.

If trapping for rats, traps should be placed in position, baited but unset, for three nights and set on the fourth night. For mice, traps may be set on the first night.

Use meal, breadcrumbs, or soaked corn grains for the bait.

Set as large a number of traps as possible over the same trapping period (four days for rats, one or two days for mice) and take up again afterwards. Do not leave set traps down permanently. Regular 'blitz' programmes at intervals of one to two weeks or more using several traps will give far better results than one or two traps left down permanently, which rodents will soon learn to avoid.

Control by poison baits. Poisons used in rodent control can be divided into two classes, acute poisons, and chronic poisons.

Acute poisons are those which are used to kill with one feeding, and the chronic poisons kill after several feedings.

Theoretically any poison could be used in either way, but the so-called traditional poisons such as zinc phosphide and arsenic all have a degree of taste, and all produce symptoms of illness associated by the rat with that particular food, so that rats very rapidly become bait-shy and avoid a second meal. These must therefore be used at a dosage which will kill immediately.

The only poisons used as chronic poisons are the Warfarin and Warfarin-type rodenticides which have been developed in recent years.

The poison is set out in small sub lethal doses, so that the risk of poisoning other animals is very much reduced.

At concentrations sufficient to cause death after a reasonably short period of regular feeding (i.e. after three or four days) the poison is completely undetectable by the rats and mice.

The effect of the poison is such that none of the usual 'poisoning' symptoms are induced so that bait-shyness is not developed.

Use of Traditional (Acute) Poisons. Where a rapid initial kill is required, traditional poisons still have their value. They should not be used for regular routine baiting.

Prebaiting with small quantities of unpoisoned bait (token prebaiting) for two or three days before the poison bait is set is *essential, when dealing with rat populations, or mixed rat and mouse populations.* Provided the bait is made sufficiently attractive prebaiting to control mice alone is less essential but is no disadvantage. It will also serve to confirm that the bait base used is sufficiently attractive.

The aim of the prebaiting is to put out enough unpoisoned bait to get the rodents accustomed to the bait and to the locations, but not so much that they will become surfeited. They must be kept hungry for the final night on which the poisoned bait should be set out in excess quantity.

Baits should be set at a large number of locations, preferably in runways or near used holes.

Fresh baits should be used each night.

During prebaiting, locations from which baits are not taken, should be omitted.

When the poison bait is set down, the same locations should be used, but with larger quantities of bait at each location.

Fresh poisoned bait can sometimes be set once again, with advantage, on the night following the first setting of poison, **but baiting should then be discontinued completely.** Any survivors are likely already to be 'bait-shy' by this time, and any further baiting is unlikely to produce worth-while results. It is often a good idea at this stage to change over to one of the Warfarin rodenticides to finish the job.

If a baiting programme fails to give satisfactory results, it can be assumed, providing that the 'take' of bait during prebaiting indicated that the bait-base was acceptable, that the rodents are familiar with the flavour or smell of the poison itself and are already 'shy' of that particular substance. In these circumstances, it is advisable to repeat the procedure after a short time lapse and to **use a different acute poison.**

Once an acute poison fails to give results it should be dropped for several months before another attempt to use the same poison is made.

Materials such as soaked dry bread-crumbs, cornmeal, coconut meal and soaked crushed corn are all suitable bases for granular or powdery poisons which can be mixed in satisfactorily. If necessary, they can be made more attractive by the addition of small proportions of sugar and/or coconut oil. Proprietary poisons which are put up as pastes are best used as a sandwich between small squares of dried bread soaked in coconut oil and sprinkled with sugar. (Directions are usually given and these are generally quite satisfactory and should be followed.)

Properly prepared dried bread and coconut oil baits to which the rodents have been conditioned by prebaiting are far more likely to give satisfactory results than a few lumps of mouldy cheese with unsightly smears of offensive smelling poison on them.

The following poisons have become standard and should give good results. The suggested concentrations should be adhered to in mixed baits.

Zinc phosphide. For black rat and brown rat: use at $2\frac{1}{2}\%$ by weight (1 part in 40) in the bait base which should be prepared as a damp mash. For brown rats *only*: may also be used at 5% in dry sugar/cornmeal mixture. For mice: either of the above bait-mixtures may be used.

Arsenious oxide. ('White arsenic'). For both species of rat and mice: 10% by weight in a damp mash base

Proprietary brands. Several of these are available and will give satisfactory results if used properly. It is advisable to use the poison in the manner suggested by the makers.

Chronic Poisons: Warfarin and similar rodenticides. A range of rodenticides of this type is now available locally. They incorporate one of a group of chemicals which on entering the blood stream of mammals, upset the blood-clotting mechanism. They are therefore referred to in general as anticoagulants. The poisoned animal eventually bleeds to death from small internal gut injuries which occur continuously in any animal but which normally heal very quickly, and by leakage from small blood vessels.

These poisons are used in very low concentration in cornmeal or a similar bait-base, and two or three days feeding on the poisoned bait is necessary before the rodent acquires a lethal dose. **This means that there is usually much less danger to other animals,** since only those likely to eat large quantities of a bait base such as cornmeal run any risk of being affected. For this reason there is more danger with dogs and pigs, for example, than with cats. However, unless a dog is receiving no other food it is most unlikely that it would eat a sufficiently large quantity of the dry meal to have any effect. Pigs, however, are very susceptible to these poisons and special care must be taken if there is any likelihood that pigs will have access to them. Bait containers can be used to prevent access to the bait by animals other than rodents.

These rodenticides are sometimes marketed in a ready-to-use form, but the majority of locally available brands require dilution with a cereal meal. These concentrates, or 'master-mixes', are usually more economical than the ready-to-use forms, and have the advantage of being more versatile and adaptable. Modification should, however, be confined to the bait base used, and the actual concentration of poison **must not be varied.**

The manufacturer's recommendation for the rate of mixing the poison with the ~~bait base~~ should be followed carefully and the suggested concentration **should not be exceeded.** (If it is exceeded, the poison may reach detectable levels when bait-shyness may develop in the rodents).

Cornmeal is excellent in most cases, and is easy to obtain. It is well worth while adding five or ten per cent sugar to make the bait more attractive and a sprinkling of coconut oil to hold it together.

Most of the master-mixes on the market require to be mixed one part to nineteen parts with the bait base so that if 5% sugar, for example, is to be included in the bait to make it more attractive the mixing would be:

1 part 'master-mix'
1 part sugar
18 parts cornmeal.

If alternative food is readily accessible to the rodents and the cornmeal bait is not taken in sufficient quantity, the use of wheat flour (preferably wholewheat flour) or oatmeal, in place of cornmeal, is recommended. Water-soluble forms of the poison can also be used in such circumstances. These are available, **but must be used with the greatest care** and

poisoned water should only be put under bait boxes which will prevent access by animals other than rodents.

Fairly large quantities of bait must be put out. Six to eight ounces at each point is the usual recommendation for rat control. Where mice alone are present, smaller quantities (one or two ounces) may be used.

At the recommended concentration the poison is undetectable so pre-baiting with unpoisoned bait is not necessary.

As bait-shyness appears not to develop when these poisons are used, baiting may be continued over an extended period. (It is usually worth while to keep a few bait-stations permanently supplied with bait.)

(iii) Control in Plantations

Trials made by the Plant Protection Division of the Ministry of Agriculture and Lands have shown that Warfarin gives excellent control of rats in cocoa and coffee plantations. Four ounces of bait mixture are put in a bamboo pot, which is then tied on to the top of a branch, sloping downwards slightly, with the open end at the bottom and away from the prevailing wind and rain. The slope should be enough for the rain to run off, but not enough for the bait to fall out.

(iv) Prevention of Infestation in Store houses and other buildings

A great deal can be done to control rodents by preventing their access to buildings in which they can establish themselves. This means preventing their access to *all* buildings, since even when scrupulous care is taken, it is often impossible to ensure that no food is available to rodents. It is wisest not to rely completely on preventing, but to combine this with hygiene both within and around the building. Few or none of man's attempts to combat nature are completely successful, and it is only by combining different methods that satisfactory results can be expected. In addition to any chemical control it is necessary both to prevent the rodents entering the building and to practise hygiene in and around the building.

Rodents are adept at squeezing through small apertures, and, of course, equally adept at enlarging and making holes in many materials, and of burrowing in the ground. Any opening larger than half an inch in width will permit entry by mice and young rats, and young mice can only be excluded with certainty if the maximum diameter of any permanent opening is not greater than a quarter of an inch. In addition, the black rat and mouse are excellent climbers. These rodents can scale any vertical surface on which they find purchase for their toe-nails. Hanging on by their fingernails is not a difficult nor an unusual practice for them since a fully-grown black rat has a body span of around twelve inches when fully extended, a vertical surface will only be unscaleable if it is interrupted at some point by a continuous strip of smooth hard surface broader than twelve inches. The presence of electric cables, and any similar attachment, or of narrow vertical buttresses, make it very easy for the rodent; and running up a wall with its back braced against the inside of a drain-pipe is child's play! Feats of acrobatic climbing by rodents are not necessarily of everyday occurrence, but the ability exists, and when driven by hunger or population pressure, these are put into practice. It is therefore necessary to allow for this.

Foodstuff should be made as inaccessible as possible. In kitchens food should be kept in screw-top glass jars or tins with close-fitting lids, and not in paper or cloth bags. Spilled and waste foodstuff must not be allowed to accumulate in accessible places. If relatively large stocks of meal or sugar are kept, the bags should preferably be kept in a metal or a sound wooden bin with a fitting lid. If a bin is not available, it should be possible to make a wooden one fairly cheaply. Until the bin has been made, bags should be kept in a place where they can be watched, and not thrown down in a secluded corner. External breeding grounds must be removed or made inaccessible—by keeping garbage in closed containers, the contents of which are satisfactorily disposed of regularly. In cases where garbage is used as mulching, this should be dug into the ground and not deposited on the surface.

Avoid accumulating disused machinery, scrap-metal, and similar junk which can be used as safe retreats and ready-made nesting sites from which rodents can forage at will.

Every effort should be made to prevent the access of rodents to water in the building and its vicinity. This is a measure which may or may not be possible, but if it can be done it should be done, and not overlooked.

Active efforts along these lines may not eliminate rodents completely, but their breeding is very much reduced in uncongenial surroundings.

CHAPTER 55

Termite Control

Termites, which are usually called duck ants or sometimes white ants or chi-chi are a most destructive pest in agriculture because their food is the cellulose of wood. As a result, houses, store rooms, stables and plants all have to be protected. The popular name duck ants is unfortunate because they are in no way related to the true ant, in fact the cockroach and locust are much closer relations. Though their social mode of life resembles that of the ant, their physical structure is very different. They live in colonies with a queen and a monogamous king. There usually are workers and soldiers, which are specialized but sexually undeveloped adults, but in the more primitive types all the work is done by the nymphs, all of which later become winged adults. All the damage which concerns the farmer is done by the workers or nymphs.

The principal difference between the termite and the ant is their method of development of the wings. In the termite, when the egg hatches, the nymph which comes out closely resembles the wingless adult. As it grows the wings develop outside the body and there is no chrysalis stage.

Except for the swarms of winged adults, termites are rarely seen. If a termite damaged branch or beam is broken, they can be seen for a short time, but before long, they hide themselves in the dark. Except for the winged adults, they are blind and avoid any exposure to fresh air and light. Normally, ~~they live only~~ within their nest, within the wood on which they are feeding or in the earthen tunnels which they build to connect the two. The workers and nymphs are very small and can travel through very narrow gaps in concrete or across considerable distances in the earthen tunnels that they can build on surfaces. Because of this adaptability, a great deal of care is necessary to make and keep buildings termite proof.

(i) Types

There are three types of termite found in Jamaica that cause serious damage to buildings and other wooden structures. Technically, they belong to the order Isoptera and the genera found are *Nasutitermes* and *Heterotermes*, which are called the subterranean termites and *Cryptotermes* which is called the drywood termite.

The colony of the termites centres round the queen termite. As she grows older she moves around much less and in the more highly developed types, her abdomen swells so much that she cannot move and she becomes little more than an egg-producing machine, tended by workers and by her king. Workers and nymphs are active in the obtaining of this food and are responsible for the feeding of the sexed adult insects and the king and queen. The colony is protected against enemies by a caste of soldiers whose head and jaws are developed to be powerful agents of destruction. There are also usually many winged adults in the nest. These have eyes and a well-developed cuticle and are preparing for the rainy season when they will all come out from the colony on their wedding flight. These are attracted to light and may appear in thousands in the house. Very soon they shed their wings by breaking them across a line of special weakness and then they seek their mate. After mating, each pair keeps together and starts building its own colony, either in the soil or in wood. Sometimes they attack such things as paper and cardboard. They may even bite ~~through lead~~ insulation to ~~reach~~ their food. Their normal supply of food is decaying wood in the forest, but man so considerately provides them with such a good supply of attractive dead wood, plenty of spores of fungi being available to help in its digestion, they have become a primary and most important pest in the timber of buildings and furniture in the tropics and subtropics.

The three types of termite can best be distinguished by their nesting habits and their mode of life. It is most important to know which type is causing the damage so as to be able to attack the colony in the right way.

The drywood termite need have no contact with the soil. It lives simply within the wood on which it is feeding. The newly mated couple enter through cracks or broken portions and live the rest of their lives within that wood. The only evidence that may be visible is the piles of excreta which may be passed out of the nest. They are also called powder post termites from the fact that posts, pieces of furniture etc., may be eaten away until nothing but powder is left within the seemingly sound piece of timber.

The *Nasutitermes* type of subterranean termite is possibly the most noticed of termites in that it builds large dark brown carton nests in trees from which earth covered tunnels go long distances across the surfaces of the trunks and branches. It makes contact with the soil through these tunnels.

Heterotermes is a more truly subteranean termite in that its nest is actually underground. It works within its food, but also builds its covered tunnels to get to other sources of food. It can work under much drier conditions than those in which *Nasutitermes* usually works, and is much more difficult to tackle because of its concealed nest.

(ii) Prevention and Eradication

Once termites are established within a building their control is very difficult. As with most things prevention is better than cure. As far as possible, structural timber should be protected from attack by care in design, strict supervision in the actual building construction and, if possible, the use of either naturally resistant lumber or treated lumber.

Care should be taken that opportunities for termites to come into the lumber are as small as possible. If it is possible, all wood should be cleared from the soil within a radius of twenty-five feet round the building. The foundations should be of concrete and the lumber of the ground floor should be kept clear from any contact with soil. There should be good ventilation underneath it with, if possible, an inspection space. There should be metal caps over the foundation pillars with a protrusion of at least two inches to retard if not prevent the entry of the termite. All trees or bushes hanging near the building should be trimmed to prevent the termites coming in that way.

Resistant Lumber. There are many trees in Jamaica the lumber from which can be used. Mahogany (*Swietania mahogani*), Fustic (*Chlorophora tinctoria*), West Indian Locust, more commonly known as Stinking Toe (*Hymenaea courbaril*), Bulletwood (*Dipholis* sp.), Breadnut (*Brosimum alicastrum*) and Sandalwood or Torchwood (*Amyris balsamifera*) are all trees producing reasonably resistant lumber. If these are not available or are too expensive, use treated lumber for any part of the building which may have direct contact with the ground or where there may be chances of attack from the subterranean termites. Creosote, PCP and various proprietary compounds are valuable. Various lumber merchants sell treated lumber and their apparently selfish advertisement that it is cheaper than building with untreated lumber is in fact perfectly sound. The cost of replacing foundation timbers far exceeds the small extra cost for the treatment.

To prevent future invasions of the lumber, a trench should be dug around the foundations, and this should be drenched with an insecticidal solution at a rate of two gallons for every five feet length of trench. One per cent chlordane has been found effective for over ten years. Also used with equal confidence are a half per cent dieldrin, four fifths per cent BHC and a half per cent aldrin. The building should be inspected regularly so as to observe any possible break through of the defence precautions.

Control, after the pest has invaded the lumber, involves either fumigation or the use of insecticidal dusts. Buildings have been closed in and fumigated with arsenic trisulphide or hydrocyanic acid. Furniture and other wooden objects have been treated at high temperature, which is also lethal to termites. Generally however insecticidal dusts are used.

Chlordane, Dieldrin or **Paris Green** are introduced into the tunnels or better still into the nests of the insects. The termites reached first will die very soon. They will have been groomed by other termites and the poison passed on. In addition, the hygiene of the colony involves the eating of dead termites, so that there is further distribution of the poison. If enough of the insecticide is put into the colony, the normal social habits of the animal will pass the chemical throughout the colony and every member be killed.

CHAPTER 56

Common Ailments affecting Domestic Animals and Poultry and their Control

Cattle and Stock

Tick Control

The ticks found on cattle in Jamaica belong to two species—the Texas Fever Tick, (Boophilus Microplus) and the Silver Tick, (Amblyanine Cajanense).

By far the most important species is the Texas fever tick, not only because it forms, on the average, 95% of the tick population found on bovines in Jamaica, but also because it transmits blood parasites which cause very serious diseases amongst cattle. Consequently, the measures of control explained hereunder refer particularly to the Texas fever tick, but they are also suitable for combating the other species of tick occasionally found on cattle.

Localized infestations, as for instance the congregation by certain species in the ears of horses, require specific treatment. Application of those remedies should, however, always be in addition to the general periodical treatment of all the carriers of the Texas fever tick kept on the farm, this being absolutely necessary to rid the pastures of their tick population. These carriers are cattle, horse-kind, sheep and goats.

Dipping

When 'dipping' can be practised it should be considered the basic control measure. In the case of very small herds and on dairy farms, however, dipping is neither essential nor even advisable if the cattle have to be sent to dipping tanks situated on other properties. In such cases, thorough spraying with a parasiticide such as Gammatox will be an adequate substitute for dipping.

Notes on the Construction and Management of Dipping Tanks

Most of the tanks used in Jamaica for dipping cattle are too short to allow for the time of immersion necessary to obtain a high percentage of tick kill.

The slanting chutes at the entrance of the tanks:

(i) are dangerous for the cattle;

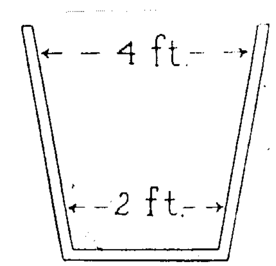
(ii) cause the animals to launch themselves into the dip instead of tripping into it, with the result that their necks and heads, which harbour many ticks, are not adequately immersed;

(iii) cause the cattle to jump over a relatively great length of the deeper section of the tank. The time of immersion is reduced and the more effective deep end of the tank is not used.

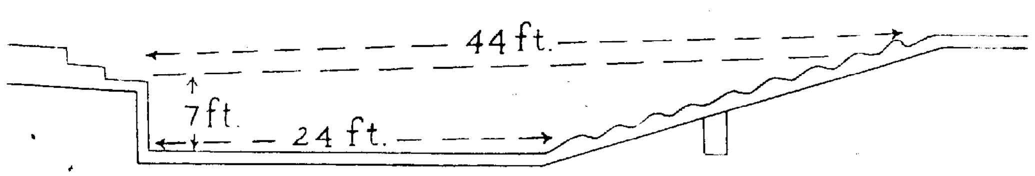
The advice briefly given hereunder will interest those who intend to build new dipping tanks, and also those who may be desirous of improving their existing tanks.

Dimensions and Shape of Dipping Trough. The shape of the trough as given in the blueprints which the Department of Agriculture issued in the past is good. This tank measures 44 feet at the waterline and its capacity is approximately 4,500 gallons.

The Take-off. The take-off or chute should not be a slanting surface, but should consist of three steps, each six inches deep. The lower step should be covered by the liquid in the trough, and the animals, deceived by the immersed last step, will fall headlong into the deeper portion of the trough. Complete immersion is thus ensured, and each animal will also remain a few seconds longer in the dip than when they launch themselves from a slanting take-off to cross the water by swimming, with head and neck well above water. Those additional few seconds of immersion have a very significant effect on the percentage of ticks that will be killed. Simple sketches giving the shape of a suitable tank in longitudinal and cross-sections are given below:



Cross Section



Longitudinal Section

Selection of Site for Dipping Tank

From the point of view of tick control, dipping tanks should be situated in the best strategical position regarding the ticks to be destroyed.

(1) *So that reinfestation after dipping may be minimized, the tank should be situated at the main cross road of the routes along which herds can be driven from the pastures to the tanks and from the tanks to the pastures.* Tick-infested cattle *en route* to the tank keep dropping engorged ticks which lay eggs producing the grass lice that will in turn develop into a new generation of ticks. Consequently, to avoid reinfestation, cattle which have been dipped should not return to the pastures by the same route as that by which they are led to the dip. The routes leading from the pastures to the tank should be as short as possible, and the movement of herds should, as far as possible, be so directed that the grass lice picked up *en route* by the animals will be carried towards the tanks, and not in the opposite direction, i.e. to the pastures.

(2) The tank should be in open country surrounded by commons, not in an irrigated pasture amongst tall grasses nor in ruinate or woodland. The immediate vicinity of gullies or of outcrops of honeycomb limestone should be particularly avoided.

Construction of Tank

Whilst the dimensions of the tank and its strategical position in the pen will be of the greatest importance to the success of tick control operations, the following points concerning construction should be borne in mind so as to keep costs at a minimum whilst ensuring durability of the structure.

It is very unwise to build tanks in clay soils or alluvial loams which, by expanding during wet weather and contracting during periods of drought, exert tremendous pressure on the sides of tanks that may result, unless strongly reinforced, in the development of cracks.

Superstructure. Too much importance has been attached to the structure above ground level, particularly the roof.

The only use for a roof over a dipping tank is to prevent excess dilution during rainy weather and to minimize evaporation during drought. The roof of a dipping tank need not be as waterproof as, say, the roof of the dairy shed or of houses.

Arsenical Dips and other Tickicides

Until recently the parasiticides generally used for tick control contained arsenic as the basic tickicide, and this is still the case to a great extent. Two such preparations are well known to our penkeepers.

(*a*) The Agricultural Department Dip, composed of sodium arsenite and paranaph;

(*b*) Cooper's Dip which is also an arsenical preparation.

Paranaph was formerly used as a wetting agent, but its manufacture has now ceased. The use of Teepol as a substitute has found favour with both these dipping materials.

Now new preparations such as 'Gammatox', 'Synklor', etc., have appeared on the market and are being increasingly used in Jamaica. Gammatox used in a long dipping tank is as effective or more so than an arsenical dip when similarly employed, but Gammatox possesses the additional advantages of not being as poisonous to humans and domestic animals as arsenic, of being more effective than arsenicals when used as a spray, and of controlling not only ticks, but at the same time, several of the blood-sucking flies and other parasites which affect livestock. Gammatox is relatively expensive, but its most important drawback when used in our dips is that the strength of the solution cannot be tested and corrected when necessary, as can be so easily done with arsenical dips.

The Tickicide sold by Government Chemist for use in Dipping Tanks (Sodium arsenite—Paranaph mixture)

All over the tick-infested tropics, for dipping or spraying cattle arsenite of soda is commonly used in solution with other substances which increase the wetting properties of the dipping fluid. In Jamaica the 'wetter' generally used is Paranaph, a paste prepared locally by emulsifying naphthalene, soap and kerosene in the following proportions:

Soap	450 lb.
Water	20 gallons
Naphthalene	56 lb.
Kerosene	16 gallons

Paranaph and commercial arsenite of soda (80%) are sold at cost price to owners of dipping tanks by the Government Chemist's Department.

The standard departmental liquid for use in dipping tanks consists of:

Arsenite of soda	2 lb.
Paranaph	3 lb.
Water	100 gallons

This is highly efficient when used in tanks constructed to ensure immersion of the ticks for at least nine seconds.

How to Charge the Dipping Tank. The required amount of arsenite of soda is dissolved in water, a little at a time, and poured into the tank, which should be about three-quarters full.

The Paranaph is mixed separately with a small amount of water until a uniform solution is obtained. This is also poured into the tank, which is then filled to capacity and the mixture stirred vigorously.

Before passing the animals through the tank the mixture should be tested to see that it is at the correct strength.

How to test the Dipping Tank and keep it up to strength

Equipment

The Government Chemist sells to tank owners the necessary equipment to test arsenical dips. This consists of:

1 graduated measuring cylinder of 25 c.c. capacity.
1 wide-mouthed mixing bottle.
Standard iodine solution.
Starch solution.
Bicarbonate of soda.

Directions for Testing

1. Thoroughly stir the liquid in the tank.
2. Take 25 cubic centimetres (c.c.) of the stirred liquid, carefully measuring this quantity in the graduated cylinder supplied with the testing outfit.
3. Pour the measured quantity of dip into the wide-mouthed bottle.
4. Add as much bicarbonate of soda as will hold on a farthing piece, shaking well to allow it to dissolve in the sample of dip.
5. Add a teaspoonful of starch solution and shake again.
6. Wash out the graduated cylinder well with water, and then also rinse out with a little of the standard iodine.
7. Fill the graduated cylinder to the 25 c.c. mark with standard iodine.
8. Pour the iodine from the graduated cylinder into the dip to be tested, adding a small quantity at a time and shaking the mixture between each addition. Continue the foregoing procedure until a permanent blue colour is just attained. Avoid excess.
9. Inspect the graduated cylinder and note the number of cubic centimetres (c.c.) of standard iodine which have been used.
10. Consult the Testing Table which will show for each c.c. of standard iodine used, the quantity of arsenite of soda in the tank and the quantity required to be added thereto.

Addition of Nicotine. The addition of nicotine increases the toxicity of the tickicide. A cheap source of nicotine is tobacco funk (waste and spent stems) or dust from cigar and cigarette factories.

The dust or funk is placed in suitable vessels and boiling water poured over to cover the dust with about three inches of liquid. This is left to seep overnight. The contents of each vessel are filtered through a crocus bag, the clear infusion so obtained being added direct to the dipping tank. Furthermore, the bags containing the material from which the infusion has been obtained are tied with a rope, loaded with a stone and suspended in the dipping tank. Immediately before dipping the cattle, these bags are agitated and finally removed whilst the cattle are being passed through the tank.

Leaving these bags to soak in the tank when the cattle are not being dipped is necessary, as this maintains the strength of the nicotine in the tank.

Nicotine in a dipping tank does not decompose (though it will in pure water). The infusion should therefore be placed in the tank soon after it has been prepared. As this will, to a certain extent, dilute the arsenical solution, the latter should be tested *after* the addition of the tobacco infusion and brought up to the proper strength.

Changing Contents of Tank. Whatever the size of the tank or the tickicide used therein, it is generally advisable to renew once a year the liquid in the tanks, which when emptied should be thoroughly cleaned.

Foot baths or other gadgets which prevent an excessive quantity of dirt from being brought by the animals into the tanks, thus causing rapid pollution, are recommended.

Other Arsenical Dips and those with Benzene Hexachloride or D.D.T. as the Active Principle

The instructions provided by the manufacturers of proprietary dips should be strictly followed. It should be remembered, however, that they are more expensive. They must also be used in tanks which are long enough to ensure immersion for at least nine seconds. Short and otherwise defective tanks may only allow of two or three seconds of partial immersion of the tick-infested animals.

Dusting

Where only a few head of cattle are to be treated, besides spraying with one of the recommended tick-destroying solutions, the cattle can be dusted with any of the new preparations such as Agrocide.

Tick Control with Chlordane

Chlordane (also known as Halodane) may be used to control external parasites of livestock. The following parasites of livestock may be controlled with Chlordane:

(1) Cattle lice	0·5%	solution
(2) Goat lice	0·2%	solution
(3) Hog lice	0·2%	solution
(4) Mange mites	0·2%	solution
(5) Sheep ticks	0·2%	solution
(6) Cattle ticks	0·75%	solution or 5% dust.
(7) Flies	0·5%	controls the horn fly which is most annoying to cattle and causes a 10–20% decrease in milk production and loss in weight.

Proper Dilutions and How to Make Them for Various Size Spray Tanks

Question 1. How much 40% chlordane is needed to make a 0·75% solution to control ticks on cattle when the spray pump has a 100-gallon tank capacity?

Computation 1. One gallon of water weighs approximately 8 pounds, therefore 100 gallons weigh 800 pounds. Next we multiply 800 × ·0075 equals 6. The 6 is then divided by 40%, as 6 ÷ ·40 and this equals 15 pounds of 40% chlordane which is needed to make a 0·75% solution of chlordane.

Answer 1. 15 pounds of 40% chlordane is needed in 100 gallons of water to make a 0·75% solution.

Question 2. How much 40% chlordane would be needed to make a 0·75% solution for a 20-gallon spray pump tank?

Computation 2. Take the 15 pounds required for the 100-gallon tank and divide each by 5.

Answer 2. 3 pounds of 40% chlordane would be needed in 20 gallons of water to make a 0·75% solution.

Question 3. How much 40% chlordane is needed to make a 0·75% livestock spray for a 5-gallon capacity tank spray.

Computation 3. By simple division we find we need 0·75 pounds or 12 ounces of 40% chlordane in 5 gallons of water to make a 0·75% spray solution.

Answer 3. 12 ounces of 40% chlordane is needed to make a 0·75% solution for a 5-gallon tank spray.

Question 4. How much 40% chlordane is needed to make a 0·75% solution in a 4-gallon spray tank?

Question 5. How much 40% chlordane is required to make a 0·75% livestock spray.

Question 6. How much 40% chlordane is required to make a 0·5% spray solution for 100-gallon, 50-gallon, 5-gallon and 40-gallon spray pumps?

The same methods are employed as in Question 1.

Answer 6. 10 pounds of 40% chlordane are required in 100 gallons to make a 0·5% spray. For a 50-gallon spray pump, 5 pounds of 40% chlordane is required to make a 0·5% spray. One pound of 40% chlordane is required in a 10-gallon pump, while one-half a pound is needed in 5 gallons. Six and four tenths ounces (almost 6½ ounces) are needed for a 4-gallon pump. To make a 0·5% spray for 1 gallon of water, only 1·6 ounces are required.

Chart of Dosages to make 0·75% Solution Spray of Chlordane from 40% Chlordane Wettable Powder 0·75% Spray Solution

Amount of Water	*Amount of 40% Chlordane*
100 gallons	15 pounds
20 gallons	3 pounds
5 gallons	12 ounces (90 tsp)
4 gallons	9·6 ounces (72 tsp)
3 gallons	7·2 ounces (54 tsp)
1 gallon	2·6 ounces (19 tsp)

Chart of Dosages to make 0·5% Spray of Chlordane from a 40% Chlordane Wettable Powder 0·5% Spray Solution

Amount of Water	*Amount of 40% Chlordane*
100 gallons	10
50 gallons	5
10 gallons	1
5 gallons	0·5 pound or 8 ounces (60 tsp)
4 gallons	6·4 ounces (48 tsp)
1 gallon	1·6 ounces (12 tsp)

0·5% spray is recommended for all animals.

Blackleg

Blackleg is a serious disease of cattle. The onset of the disease is sudden and severe, and it almost always ends fatally. Cattle between the ages of four and thirty months are the most susceptible, but cases have been known in cattle of almost any age. The disease also occurs, but less frequently, in sheep.

Cause. The disease is caused by the germ *Clostridium chauvoei*, which like that of anthrax forms a resistant 'spore' when outside the animal's body, and so is able to live for long periods in the soil and similar places. For this reason the disease occurs frequently on certain properties—so-called 'blackleg areas'—where a heavy death rate is experienced year after year unless the young cattle are vaccinated. Heavy soils under permanent pasture seem most conducive to the persistence of the blackleg germ.

It is not known definitely in what way the organism is picked up by the animal, probably it is swallowed in contaminated food or water, or possibly it gains access to the body through cuts or abrasions.

Symptoms. Symptoms are not distinctive in the early stages, but where the disease is known, cattlemen soon become familiar with it, and the experienced eye can often make an early diagnosis. The period from the time the animal is infected till the time the symptoms come on is between one and five days.

There is at first dullness and loss of appetite, the animal ceases to chew the cud, and a temperature soon develops, rising to 106° F. or more. Lameness soon develops, and the animal at first lags behind the herd, and later stands still with arched back or lies down groaning.

These symptoms result from the growth of the germ in the muscle of some part of the body, usually one of the legs, producing a soft swelling. At first the swelling is hot and painful, but later it becomes cold and spongy, being filled with a gas which causes a 'crackling' feeling under the skin when massaged. These swellings may occur in any muscle of the body, being most often seen on the neck, loins, thighs or shoulders. They are never found below the knees or hocks or on the tail.

The animal becomes more and more distressed as the disease advances. Panting, a quickened pulse and a high temperature are typical symptoms at this stage. Blood-stained dung may be passed, but diarrhoea is uncommon. The animal cannot rise and death occurs, as a rule, between 12 to 48 hours after the onset of the symptoms.

Diagnosis. If blackleg is suspected, first look for the soft crackling swellings. Feel along the back, neck, shoulders and flanks. If any such swellings are found, a small cut should be made into one of them and a smear taken of the blood that oozes out. This should be sent to the nearest Veterinary Officer or to the Veterinary Division of the Ministry of Agriculture, and will be sufficient to confirm the disease.

If no swellings are found, then anthrax should be suspected. The symptoms of the animal, if any, before death; the season; whether there have been any other deaths from blackleg or anthrax in the district; whether there is any bleeding from the nose and anus; these should all help to decide whether the case is one of suspected anthrax, or of blackleg that does not show the typical symptoms. In any case, a blood slide from the ear should be taken if possible, and a call sent to the nearest Veterinary Officer, who will be able to decide.

Blackleg carcasses distend with gas very quickly, and this might mask any local swellings.

When the swellings are cut into, a lot of gas and bloody froth escape; this fluid is highly infectious and should not be allowed to contaminate the pasture. If the swelling is further cut into (and this should not be done, due to the danger of spreading the germ on the pasture), the underlying muscle will be seen to be dark red or black, and broken up with gas bubbles to form a spongy mass which crackles when squeezed.

Treatment. Large doses of penicillin or other antibiotics might be worthwhile in an extremely valuable animal, but apart from this, treatment is worthless.

Prevention. Prevention depends upon two factors:

(i) Protecting the animal by vaccination.
(ii) Preventing contamination of the ground with the germ by hygienic disposal of all carcasses.

Vaccination is safe and effective. Reliable vaccines give almost 100% protection, the immunity developing within 14 days of vaccination and lasting about one year. The usual procedure is to vaccinate all young stock at the time of branding or castration. Yearlings, and in bad areas older animals, must also be vaccinated. The most effective vaccines include 'Blackleg aggressin', 'Blackleg bacterin' and 'Blackleg vaccine' made by any reliable firm, and are given as an injection under the skin, the only equipment required being a syringe and needles. Vaccination is a preventative measure; it is useless vaccinating sick animals.

Hygiene. Burn all blackleg carcasses. If for any reason burning is impossible, bury deep in *quick* lime to prevent spread of the germ on the pastures.

Burn any refuse such as litter, bedding or crocus bags that might have been contaminated, and wash out the shed or stall with a 5% solution of Jeyes fluid or carbolic acid.

Blackleg is an easily preventible disease. Deaths from blackleg indicate irresponsible farming.

Contagious Abortion (Brucellosis or Bang's Disease)

This disease has been a scourge of penkeepers, especially dairy farmers, for a long time, but until recently its wider danger to human beings has not been appreciated by the medical profession or the public at large.

A survey of the disease in Jamaica some years ago showed an overall infection of slightly more than 5%* of all dairy animals. Every cattle owner should tackle the disease in his own herd by the methods outlined below, as the disease is one which strikes heavily and can only be combated by sound preventive measures. As those who have experienced it know, Bang's disease can be very costly if it obtains a grip on a dairy herd.

Nature of the Disease. The term contagious, infectious, or epizootic abortion of cattle refers to those abortions which occur in otherwise healthy cows as a result of an infection causing inflammation of the lining of the womb and of the foetus and its covering membranes. The act of abortion is therefore not the disease itself, but one of the effects that the disease has on the animal's body, and is consequently a symptom of infection.

In cattle, by far the most common cause of contagious abortion is a minute germ known as *Brucella abortus*, and hence the name Brucellosis has also been given to the disease, especially when infection occurs in human beings (where abortion is not a symptom). The name Bang's disease, by which it is known in Jamaica, is derived from the Veterinarian who first discovered the germ of the disease.

It should be noted that premature births or abortions can occur from other reasons besides infection with Bang's disease, for example, during a period of drought or very poor feeding; or even during a time of apparently adequate food a particular vitamin deficiency can produce reproductive disorders and abortions. Abortions may also result from injuries, undue excitement, or from other infections.

* On the basis of monthly tests carried out the incidence now is of the order of 1-4%.

Infection occurs in the vast majority of cases by the mouth as a result of the intake of fodder or of drinking water which has become contaminated. An aborted calf, the afterbirth, and discharges contain a vast number of the germs, and the contamination of surrounding pastures, nearby ponds, and feeding-stuffs on the farm is a simple process. Dogs and crows frequently play an important part in the spread of the infection, as also do the boots and clothing of attendants. It is important to remember these points, especially when dealing with a first abortion.

A cow may become infected from a bull which has been contaminated by the discharge from an infected cow. It is therefore unwise to send cows from a clean herd away to a bull or to accept cows for service unless it is certain that the other bull or herd is also free from the disease.

Course of the Disease. Following the act of abortion, the germs usually disappear from the womb of the cow within a few weeks, but they can establish themselves in the udder and in certain lymph glands, where they may persist for very long periods and may be excreted in the milk. Milk so contaminated can infect human beings, giving rise to the condition known as Undulant Fever.

When a cow in which the germs have become established in the udder or lymph glands again becomes pregnant the germs reappear in the womb and its contents, and although the calf may not be born prematurely, the membranes and discharges are often contaminated and therefore capable of spreading the infection. Once infected, therefore, cows are dangerous spreaders of the germs each time they calve.

Bulls sometimes become infected, usually in the testicle, in which case they often become sterile.

The germ remains active outside the animal's body in discharges and aborted tissues for very considerable periods in cool moist surroundings. In ideally suitable surroundings it will survive for six months.

The Blood Test. The blood test for Brucellosis is used to detect infected animals. A small quantity of blood is drawn from the cow and the serum tested by mixing with a suspension of the *brucella* germs in the laboratory. The result is read as '*Negative*', '*Positive*' or '*Suspicious*'—animals in the latter category should be re-tested two to three weeks later.

A *positive* reaction indicates that the cow has had some past experience of Brucellosis—i.e. has either been infected or vaccinated. The strength of the reaction may give some idea of the time when she was vaccinated, and after two or more tests a reaction due to vaccination may usually be distinguished from one due to infection, since the latter persists for a far longer period in the blood.

The test is most useful in finding the extent to which infection is present in a herd, so that the general policy—i.e. 'vaccination' or 'clean herd policy'—may be decided on.

What to do if an Abortion occurs. If an abortion occurs in a herd the first step is to isolate the cow that has aborted in order to prevent spread. The cow should be blood-tested three to four weeks later to check if the abortion was infectious or not, and meanwhile kept strictly isolated.

The aborted calf and the membranes should be burnt, and the place where it was aborted and the vulva and hind quarters of the cow must be disinfected. The methods used for the former will depend on the situation, e.g. pasture must be fenced off and cattle kept off for six weeks, sheds should be scrubbed with disinfectant and litter burnt. The quarters of the cow can be scrubbed in weak Jeyes and water. All bedding, grass, etc., contaminated with discharges should also be burnt.

Vaccination at this stage can rarely prevent further spread, but it can perhaps limit it. Consult a Veterinary Officer at once, and he will advise of the extent vaccination can be used on the older animals in the herd at that stage.

It cannot be too clearly emphasized that up to the present there is *no* known means of *curing* the disease once it has become established. Many so-called cures have been advertised from time to time, but evidence of their efficacy based upon scientific tests has never been established.

In any attempt to control the spread of the disease in a herd it is of greatest importance that the first abortion should always be regarded as of an infectious nature until it has been proved otherwise, and every precaution should be adopted to ensure the complete isolation of the animals and thorough disinfection of its discharges and their surroundings. An observant stockman is probably of more value in the prevention and control of contagious abortion than any other agent, as he will detect a cow that is threatening to calve before her time and remove her from the herd into isolation.

Control

There are two means of attacking the Brucellosis problem in a herd. Either (*a*) the disease may be kept out from the herd altogether (Clean-herd Policy), or (*b*) its ravages may be controlled by vaccination.

(a) Clean-herd Policy

If as a result of a herd test it is found that the infection rate is less than 5%, it may be worth while to adopt this policy of control. It is only justified when there is a fair chance of keeping the herd free from contamination from outside sources and where animals are not brought in (unless first tested). As a general rule this is difficult to control and organize, but if success can be assured it is undoubtedly the method of choice.

Repeated blood tests and immediate disposal of reactors are necessary to ensure that re-infection does not occur.

This method is less expensive than vaccination, but demands constant care to prevent reinfection and leaves the herd very vulnerable should the disease be introduced. It should never be adopted without careful veterinary enquiry.

(b) Vaccination Policy

Vaccination with strain 19 live vaccine is the method advocated by the Veterinary Division as being most practicable for the commercial dairyman. The vaccine is a type of germ which has been modified in the laboratory so that it sets up a mild 'attack' of the disease, which results in subsequent immunity to the true infection. It causes a temporary upset in the body which may result in a slight rise in temperature. If vaccination has been carefully done, it is never harmful to calves and young heifers.

The vaccine is best injected in calves of 4 to 8 months. Its administration results in the animal reacting to the blood test, but the reaction usually fades within twelve to eighteen months. Immunity against infection lasts longer than this, and usually gives protection until the second or third calf has been born. After this time vaccination may need to be repeated, although it is not usually necessary if all calves are being vaccinated as they come along to join the herd.

Vaccination is organized from the Veterinary Offices throughout the Island. The vaccine is handled by the Ministry of Agriculture, and advice as to the best course to pursue with any particular herd can be obtained from the Veterinary Officer in the area, together with order form for vaccine, etc., if this is needed. The vaccine has a very short 'life', and vaccination campaigns are arranged three or four times annually. All the dairyman need do is to notify the Veterinary Officers of the number of calves between four to eight months which need vaccination. The cost of vaccine varies, but the injection is done free of charge.

Anthrax

Anthrax is a severe, usually fatal, disease of all animals, including man. It is, however, more often seen in cattle and pigs than in other animals, although sheep and goats contract it from time to time. It is not often seen in horses. The disease is characterized by sudden death with great enlargement of the spleen.

Cause and Spread. Anthrax is caused by a small rodlike germ, *Bacillus anthracis*, which can only be seen under a powerful microscope. Outside the animal's body this germ forms 'spores' which can live in the soil, resisting the effects of sun and rain for many years. These spores, when picked up by an animal, develop into the rod-shaped bacilli within the animal's body and cause the disease. This explains the fact that the disease appears to be localized in certain areas, and that certain soils seem to favour its survival, since one finds 'anthrax districts' where the disease strikes every year. The whole of the carcass of an animal that has died of anthrax is infective, and from it the germs are readily spread by crows, flies, dogs, and on boots and shoes.

Anthrax can be introduced into a country formerly free of it by the importation of infected hides, straw, litter, and in fact anything that has been in contact with a diseased animal and that can carry the 'spores'.

Symptoms. In Cattle, Sheep and Goats. The *very acute* form of the disease may be so sudden in its onset that the symptoms are similar to 'Nightshade' (Urechitin) poisoning. The animal staggers, collapses, and dies at once. Often the period of illness is so short that the owner finds his animal dead without it having appeared at all ill. Frequently blood may be seen oozing from the nostrils and anus.

In the *less acute* form the onset is sudden, the animal is very dejected, food is refused, there is a decrease or complete loss of milk, shivers and fits may occur, and there is a temperature of 105–107° F. These symptoms may last from one to two days, during which time there may be some bloody diarrhoea, and swellings may occur on the tongue, in the region of the throat, or on the flanks. Bloody froth may be discharged from the nose.

The *chronic* form, in which symptoms may continue for a few days with ultimate recovery, seldom occurs in cattle, sheep or goats.

In Horses. Anthrax is not common in horses, but when it occurs it may, as in cattle, be very acute, death occurring before symptoms of illness are noticed. More usually, however, the disease is less acute, lasting for two or three days. Bloody diarrhoea, intense colic, trembling, rolling, soft swellings round the throat extending down the neck, and congestion of the lungs may occur; the temperature is at first high, about 106° F., but this drops to 104° F. on the second day, and below normal on the third day, when death usually occurs.

A common symptom is the swelling of the sheath or vulva, which becomes hot and painful and prevents the horse from walking.

In Swine. The usual symptom seen in swine is a soft inflammatory swelling around the throat. Other symptoms as bloody diarrhoea, high fever, colic, bloody froth from the nose, may also occur. Death may occur suddenly or within 48 hours of the symptoms commencing.

In Man. Anthrax occurs in three forms. The more usual form is known as the 'malignant pustule', which is an infection of the skin from a slight abrasion. This usually occurs on the hand, finger, or neck, and is in the form of a black, intensely painful swelling. Another form, contracted by inhaling anthrax spores, is called "wool-sorters" disease. This is a severe pneumonia. A less common form is the intestinal infection, from eating

improperly cooked meat from an animal infected with anthrax. This takes the form of a bloody diarrhoea. Any of these forms may turn into a generalized septicaemia with sudden death, unless treated promptly.

Procedure on suspecting Anthrax. Whenever an animal, especially cattle, dies suddenly, you should suspect anthrax. If there is any sign of blood at the anus or nostrils, you should be even more suspicious.

The Anthrax Regulations 1948 require the owner of any animal that he suspects is affected with anthrax, or of any animal that he thinks has died of anthrax, to notify the nearest police station. The Constable in charge of the station must then telegraph the Director of Agriculture or the nearest Veterinary Officer immediately. As soon as the Veterinary Officer is thus notified, he must investigate as soon as possible.

Pending the visit of the Veterinary Officer, the owner should cover the carcass to protect it from crows and dogs. It would also be as well to spray it with some fly repellent or Jeyes to keep off flies.

Under Jamaican conditions it is possible that a Veterinary Officer may not be able to investigate the cause of death until some time has elapsed, and in these cases the owner would be justified in burying or burning the carcass after a period of 24 hours has elapsed from the time of death. The owner is always justified in making a blood smear from the carcass, if he takes care not to get any blood on himself or his clothes, and pours Jeyes on to any wound he may make on the carcass. Do not attempt to perform a post-mortem examination; this is dangerous to yourself and will only tend to spread the germs.

Diagnosis. Sudden unexplained death, with blood oozing from the nostrils or anus, swellings in the throat region, and the other symptoms mentioned above, should make you suspicious, but the only certain way to diagnose the disease as anthrax is to see the causative organism, and this can be done by taking a blood smear and examining it under a microscope in a laboratory. Anthrax can nearly always be diagnosed from blood smears, provided they are taken not more than six hours after death; and this should be done immediately the carcass is found, especially if the Veterinary Officer may not be able to visit for some hours.

To get blood for the purpose of a smear, it is best to cut off one ear, or cut into the tail of the carcass. These smears should then be sent to the Veterinary Division, Hope, Kingston, or given to the Veterinary Officer when he arrives to investigate the disease.

Should an anthrax carcass be accidentally opened the following changes would be noticed:

In Cattle. The blood is dark and does not clot properly. There may be splashes of blood or areas of pink jelly-like substance beneath the skin. The organs of the body are usually dark and congested with blood. The spleen shows the most characteristic change of all; it is very enlarged, and has a dark red-black porridge-like consistency, and is sometimes called a 'blackberry jam' spleen. Should you find these changes in any carcass, you should immediately stop, wash your hands very well in Jeyes, notify the nearest police station of your suspicions, and have the carcass covered up to await arrival of the Veterinary Officer.

In Swine and Horses. The post-mortem picture is rather different in swine and horses. In swine there is a clear gelatinous swelling in the throat region, and probably the stomach and intestines are very inflamed. In horses there are swellings in the neck. In neither of these animals is the spleen constantly enlarged. Blood smears will usually clinch the diagnosis.

Never, never perform a Post-mortem on a Carcass if you suspect Anthrax.

Treatment. Broad spectrum antibiotics seem to hold promise as a cure, but only if given early enough in milder cases. Anthrax serum is also very good, but is expensive and impracticable under Jamaican conditions.

Prevention. Vaccination. This is the wisest and least expensive way of tackling the disease.

There are many types of anthrax vaccines, varying in their dose, safety and efficiency. On the whole live-spore vaccines are to be preferred, since the protection they give is most complete. There is, however, some danger in their use under unfavourable conditions, and their administration should only be done under professional supervision. Vaccination must be repeated annually, since the immunity set up will only last about twelve months.

Anthrax is more prevalent at certain times of the year, noticeably in spring and early summer. Vaccination should be done before this time, and the annual vaccination campaign which the Veterinary Division has conducted for the past few years in St. Elizabeth is carried out in February or March.

As a rule only cattle, goats and horses are vaccinated against anthrax in Jamaica, but pigs and sheep in anthrax areas should also be so treated. Remember that no vaccine is 100% successful, and that anthrax is a deadly disease.

Prevention of Spread. All carcasses, and everything that might in any way be contaminated with the germ, such as bedding, litter, food, water, stables, soil, etc., must be burnt or otherwise disinfected. It is important to realize that the germ, once outside the animal's body, forms spores that are very resistant to disinfectants, and therefore as much of the contaminated material as possible should be burnt. Wash out the stall or shed with a 5% solution of Jeyes or carbolic acid.

Anthrax can be prevented by vaccination at a cost of a few pennies per head. If you are in an anthrax area take advantage of this protection.

Mastitis (Garget)

Introduction

The Udder. The most important part of a cow to all dairymen is the udder. This gland, designed by nature to provide milk for the young calf, has been abused by man to provide milk for humans, young and old, and it does not always take to the ill-treatment it receives without grumbling.

As far as the cow is concerned, the udder is no doubt placed in the most convenient place for carrying around. It is, however, subject to injuries, to splashing with mud and dung and urine, and dangerously exposed to thorns, barbed wire and other hazards. Furthermore, man by selective breeding and by his crude methods of withdrawing the milk, has produced a cow with a large udder and pendulous teats hanging perilously near the dirt and germs of the cowshed floor. The dairy cow's udder, then, is a most unnatural and overdeveloped organ, and it is no wonder that it is so often subject to infections of one sort or another. A better understanding of the structure and functioning of the udder will enable the dairyman to treat it more kindly.

Anatomy of the Udder. Each quarter of the udder is a separate system of glands and ducts and has no direct connection with the other three. The milk is formed from 'cells' situated around the ends of the ducts. These milk-forming cells are small (about $\frac{1}{500}$ inch across), but are present in very large numbers, and each pours its own quota of milk into the duct.

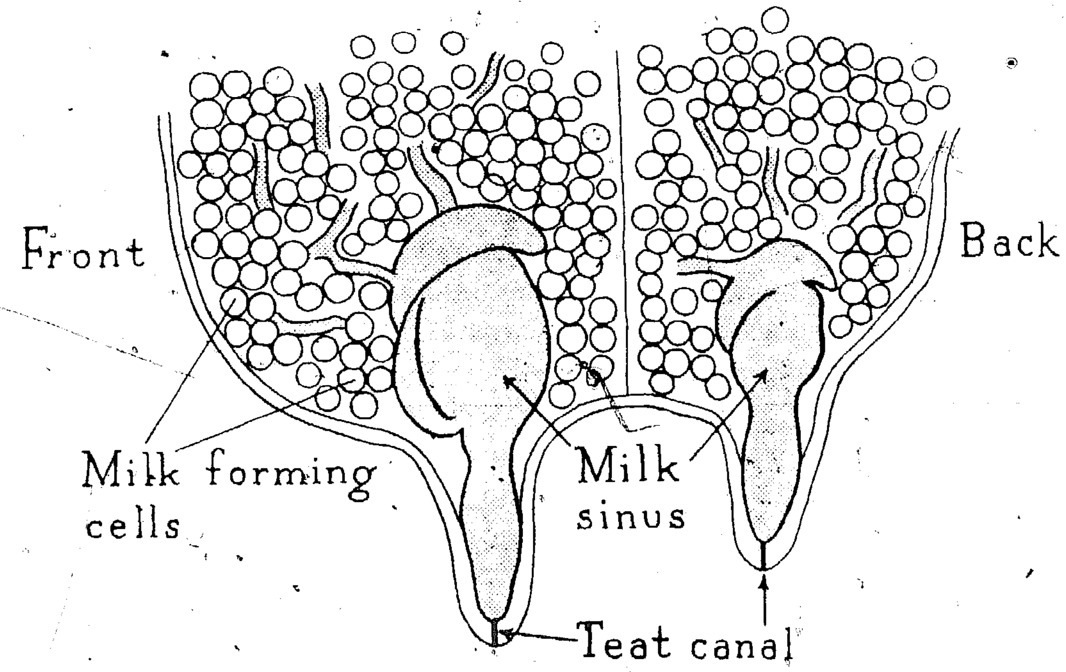
These ducts join together and lead the milk to the base of the udder, where they all join together to form the milk sinus above the teats. From this the teat drains, its outer opening being protected by a ring of muscle.

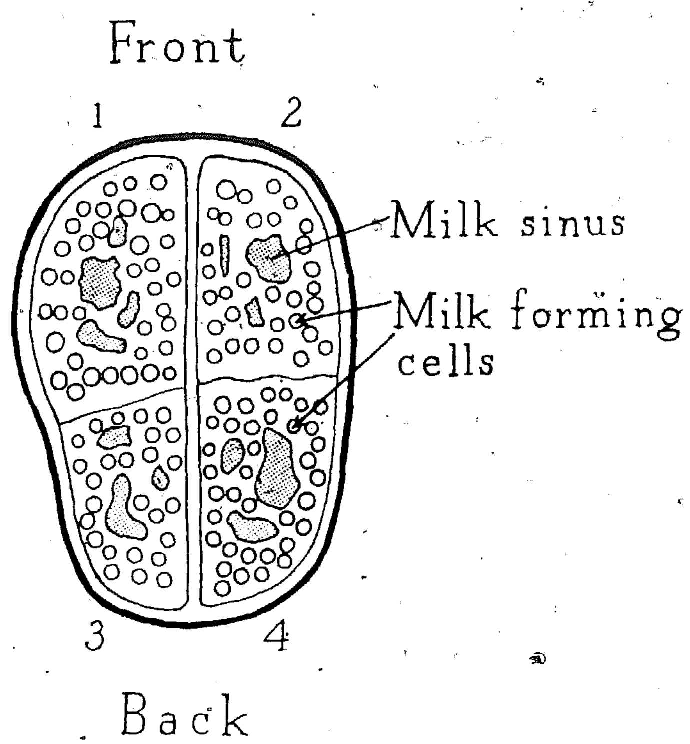
Formation of Milk. The smaller ducts of the milk-forming cells are surrounded by blood vessels, and all the constituents of milk are carried to the udder by the blood stream. It has been calculated that 2 tons or 450 gallons of blood flow through the udder to produce 4 quarts of milk.

In addition there are numerous nerves running to the gland, both to detect pain and also to control the various muscles of the duct system. The udder is thus both sensitive and delicate, and very susceptible to damage from wrong treatment.

The actual production of milk is basically controlled by hormones. These are chemical substances, formed in the 'master glands' of the body (pituitary, thyroid, adrenal, ovary, etc.) which travel in the blood stream and affect particular tissues.

Thus the development of the udder before calving is caused by hormones from the placenta (afterbirth) and pituitary gland which cause growth of ducts and milk-forming cells ('springing'). At calving time, other hormones take over and act upon the cells, causing milk to be formed and to flow into the ducts of the gland.





The actual formation and 'letting-down' of the milk is of the greatest interest to the dairyman.

Milk formation is continuous while the cow is in milk, but the milk is stored in the udder, partly in the ducts and partly in the milk sinus, until the time of milking. At this time, the cow 'lets down' the milk, and the

stored supply is rapidly made available and can be withdrawn. For this reason it used to be thought that it was only at this time that milk was formed in the udder.

The sudden release or 'let down' of milk depends upon a hormone released from the pituitary gland; this, acting upon the muscles of the ducts, squeezes out the milk. The gland will only release this hormone in full amounts when the cow is in the right mood to be milked, usually when she is in quiet surroundings, with a calf or milker she is accustomed to and with no annoyances to disturb her contentment. In these circumstances the milk will be let down most quickly and in greatest amounts. Disturbing influences such as noise, unaccustomed surroundings, people or dogs in the cowshed, lack of food or any alteration of routine, cause a fall in the amount of hormones discharged and a lessening of the yield. Some cows will not 'let down' their milk unless their calf is present alongside them.

It is most desirable at milking time to ensure quiet surroundings for the cows, to have a smooth-running system of handling the animals and to avoid any harassing or disturbing influences. Handling of the udder must also be both gentle and clean, to avoid physical damage to such a delicate structure and to ensure a clean supply of milk. For these reasons a routine of milking is strongly recommended. This must be instilled into the milker until the correct method becomes a habit.

Milking Routine. A practical routine is as follows. Its success depends upon *meticulous attention to detail*—which means, in its turn, responsible supervision at milking time.

Before milking, clean the udder and surrounding skin. This not only destroys the mastitis bacteria, but also those causing souring of milk; it will therefore improve the keeping qualities and flavour of the milk. For this purpose use a small towel which is kept in a bucket of hypochlorite-type disinfectant. Wash the whole udder, especially behind, and pay particular attention to the ends of the teats. Use the towel wet, but later wring it out and dry off any remaining drops of disinfectant. The massage and handling of the udder prepares the cow to let the milk down freely.

The disinfectant should be made up at the proper strength, and one bucket should be made to serve, at the most, ten cows. After this its strength is lowered and a fresh bucket should be made up.

The towel should be replaced in the bucket after each cow and should be rinsed. At the end of milking it should be rinsed in clear water and dried and bleached in the sun.

For hand-milking, wash the hands well in soap and water or in the disinfectant bucket *before milking each cow* and dry the hands on a clean towel. This towel also must be thoroughly washed and dried in the sun after each milking. During milking the hands must be *dry*, and the teat should be gripped and squeezed from above downwards, but *not pulled*. The practice of milking with wet hands and of pulling the teats is the cause of much mastitis. The teats are damaged and left in a moist condition. Small cracks and sores appear and the delicate teat lining is injured, and this favours the multiplication of mastitis germs.

After milking wash the teats again, leaving them quite dry. This removes any beads of milk, which attract flies and so spread the germs. It is a good plan to put a small dab of teat ointment on the orifice after milking, but hands must be clean.

Machine Milking. Milking by means of mechanical devices is a great time- and labour-saving operation, but one has to be, if anything, even more careful about disinfection of the udder and the machine than with hand-milking.

It is essential to sterilize the teat cups before transferring them to another cow. This is usually done by washing them in water and then immersing them in a hypochlorite solution for at least one minute, and preferably two or three minutes. To save time, therefore, it would be necessary to have at least two sets of cups, and use one set while the other is being sterilized.

Mastitis can spread extremely rapidly in herds milked by machine, as the teats, unless disinfected, can carry the germ from one cow to the next, and also any prolonged action of the machine such as leaving the cups on after the udder has been milked dry, may tend to damage it and set up mastitis.

Well supervised and intelligently operated, the milking machine is a great asset, but it can be very dangerous if carelessly used.

The makers usually issue full instructions on disinfection, and these should be adhered to rigidly.

Teat Injuries. Injuries to the teats are dangerous and result in much mastitis. There will be less bruises and tears if the cows receive sympathetic attention, if they are driven with care, and if they are not herded together for long periods in a confined space. Bully cows are often best disposed of, even if high yielders, as their victims drop heavily in yield as a result of being chased around. Horned cows which attack other cows can be dehorned. Any teat sore should be treated early. It is often best to isolate these cows indoors for a while and to provide clean bedding to prevent infection. Clean the sore or cut with a mild disinfectant such as Dettol, and then paint with friars balsam, mercurochrome, or iodine, putting a fly repellent oil around the edges of the wound. If the teat is penetrated the case is more serious, as the escape of milk prevents healing. It is best to get veterinary advice as soon as possible in order to save the quarter from an attack of mastitis. Frequently, however, the teat will not heal until the cow goes dry.

Care of the udder is not likely to be rewarded by any spectacular results, but careful attention to the details advocated above will ensure a minimum of trouble from mastitis and give the greatest yield of clean milk.

Mastitis (or Garget) in Dairy Cows

Mastitis is a disease of serious economic importance to all keepers of dairy cattle. Whenever cattle are kept under conditions where little demand is made on them for milk production there are few cases of mastitis, but with the introduction of more intensive methods with resultant strain upon the udder, this disease inevitably appears unless care is taken to control it.

'Mastitis' means simply an 'inflammation of the udder'. As it may be due to a variety of causes or take a variety of forms it is important to distinguish between them. Thus we talk of 'acute mastitis', meaning that it is of sudden onset and runs a severe course, or of 'chronic mastitis', which is slow in its development, less spectacular in its symptoms, but perhaps equally costly to the dairyman. Each of these may be caused by a variety of germs, and the veterinarian must decide which particular germ is responsible before recommending treatment.

Cause. The germs responsible for mastitis are of two main types, but other germs including those of tuberculosis and Bang's disease may sometimes invade the udder, making the milk dangerous for human consumption.

Staphylococci cause 70% of the cases of acute mastitis and the majority of the cases of sub-acute or chronic infection. They live on the teats and in the udder, and are relatively easily killed by disinfectants.

Streptococci are also important in causing mastitis.

It must be emphasized that these germs can be found in milk and on the teats of cows with apparently normal udders. The immediate cause of the disease must therefore be sought elsewhere, and it is known that there *is some factor in every case which causes damage to the delicate udder tissues* and enables infection to obtain a foothold.

In some cases the cause of injury is easily found. Common examples are bruising, treading on teats, cuts with wire, 'horning' by other cows, irritation from the teat sores or from flies, chilling, bad milking—particularly pulling on the teats, wet milking, badly used milking machines or irregular hours of milking, but in other cases the cause is less easily determined. In the more obscure cases it seems likely that such factors as feeding, inbalance of sex hormones and forced production play a part.

In nearly every case the association of germ and udder 'injury' seems necessary for the production of the disease.

Symptoms. Acute mastitis has a sudden onset. The cow, usually in full production shortly after calving, is found to have a distended quarter, hot and tender to the touch. Sometimes more than one quarter is affected. She usually has a high temperature (up to 105° F.) and refuses her food. At the same time the milk is changed to a thin watery or blood-stained pus-like fluid and is difficult to draw from the teat. In some cases the skin of the udder is discoloured, and there may be swelling of the surrounding area due to collection of fluid beneath the skin. Severe cases may result in loss of the quarter or even death of the cow. Such acute cases may arise as a result of a 'flare up' of a previous chronic case, or may result from a recent severe infection or injury.

The chronic type of mastitis is less severe. It causes, however, the greater loss in the long run since its onset is insidious, and frequently it has obtained a firm grip on the whole herd before advice is sought or action is taken.

The first sign of the chronic mastitis is to be seen in the milk. When examined on the fine mesh of a strip cup, small clots or strings may be seen. These are most frequent in the fore milk (the first 'squirt' from the teat at milking). Other changes occur at the same time in the chemical make-up of the milk which reduce its nutritional value and may cause it to appear thin and watery, and to taste salty and acrid. If the disease is allowed to progress a slow hardening of the udder substance takes place, due to the building up of a fibrous scar tissue in the delicate tissues of the udder. This eventually results in the milk-forming cells becoming quite destroyed and the quarter going 'light' and 'blind'.

A condition often confused with mastitis is '*red milk*'. This is due to a rupture of a blood vessel on the inside of the udder and is not true mastitis. It is generally caused by rough milking soon after the cow has calved while the udder is still developing and congested.

Diagnosis. Diagnosis of *acute* cases presents no difficulty, except in the distinguishing between the different types of causative infection. Bacteriological diagnosis, often impossible without laboratory assistance, is of great assistance in treatment.

Early detection of chronic mastitis is important, because not only are mild latent cases liable to flare up into severe attacks, but also because they are spreading the germs of the disease around the cowshed, where they are likely to infect other healthy animals. Knowledge of infected animals enables these to be isolated to prevent spread of infection and to be treated.

Mild cases of mastitis are accompanied by only slight changes in the milk. The earliest and most reliable method of diagnosis is in the laboratory, but for this purpose a freshly-taken sample of milk is required, drawn with special precautions as regards cleanliness into a sterile bottle, and kept

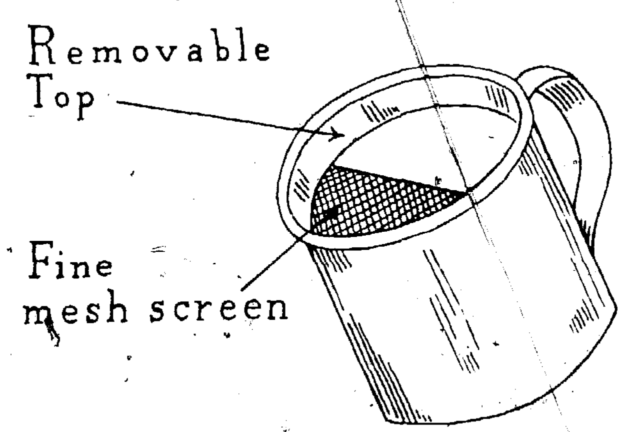
on ice. More practical methods are required for day-to-day use in the cowshed.

There are a number of popular tests, each with its own advantages, for the detection of mastitis by the dairyman. They are of varying sensitiveness in detecting slight infections, but they all depend on the detection of changes in the milk caused by the damage already done to the milk-forming tissues by infection.

Tests for Mastitis

Strip Cup. This is the most valuable test for mastitis for the practical man. A squirt of milk is drawn on to the black surface or mesh of the cup and then examined for discolouration and/or the presence of small flecks or clots.

The cup should be used at least once daily, the first stream of milk being used from each quarter at milking time. In addition to giving an early indication of mastitis infection, the strip cup removes the germ-laden 'first stream' of milk from the main supply.



A Strip Cup

Bromothymol Blue. Bromothymol blue (Thybromol) test depends on the fact that diseased milk is alkaline, whereas healthy milk is very slightly acid. When paper, impregnated with bromothymol dye, is wetted with alkaline (diseased) milk from the suspected quarter, the paper assumes a green colour, the depth of colour depending to some extent on the degree of infection; healthy milk leaves the paper a yellow colour. This test is of limited value as a routine method, but is valuable in outbreaks of mastitis.

Tasting the milk was at one time used as a test. Milk from diseased quarters has a higher salt content and is 'sharp' to the taste. Recently an electrical instrument for diagnosing mastitis has been put on the market

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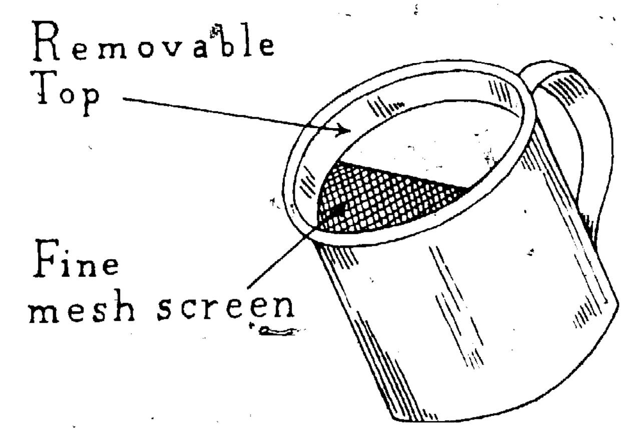

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Tasting the milk was at one time used as a test. Milk from diseased quarters has a higher salt content and is 'sharp' to the taste. Recently an electrical instrument for diagnosing mastitis has been put on the market which depends upon the same principle. This is quite efficient in the detection of early cases, but is rather too expensive for the small dairyman.

Routine tests for mastitis should be performed in every dairy. They may appear to be tedious, but when disease threatens, the value of knowing the 'safe' and 'carrier' cows is soon seen. Early detection aids prompt treatment.

Treatment. There are two drugs commonly employed in the treatment of acute and chronic mastitis. These are the sulphonamide group (drugs such as sulphamilamide, sulphathiazole, sulphadiazine) and penicillin. The sulphonamides are usually given by mouth to the animal, although they can be infused through the teat canal into the udder. Penicillin is usually given by infusion, either as a solution or in oil or wax, into the teat.

Acute mastitis. Treatment of acute mastitis is a matter of urgency.

Treatment with Sulphonamides. In most cases, and especially when the cow has a high temperature, dosing with sulphamilamide (first dose 3 oz. followed by 1 oz. every 12 hrs.) or sulphyapyradine or sulphathiazole (first dose $1\frac{1}{2}$ oz. followed by $\frac{1}{2}$ oz. every 8 hrs.) gives good results.* This should be continued 4–5 days, or for at least a day after the milk has returned to normal. Penicillin may be used in addition to, or instead of, the sulphonamides. Where sulphonamides alone are being given, it is essential to strip out the quarter at least six times a day.

Treatment with Penicillin. Penicillin for treating mastitis is marketed in various forms, either as a powder, in oil, or in the form of little wax sticks called 'bougies'. Most forms still have to be kept on ice, and if so, this will be stated on the package.

The most useful type is the oily suspension of penicillin which is put up in small tubes for squeezing up into the teat. A course of treatment consists of one tube squeezed into the udder morning and evening, after milking out, for two to four days. Instructions in detail are always given on the package.

Bougies are used in the same way, but are not so easy to insert and are apt to break. Be sure and clean the end of the teat before inserting the tube or bougie.

The dry penicillin powder may be diluted with distilled water or normal saline solution and infused by means of a syringe and teat tube into the udder, but this is not a convenient method and relies for efficiency on the strict cleanliness of the operator and syringes. It is not recommended for general practice.

Penicillin is measured in units and the dose is calculated in the number

*A useful way to calculate the exact dose for the 'sulpha' drugs is to allow 1 gram for every 15 lb. live weight for 24 hours. This dose may be reduced to $\frac{1}{2}$ gram per 15 lb. live weight on the third and subsequent days.

of units given. Thus the tubes of penicillin in oil solution are usually 100,000 units each; bougies from 5,000 to 50,000 units, and the penicillin powder comes in bottles of 100,000 or 200,000 units.

For infusion of the udder with penicillin in distilled water 50,000 to 100,000 units should be given in 50 c.c. of water every twelve hours for two to three days.

In addition to the above treatments the udder should be bathed in warm water and massaged with coconut oil. On no account should an injection be made into the udder without veterinary advice.

Chronic Mastitis. Treatment of chronic mastitis is best undertaken by a veterinarian. He will probably recommend an infusion of the affected quarters, choosing his drug according 'to the nature of the infection'. Various antiseptics and sulphonamides are good, but penicillin is probably the best and most convenient. Frequent stripping and gentle massage are useful adjuncts to treatment. Injection of drugs into the udder without strict aseptic precautions can lead to a severe reaction, and this should on no account be attempted without qualified advice.

Other Drugs for Treatment of Mastitis. In the past, drugs such as Lugol's iodine, acriflavine and formalin have played their part in mastitis control, but with the arrival of the sulphonamides and penicillin, these drugs are seldom used today. New drugs are continually being tried out and some, particularly phenasone, are proving very promising, but until their efficacy has been proved treatment with penicillin or the sulphonamides is recommended.

Prevention and Control. The real control of mastitis lies in the *prevention* of the disease, and it is one of the attributes of a good dairyman to be able to *avoid* mastitis. Since both the presence of the germ and the stimulus of an injury are needed before the disease occurs, efforts should be directed towards:

(1) Avoiding the spread of germs from the udder of one cow to another.
(2) Ensuring that the teats and udders are kept free from injuries and sores.

(1) Spread of germs from cow to cow can be prevented to a large extent by careful washing of the udder of the cow and of the milker's hands in weak disinfectant between milking. Before milking a cow her udder should be wiped carefully and thoroughly, especially around the teats, with a cloth soaked in a weak disinfectant solution such as a hypochlorite solution (two eggcups per gallon of water), and at the same time the milker should disinfect his hands before passing to the next cow. Ideally each cow should have an udder cloth of her own. Especial care is necessary where teat sores exist, and these should be smeared with a fly-repellent teat ointment after milking is over and before the cow is turned out.

A useful formula is:

Iodoform	1 oz.
Boric acid	1 oz.
Oil of eucalyptus	½ oz.
Lanoline	¼ lb.
Vaseline	¼ lb.

Wet milking is often instrumental in the spread of the disease, but until the correct technique of milking by squeezing the teat is learnt by the cowmen of the Island, it is preferable to 'hard' milking involving pulling on the teat with resultant stretching.

(2) *Much injury to the udder can be prevented* by careful handling of the cows. Do not hurry them before milking, when their udders are full and easily bruised. Do not allow 'bully' cows to horn other weaker ones; if necessary the bully should be dehorned. See that fences are well built, so that cows do not break them down and tear their udders on the barbed wire. Cut down injurious plants likely to lacerate the udder in pastures. Give wide standings to the cows when lying-in, so that they are less likely to tread on their teats. Do not milk 'hard', and milk as far as possible at regular intervals during the day so as to avoid 'overstocking' of the udder.

Flies are important, both as spreaders of the germs from cow to cow and also because of the irritation they cause to the udder and to the cow. Measures such as the careful removal of manure to a safe distance from the cowshed should be taken against these pests.

It cannot be over-emphasized that the surest way of combating mastitis is to *detect early cases by careful observation* and to prevent it by taking these precautions.

Mastitis in Goats and Sheep

The germs attacking the udder of goats are similar to those affecting cows, but the chronic type of mastitis so common in cattle is seldom seen in goats, probably because they are seldom kept under such intensive and unnatural conditions.

Mastitis in goats is usually an acute infection with sudden onset and severe symptoms.

Cause. Various germs, but usually *staphylococci*.

Symptoms. The symptoms are those of an abscess in the udder. The affected side becomes hard, painful, and tense to the touch. The teat is usually bright red and the skin stretched and shiny. Often no milk can be withdrawn, but a small quantity of dirty, blood-stained, evil-smelling pus can be forced from the teat in a few cases.

Another type is more gangrenous in appearance, with great swelling of

the breast and obstruction of the circulation—'blue bag'. This form is rapidly fatal.

In all cases the ewe is badly distressed. The temperature is high, often to 107° F., respiration is laboured, appetite is lost and the gait is stilted, partly as a result of joint pains and partly because the swollen tender udder rubs the inside of the thighs.

Without treatment acute mastitis in goats is usually fatal.

Treatment. Remove the kid and isolate the ewe. Massage the udder and strip out as much milk as possible. Apply warm fomentations frequently to the outside of the breast, but do not massage more than is necessary to draw off any pus or clotted milk that will come.

For internal medication a saline purgative such as Epsom salts (4 oz. in 1 pint of water) will be of value.

Sulphonamides or penicillin may be given under veterinary supervision. In the case of a valuable animal it will pay to call in advice early, as surgical measures will often result in saving of the animal's life.

Careful nursing will assist toward recovery. Provide ample bedding, give fresh food 'little and often', and keep the bedding clean.

Loss of the affected breast is to be expected, although partial function may be retained in cases tackled early.

Mastitis in Other Animals

The symptoms and treatment are the same as for the cow.

Summary and Conclusions

Bovine mastitis is recognized as the most important disease confronting the dairy industry.

Infectious mastitis is caused by germs that enter the udder through the teat canal.

The germs are shed in the milk of diseased udders, and often transferred to non-infected udders by contaminated milking equipment and other mechanical means, also by flies.

In a mastitis control programme the major emphasis should be directed toward preventing spread of the disease through use of necessary precautionary measures.

Sanitary milking practices and good herd management methods are fundamental and essential in mastitis control, and constitute the only reliable safeguards in maintaining healthy udders.

Treatment of infected udders by intramammary injections of penicillin is a valuable aid to the sanitary programme in combating most types of mastitis.

A programme of sanitation controls the spread of udder infections, reduces the incidence of inflamed quarters, lowers the bacterial content of the milk, and maintains productive ability of valuable dairy cattle.

Swine Fever (Hog Cholera)

Cause. Swine Fever or Hog Cholera, as it is called in America, is a highly infectious and often fatal disease of pigs. It is caused by an organism called a virus, which is too small to be seen with the ordinary microscope. In Jamaica the disease is known as 'Hog Sick', a general name which unfortunately includes all the other diseases of the pig as well.

How it is spread. Swine fever is rapidly spread by contact and co-habitation, by putting healthy pigs in a place from which diseased pigs have been taken and which has not been properly disinfected, and by indirect means such as shoes, clothing, fodder, grass, straw, etc. Carcasses of infected pigs can also spread the disease, and in this way pig meat, such as is imported into Jamaica as salted, pickled, smoked or fresh pork, can be a dangerous source of swine fever infection, since scraps of bacon or pork may eventually find their way as swill to the pig trough.

Usually the disease appears periodically both in towns and in the country, sweeping through a district and killing a great many pigs of all ages. Between sudden outbreaks the disease may exist in a milder form.

Since swine fever is a disease notifiable by law, under the Animals (Diseases and Importation) Law, 1943, it is well that owners of pigs should become familiar with the symptoms.

Symptoms. After exposure to infection it takes about five to ten days for the pig to become sick. This is known as the period of incubation.

In the *acute form* of the disease the pig may die very quickly without showing any symptoms save a high fever; or it may appear to develop a chill and run a high temperature which fluctuates until just near the end, five or six days later, when the temperature becomes subnormal. (The normal temperature of the pig is 102·5° F.–103·5° F.) Usually the first symptoms to be noticed are marked depression and prostration associated with a high fever. The affected pigs try to hide themselves in shady corners, pools of water, or in their bedding, and refuse to eat. They do not like moving, and stand in a listless, dejected posture, with drooping head and ears, limp tail, and weak hind quarters. If they move the gait is stiff and they sway at the hind quarters. Occasionally purplish areas appear on the skin of the ears and over the belly. Conjunctivitis is often present. At first the pig is constipated, but this may give way to diarrhoea before it dies. Complications such as pneumonia may set in, especially during cold or wet weather when the pigs get chilled. In this case there is harsh breathing, coughing, and a discharge from the eyes and nose. Sometimes vomiting occurs.

The death rate is very high, and all pigs in the pen or on the farm may die. Those that survive may recover completely, but more often than not they continue to suffer from a milder or chronic form of the disease. These

pigs are very dangerous, since they retain the germ of the disease in their bodies and can infect healthy pigs.

The symptoms of the *chronic form* of swine fever are, in general, poor appetite, chronic cough, loss of weight, stunted growth, diarrhoea and general ill-health.

Diagnosis. Swine fever resembles other infectious diseases of pigs, but it is usually more infectious and more fatal than these, and so is more dangerous.

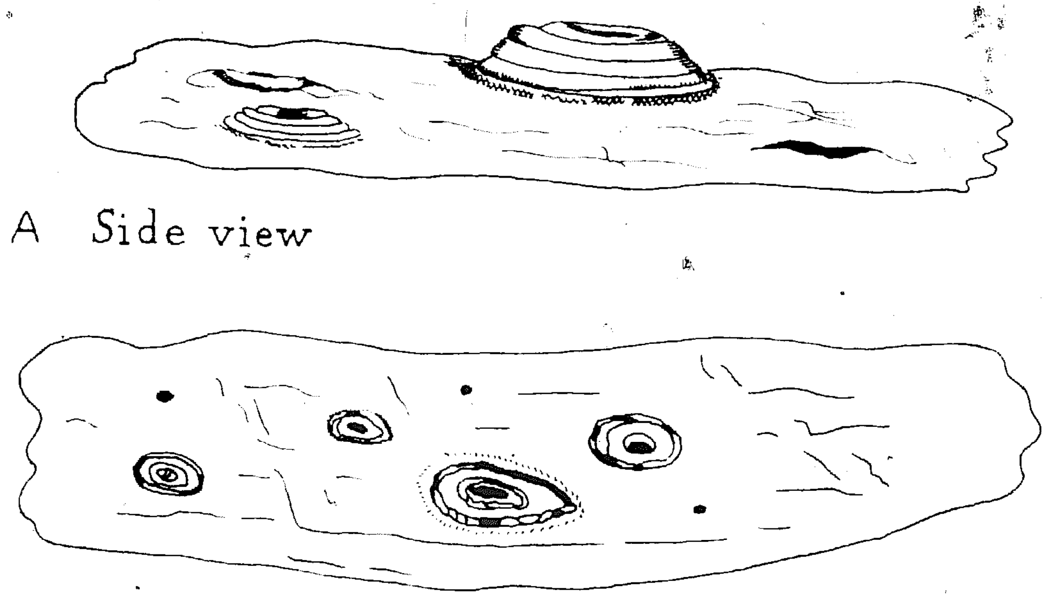
Diagnosis during life is made on the symptoms, e.g. high fever, prostration, purple discoloration, vomiting and the number of pigs sick. The mere fact that several individuals are sick is highly suggestive of swine fever. Account must also be taken of how the pigs may have become infected; for instance, by eating infected garbage containing imported pig meat; by new arrivals brought to the property; by sows coming to the boar at stud; or by contact with cases of swine fever in the district. It is, however, often very difficult or impossible for a veterinarian to be certain of a diagnosis without the post-mortem examination of a carcass, for it is here that the most useful diagnostic evidence of the disease is seen.

Post-mortem Examination. A post-mortem examination is essential for accurate diagnosis. If it is not possible to obtain veterinary attention immediately, the owner should do the post-mortem himself and put any organs he suspects of having the disease into a jar containing a little white rum, methylated spirit, or dilute formalin, and send them to the nearest Veterinary Officer, or give them to an Agricultural Officer to forward.

The skin of the pig may show purplish areas which would at once make one suspicious. (These also occur in swine erysipelas.) On opening the carcass splashes of blood may be seen on various organs. These may be large (½ inch across) or of pin-head size. The common sites for these are the heart, kidney which may have red spots on it ('Turkey-egg Kidney'), bladder, spleen, lymphatic glands and the lungs.

If the pig has died very quickly, there may be very few signs of the disease to be seen in the organs.

The most characteristic lesions are found in the stomach and intestines. The stomach is often acutely inflamed and its lining is a vivid red colour instead of the usual pink. The small intestine may be inflamed, but it is in the large intestine (especially the caecum) that the typical lesions of swine fever are seen. These consist of ulcers covered with dirty, cheesy material. They are about the size of a three-penny piece or smaller, and range in colour from light brown to almost black. The ulcer is raised above the surrounding lining of the intestine, and looks like a scab with a brown, crusty border. They are often called 'button ulcers'. These ulcers are the most characteristic lesion of swine fever, but are only present in



A Side view

B View from above

pigs that have suffered from the disease for more than a few days. In pigs that die soon after becoming sick, the ulcers do not have time to develop. A portion of the large intestine should always be kept and sent to the Veterinary Officer, especially if anything resembling ulcers is seen.

After the autopsy the carcass of the pig should be burnt, or buried at a depth of six feet.

Diseases that resemble Swine Fever

There are a few other diseases that may resemble swine fever very closely, and it is only the expert who can distinguish between them at times. They are:

1. **Swine Erysipelas.** This is an infectious disease of pigs caused by a bacterium, *Erysipelothrix rhusiopathiae*. It is uncommon in Jamaica. In the acute form purple diamond-shaped patches appear on the skin over the stomach, back, ears and face, there is a high fever, and the pig is prostrate and weak. In the *chronic form* the pig has a persistent chronic cough, and is unthrifty. It may suffer from arthritis and have enlarged joints.

Diagnosis is made from the above symptoms and the post-mortem findings which differ from swine fever in that there are no ulcers in the intestine, although the lining may be very inflamed. Also, growths are sometimes present on the heart valves, which are never seen in swine fever.

2. **Necrotic Enteritis (Swine Paratyphoid).** This is not an infectious disease, but occurs in young pigs (usually under six months old) kept in unhygienic, overcrowded conditions. The organism that causes this disease is always present in the intestines of normal healthy pigs, but when the resistance of the pig is lowered, for example, by cold or wet weather, worms or poor feeding, the organism causes ulcers in the intestines which resemble those of swine fever. Only an expert will be able to distinguish them. Probably quite a lot of pigs die from necrotic enteritis in Jamaica. One of the chief symptoms is diarrhoea.

3. **Pig Pneumonia.** This is seen in pigs that have been exposed to adverse conditions, such as cold, wet weather. It is probably fairly common in Jamaica, and many of the pigs on which post-mortem examinations have been conducted were found to have died from pneumonia. The housing of pigs in a warm, dry shelter at night would materially reduce the numbers dying from this cause.

Opportunity for treatment rarely occurs, and consists of keeping the animal warm and dry, and giving a course of sulphanilamide (1 gram per 15 lb. body weight daily, in two doses for three or four days, together with plenty of water or other fluids).

4. **Worms.** Heavy infestations of hookworms, kidney worms, thorny-headed worms, and stomach worms may cause symptoms resembling swine fever. The post-mortem examination will soon determine the cause of death.

5. **Vitamin Deficiency. Vitamin A** deficiency causes unthriftiness, lack of appetite, dirty coat, poor growth, partial blindness, weak hind quarters and convulsions. Vitamin A is supplied by feeding green forage, corn, cod liver oil, whole milk, etc. Deficiency of Vitamin A is not likely to occur, except in pigs kept permanently in sties without access to green fodder.

Vitamin B Complex deficiency causes lowered resistance to intestinal infection (predisposition to necrotic enteritis), lack of hair, diarrhoea, vomiting and a 'goose stepping' walk. Heavy worm infestation may be accompanied by a Vitamin B complex deficiency.

Vitamin B Complex is supplied by feeding dried brewers' yeast, food yeast, wheat germ oil, milk, raw liver, etc.

6. **Swine Influenza.** This is caused by a virus. It attacks mainly young pigs, and is not present in Jamaica as far as is known.

Treatment. No treatment of swine fever is known which is at all successful, and although in every district there is someone who willingly describes his 'infallible' line of treatment, nothing that is known will affect the course of the disease at all favourably. In fact, it is not in the interest of the community that pigs suffering from swine fever should be permitted to recover, as some may remain as 'carriers' of the disease to healthy pigs. It is probable that this is the way that the disease is maintained from year to year throughout Jamaica, breaking out now and again when a 'carrier' pig infects a group of susceptible healthy pigs.

Prevention. The way to prevent trouble is to prevent the disease by vaccination. Pigs of all ages can be vaccinated, but the best plan is to vaccinate all piglets at about three months old, just after they are weaned. This should protect them up to the age of marketing, say at one year old. Any pigs kept after that age should be vaccinated each year. Valuable breeding stock should be vaccinated again within six months of their first vaccination and at yearly intervals thereafter.

Vaccination will not *cure* the disease, it will *prevent* it, but since the vaccine takes about two to three weeks to produce an immunity in the pig's body, the vaccination of pigs in an area where swine fever has already broken out will probably be too late to do much good, for most of the pigs will have contracted the disease (even though they appeared healthy when vaccinated) before the vaccine has had time to protect them. It is these cases that give vaccination a bad name. The duration of immunity after vaccination is about nine to twelve months.

Where vaccination is carried out once a year it is wise to arrange it to take place about two months before the usual swine fever season, which in most districts is about August to October. Vaccination done in June will therefore have had sufficient time to build up an immunity before the danger months. Vaccination in June will also protect pigs from swine fever outbreaks in the cold months of December–February, which occur in some districts.

Vaccination is carried out by the Veterinary Division at a nominal cost to the farmer. In spite of this sure means of obtaining protection, many pig owners will not avail themselves of the opportunity, but prefer to let their pigs contract the disease, then waste their money on useless 'remedies' trying to cure them.

Control of Swine Fever

Control of swine fever in Jamaica is extremely difficult. The main line of defence against the disease is in the importation and disease control laws. Under the Animals (Disease and Importation) Law 22 of 1943, and the regulations made thereunder in 1948, the importation of pigs and pig meat is prohibited, except from certain countries and under conditions which reduce the risk of introducing the disease to a minimum.

The Swine Fever Regulations of 1948 also require any pig owner who suspects swine fever in his pigs to report the fact to the Constable in charge of the nearest Police Station at once. The Constable must then send a telegram to the Director of Agriculture or to the nearest Veterinary Officer, who must investigate immediately. If the disease is confirmed, a notice is posted on the premises stating that it is an infected place. No pigs may

enter or leave the premises, nor can any carcasses or portion of any carcass nor any litter, fodder or utensils used in connection with the pigs be taken off the premises. All the pigs on the infected premises must be confined to a sty or pen. Any pig that dies must be buried at least five feet deep, or burnt, as soon as possible.

No flesh from pigs on the infected premises can be offered for sale or used for human consumption.

The main line of attack on the disease is vaccination. When an outbreak occurs all pigs in the neighbourhood are vaccinated free of charge. Vaccination campaigns in the field are difficult, owing to the fact that the vaccine is easily destroyed by heat, must be kept on ice, and cannot be sent by post. The fact that the life of the vaccine in storage is relatively short means that it is impossible, from the point of view of expense, to hold large quantities in stock. For this reason it sometimes happens that when outbreaks occur, immediate supplies are inadequate.

Advice to Farmers

1. Vaccinate your pigs every year. Don't wait till an outbreak occurs before you vaccinate, or it will probably be too late.
2. If you suspect swine fever:
   (i) Isolate your pigs.
   (ii) Report your suspicions immediately to the nearest Police Station, your Veterinary Officer or your Agricultural Officer.

Internal Parasites of Livestock

All those factors which help to breed, multiply and succour animal parasites, such as warmth, moisture and shade, occur in Jamaica in abundance. The economic loss suffered by livestock owners from worms and ticks is great. About 80% of all young animals and about 30% of all adult animals actually suffer from parasitism of one kind or another.

From the earliest times man and animals have suffered from internal and external parasites, and the neat little poem:

'Adam
Had 'em'

aptly describes the universal distribution of these age-old pests.

The two main groups of parasites are:

(*a*) Internal parasites, e.g. worms, coccidia, etc.
(*b*) External parasites, e.g. ticks, lice, mange and certain flies.

Worms are important because of the vitality they suck from the animal, and ticks are important for the same reason and because they also transmit certain diseases.

Different worms may live in nearly every part of the animal body. The stomach and intestines, kidney, liver, lungs, heart, blood, muscles, peritoneal cavity, scrotum, the eye—all these organs may harbour one or other of the many species of parasitic worms. There are well over a thousand different species infecting animals, but only a few of the most important ones in domestic stock will be considered here.

To appreciate the method of controlling worms in stock and on pastures it is essential to know something about the worm itself and understand its life-history, since at certain times during its life-cycle the worm is more easily destroyed, while at other times it is more resistant to destruction.

Life-history of an Intestinal Worm. The life of most stomach and intestinal worms follows a typical course. The adult worms are either male or female. The adult females in the intestines or stomach of the animal lay eggs almost continuously, and these pass out in the dung on to the ground. They are too small to be seen with the naked eye and can only be detected under a microscope. This is the method used in diagnosing worm infestations, and will be fully explained later on.

The egg at the time of being passed on to the ground is non-infective, i.e. it will not develop into a worm if swallowed by another animal, but after a varying period of time (approximately 3–5 days) this egg becomes infective, and should it then be eaten by another animal of the same species it will develop into an adult male or female worm in this animal. Fig. 1 illustrates what happens.

Sometimes the egg on the ground hatches and a small larval worm crawls out on to the grass. If this larva is eaten it will develop into an adult worm. (This usually happens with the lung worm.)

The eggs and larvae on the ground need certain climatic conditions for development. Warmth, moisture and oxygen are essential, and shade is important. Hot sun and desiccation, or the heat of a compost pit will kill them fairly quickly, whereas long, damp, shaded grass is ideal for them to develop in.

After the infective egg or larva is eaten, it will soon develop into an adult worm in the stomach, intestine or other organ of the animal that eats it, according to the species of worm.

Since the females are laying eggs all the time and these eggs are being passed out on to the ground, it will be appreciated that in a very short time a pasture hitherto free of worm eggs will become heavily laden with worm eggs and thus highly infective. The more eggs passed out, the greater will become the number of eggs lying on the ground, and thus the grazing animals will consume more eggs with each mouthful of grass, leading to more worms in the intestine and resulting in a much greater number of eggs being passed out. This is the explanation of the old adage, 'Permanent pastures perpetuate parasites', meaning that pastures of long use, and

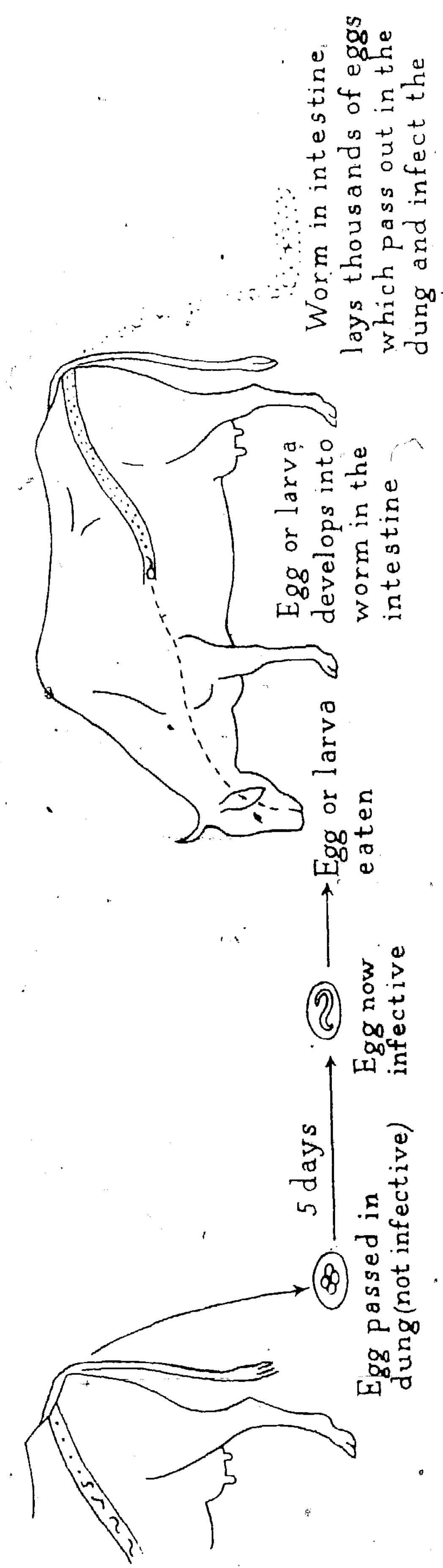


Fig. 1 The Life History of a Worm

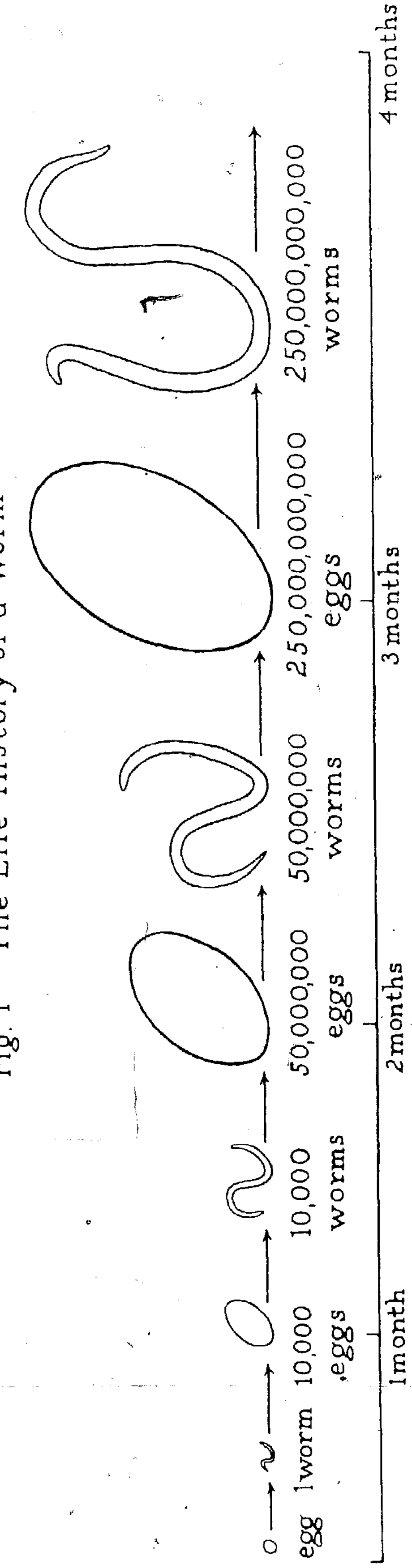


Fig. 2 Diagram Representing the Rapid Multiplication of Worms

which are never ploughed up for crops, are known to be dangerous worm-infesting grazing grounds.

The rate of multiplication of worms is shown diagrammatically in Fig. 2. The life-cycle of most worms from egg to egg takes about one month.

Factors that Help to Control Worms. There are, of course, factors which limit the increase of worms. These are:

(*a*) Natural Factors.

(1) Not every egg will reach the infective stage. They will die or be eaten before they reach it.

(2) Sun, drought, or other unfavourable conditions will kill many eggs and larvae.

(3) Other species of animals will eat some eggs and so destroy them. Thus a cow will kill any horse worm egg she eats, and *vice versa*. In general, each species of animal tends to control the parasites of the other.

(4) The natural resistance of the animal will account for some worms.

(5) Eggs and larvae may be eaten or destroyed on the ground by insects, birds, etc.

(*b*) Artificial Factors.

(1) Rotational grazing and proper pasture management.

(2) Worm remedies (Anthelmintics) will kill some worms.

Susceptibility to Worm Infestation. Many factors help to determine whether an animal will actually suffer from worms.

(i) **Age** is important. When an animal is young and growing fast, the strain on its resistance to infection is great. Moreover, it has not yet acquired an immunity to infection beyond that given it in its mother's milk. This is why all young animals are especially susceptible to worms. When maturity is attained a 'gentleman's agreement' is struck between the worm and the host, and unless for some reason the animal's resistance is lowered, the worm and animal get along pretty well together. However, if the resistance of the host is lowered, the worm tears up the agreement, rapidly multiplies, and soon kills the animal. If the animal's resistance is increased, it will in turn overcome its worm infestation to a very large extent.

(ii) **Food** is all-important in maintaining health and increasing resistance to worms. With adequate and proper diet, resistance is built up and worm infestation is very much reduced. With insufficient food, the host's resistance is lowered and the worm gets the upper hand. Once the worm is in control, the animal finds it very hard to shake off the infestation, and in

addition becomes much more susceptible to other diseases that may be about. Also with poor grazing the animal has to eat more to satisfy itself, and in so doing will pick up many more worm eggs and larvae with every extra mouthful of grass. Thus the vicious cycle grows: less food—less resistance—more worms—still less resistance and still more worms—death. With good food and clean pastures the animal will throw off worm infestation, especially if dosed regularly for worms.

(iii) **Specificity of Worms.** As a rule worms are specific for their hosts, that is to say, a pig eating a cattle stomach worm egg will kill that egg. It will not develop in the pig, but only in the animal to which it belongs—in this case, cattle. There are exceptions; for instance, some cattle worms are transmissible to sheep and *vice versa*, and one of the dog hookworms occurs in man.

From this it is easy to see that an appreciable amount of worm control can be obtained by grazing different animals together, such as mules with cattle, pigs with goats and sheep. Of course, this may be impracticable in most cases, especially in Jamaica where open range methods of grazing are practised, but is worth keeping in mind for special occasions.

(iv) **Climatic conditions** are important. Calves left out in the rain and cold will be much more susceptible to worms amd other diseases than those kept warm and well-fed in stalls. Calves also reared in small enclosed paddocks will soon infest the ground with eggs and larvae, and become heavily infected themselves. They should be kept in easily-cleaned, warm stalls until of sufficient age to accompany their dams to pasture. Vitamin deficiencies, more especially in poultry, predispose to worm infection.

Diagnosis of Worm Infestation

In the Field. Symptoms and appearance of the animal are the main guides. Paleness of the conjunctiva, persistent diarrhoea, oedematous swellings of the chest and neck, emaciation, staring coats, digestive upsets, etc., all help to clinch a diagnosis. Occasionally the worms themselves are seen in the dung.

In the Laboratory. For this a sample of dung is required. When despatching by post, pack about a tablespoonful of the dung in a small tin or bottle, filling the container as completely as possible. It is important to get the sample to the Veterinary Officer or Hope Veterinary Laboratory as soon as possible after taking it. Diagnosis on samples which have been kept for twelve hours or longer may be unreliable. If a sample is to be kept for a longer period it must be stored on ice. At the laboratory the dung is mashed up with a saturated salt solution and left to stand. The worm eggs float to the top of the solution and the debris falls to the bottom. A specimen is taken off the top and examined under the microscope. The different types of worm eggs seen indicate the various kinds of worms present. In special cases a count of the eggs is done. To do this the sample of dung is carefully weighed and mixed with a known volume of water. A measured sample of the water is examined and all the eggs contained in it are counted. From this is worked out how many worm eggs there are per gram of dung. As many as 30,000 and 50,000 eggs per gram have been recorded for certain worms, and more than 100,000 worms found in the intestine.

Post-mortem. As so many animals die of worms, it may be useful to describe briefly how to open the animal to determine whether it did die from this cause, and what to look for. Take, for example, a goat. The same will, however, apply to all animals.

Cut down the midline of its belly and notice whether the underlying muscles and fat are water-logged and dropsical. This is the first indication of worm infestation. Carefully open into the abdomen (not intestines). If a lot of clear water pours out (dropsy or ascites) it is a further indication of death from worms. Open the abomasum (fourth or last stomach) and examine the contents carefully to see whether any worms can be seen wriggling in it. Open into the small intestines (continuation from the fourth stomach) and repeat observations.

Notice the appearance of the lining of the intestine, whether inflamed or normal, and whether there are any little dark pimples along it which can readily be seen from the outside. This is called 'pimply gut', and is caused by a worm called *Oesophagostomum columbianum*. Do the same thing to the large intestine and caecum. Tapeworms and large white worms will easily be seen if present.

Examine the bile ducts of the liver for 'fluke'. In pigs look at the kidneys and ureters (the pipes from the kidney to the bladder) for 'Kidney Worm'. In horses look in the stomach for 'bots'.

Now turn to the chest. Open the trachea (windpipe) and look for lung worms. Follow the branches of the trachea right down into the lung tissue.

These are by no means all the sites for worms, only the most important ones, and will give an indication as to where to look and what to look for. Remember most worms are extremely small, and only by carefully examining the contents of the stomach and intestine is it possible to observe them wriggling about. Because you do not actually see any, do not conclude that there are none. Collect a bit of stomach contents and intestinal contents, preferably scraped off the bowel wall, and send it to your nearest Veterinary Officer or to the Veterinary Laboratory, Hope, Kingston, for diagnosis.

Worms in Cattle

The Large White Roundworm of Calves (Ascaris vitulorum)

The first important worm that may cause symptoms and deaths in calves is the large, round white worm—very much like an earthworm, and in fact a cousin to it. It is from 4 to 10 in. long. It may affect calves from birth to the age of six months, after which time the infection is usually thrown off. It is very common in certain localities and on certain properties, other places seemingly being almost free from it. The calf loses its appetite, is unthrifty, has a tendency to diarrhoea and colic. The coat is staring, and often the animal is anaemic—a fact which can be readily determined if the conjunctiva of the eye is examined: Normal conjunctiva should be a healthy pink. If it is pale or white the animal is anaemic.

The worms may be seen in the calf droppings, and if this occurs treatment should commence straight away and include all the young calves on the property.

Treatment. One or two teaspoonfuls of oil of turpentine mixed in a quarter pint of linseed or castor oil and given early in the morning before the calf has had any feed is quite effective. It may be repeated the following morning. A couple of dosings at an interval of one month should carry the calf through the period of danger as far as this particular worm is concerned. Copper sulphate (bluestone) is quite useful against this worm.

Piperazine compounds are extremely effective.

Prophylaxis and Prevention. On properties where this worm occurs it is a good plan to treat the dam with bluestone while in calf, giving the last dose one month before calving. Calves should be kept in large, well-drained paddocks, so that their droppings will not be concentrated on the ground. Preventive dosing on properties known to have this worm should be practised.

The Stomach or Wire Worm (Haemonchus contortus)

Having grown out of the large roundworm stage, the calf is prone to attack by smaller but just as deadly worms. The chief of these, the Stomach or Wire Worm, may affect the calf from about four months of age until maturity, and probably causes more economic loss to the breeder than any other single parasite. Deaths are frequent, stunted growth and unthriftiness are very common. The animal becomes very anaemic, as this worm attaches its head to the stomach wall and sucks blood. Dropsical swellings are sometimes seen under the jaw or in the dewlap. If an ear vein is pricked the blood looks watery. The coat is staring and the belly usually distended, while the legs and the rest of the animal are thin. The worm itself is about an inch long, the males are red and the females are red with white spiral rings around them, producing an effect like a barber's pole or stick of candy.

Treatment. Probably the best drug to use is Phenothiazine. This is sold either as a green powder or in tablet form under various trade names. The dose is given on the bottle or carton. It is well to remember that animals heavily infested cannot tolerate the full dose, and in this case it is better to give half the dose, and repeat in ten days' time with the other half, giving a full dose three weeks to a month after this, and repeating the full dose at monthly intervals until the calf is ten to twelve months old.

Bluestone (Copper Sulphate) is also a very good and a much cheaper drug, and can be used instead of Phenothiazine.

Prevention. This entails good hygiene and animal husbandry, common sense and preventive dosing. Briefly, the animal should have sufficient food and clean water and sufficient added minerals (if the soil lacks them). Overstocking must be avoided, and as calves are the most susceptible, they should be separated from their mothers as early as possible and made to graze in a clean pasture or kept in a stall, and only put with the cows to suckle. It is dangerous to put calves into small paddocks for any length of time, since the concentration of worm eggs and larvae on the grass becomes very great. Either put them in large well-drained pastures, or in stalls which are cleaned out daily, or let them run with their dams at pasture. A clean pasture is one on which no cattle have grazed for six months, or one that has recently been ploughed and is being grazed for the first time. All others will probably be infective. Wet or damp pastures, especially those that have ponds with extensive marshy areas around, should be avoided, and the animals are best watered from raised troughs with gravel around them. More larvae and eggs are picked up when there is dew on the grass, so where possible animals should not be allowed to graze until the dew has gone. Some of these considerations may appear impracticable in Jamaica, but with a little thought and work it should be possible to organize the herd management to suit these requirements.

There are other stomach worms which cause similar symptoms and are treated in the same way.

Intestinal Worms

Other worms (*Trichostrongylidae*, *Cooperia oncophera*, *Ostertagia ostertagi*, *Nematodirus filicollis*, *Bunostomum phlebotomum*, *Oesophagostomum radiatum*, *Chabertia* spp., etc.), classified under the general heading of 'Intestinal Worms', may infect the calf over the age of three months. The precaution against infestation and spread of these is the same as for stomach worms, and treatment with phenothiazine or bluestone is effective for most of them. These intestinal worms live in the large or small intestines; they are

very slender, about ½ to 1 in. long, looking rather like a coarse, white hair. Symptoms include all those mentioned for stomach worm together with a persistent diarrhoea. They attach themselves to the intestinal walls and suck blood, producing severe anaemia and enteritis.

Treatment. Phenothiazine is the best and safest drug to use, although bluestone can also be given. An iron tonic is recommended to help build up the blood which the worms have sucked out, and so enable the animal to regain condition.

The Lung Worm—'Husk' or 'Hoose' (Dictyocaulus viviparous)

This worm is extremely common. It lives in the small air passages of the lungs and in the windpipe, and is two to three inches long. It usually affects only young animals, giving them a characteristic spasmodic cough, known as 'Husk' or 'Hoose'. Meagreness, anaemia and diarrhoea are also seen. It causes more trouble in the rainy months or on pastures that are permanently or frequently damp. The life-history of this worm is more complicated than the preceding one. The female worm lives in the lung passage, where she lays her eggs. These are coughed up into the pharynx of the calf and swallowed. On the way through the intestine the eggs hatch out into small worm-like larvae, which are deposited on the ground in droppings. These larvae are very delicate and are quickly killed on dry soil. They need shade and moisture to continue development. If these conditions are satisfied, they go through certain stages and become infective in a few days. They are now much more resistant to dry conditions, and are able to live on the ground for several months. They attach themselves on to the blades of grass and are eaten by another calf. They penetrate through the intestines of the animal and enter some glands (mesenteric lymph glands) near the stomach. After a while they are carried in the blood and lymph streams to the lungs, where they break through the small vessels and enter the air passages.

Symptoms. The worms attach themselves to the walls of the air passages and suck blood. This irritation of the air passages sets up a catarrhal bronchitis which gives the animal a characteristic cough. The calves lose condition quickly and become anaemic. Pneumonia sometimes follows. Diarrhoea is sometimes seen. One of their worst effects is that the lung worms so lower the resistance of the calf that other worms (e.g. stomach or large roundworms) attack it, and this contributes to the ultimate death of the calf.

Treatment. Within recent years a new drug Cyanacethydrazide (trade-name Helmox Dictycide) has been put on the market and has given very promising results. However, the best treatment of all is to shelter the animals against adverse conditions, keep them warm and dry and see that they have plenty of food. With care they should soon throw off the infection. Elimination of other intestinal worms and administration of tonics will help to build up the animal's resistance.

Prevention (i) *Vaccination.* Within the past year a vaccine against 'Husk' has been placed on the market. The vaccine consists of specially irradiated larvae which when administered to young animals do not develop to maturity but at the same time confers an immunity against natural infection.

(ii) Since the worms can live only in damp places, all pastures that are inclined to be damp should be banned to young cattle. Good food and good shelter are also advised. Regular dosing with worm remedies ensures that their vitality is not being sapped by other worms. Where it is possible to keep the animals in overnight, they should be taken off the pasture before sunset and not let out to graze before the sun has dried the grass a bit, for they pick up many more larvae when the grass is damp with dew. Older animals may harbour the worm and, although they show no symptoms, may provide a source of infection to the younger and more susceptible calves. Older animals, therefore, should not be grazed with young stock in areas where lung worm is prevalent.

Tapeworms (Monoezia spp.).

These worms are fairly common in cattle, but usually only affect young animals, and then only when present in large numbers. Adult cattle from which the calves become infected may sometimes harbour tapeworms, but usually they show no symptoms. The tapeworm is a long, flat, ribbon-like worm—hence its name. It can reach a length of several feet and is about $\frac{1}{2}$ in. wide. It consists of numerous segments, each of which is a complete animal in itself. When first a tapeworm egg is eaten, it develops into a head or scolex which anchors itself to the intestinal wall by means of hooks. Here it remains and produces segments which grow in a long line, giving the tape appearance. These segments continually pass out eggs, which are eventually eaten by a species of mite living on grass. They develop into cysts inside the mite, and when accidentally eaten by a grazing calf develop into adult tapeworms.

Symptoms. The calves show lack of vigour and strength and have a staring coat. They have pot-bellies and become stunted. Constipation and diarrhoea may both occur. The tapeworm segments may be seen in the droppings looking like boiled rice grains. Sometimes a chain of segments hangs out of the anus.

Treatment. (i) Lead Arsenate is very effective.

(ii) Bluestone is quite effective, the more so when used with nicotine (for doses see copper sulphate *seq.*). Dosing for other worms keeps tapeworm in check.

Prevention. The regular treatment of infected animals to destroy

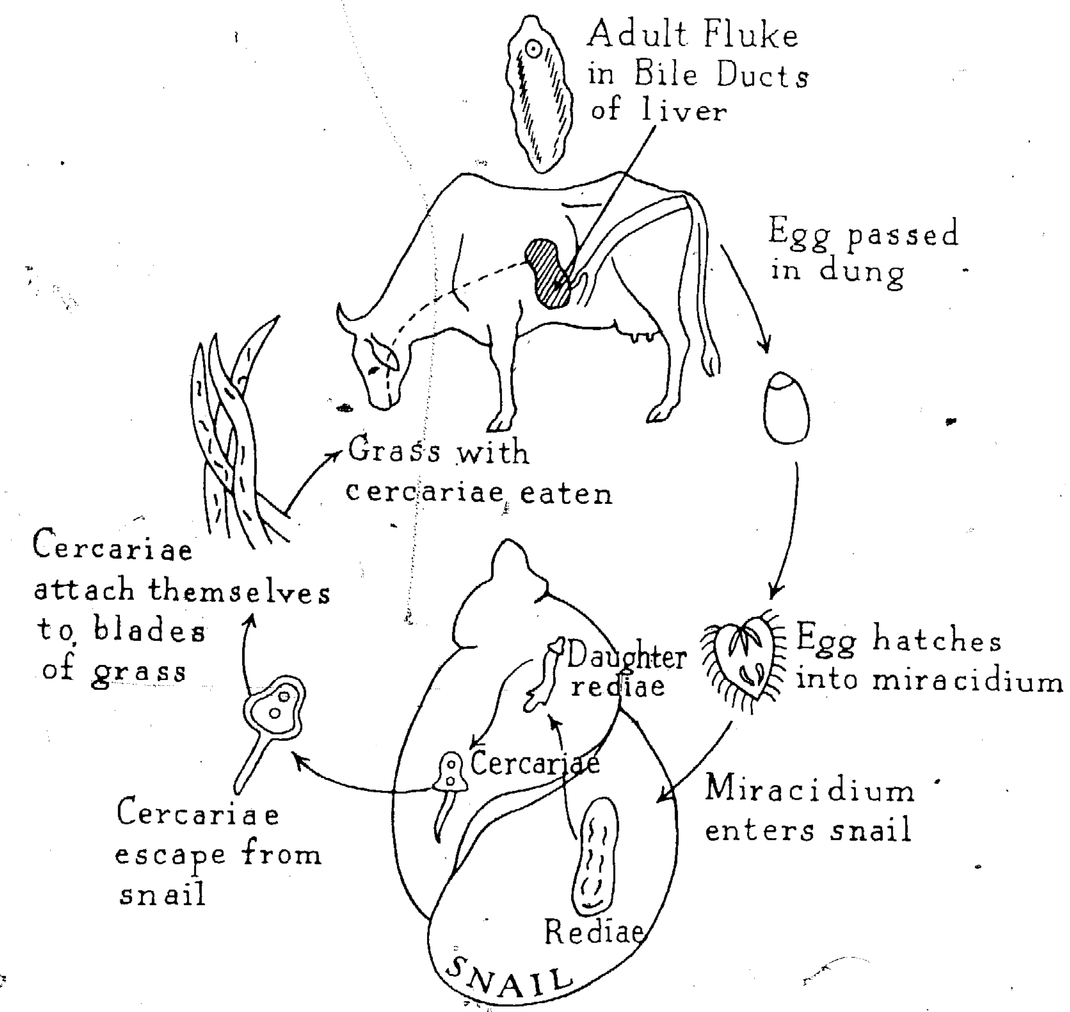
sources of infection and the avoidance of wet pastures should be practised.

Other tapeworms sometimes live in the liver and bile ducts of sheep and cattle in Africa, but they rarely cause any harm.

Liver Fluke (Fasciola hepatica)

This is a very common parasite causing enormous economic loss, especially in certain marshy, poorly-drained districts, or where the source of drinking water is mainly from small lakes or ponds.

The adult fluke, which may reach an inch in length, is a grey, flat, oval-shaped, leaf-like organism, and lives in the bile ducts of the liver, causing the condition known as 'liver rot'. In old-standing infections there is a great thickening of the bile ducts, which appear as large white pipes. Livers in this condition are condemned as food for human beings. Flukes are hermaphrodite—that is to say, each one is both male and female—and so all of them lay eggs, which pass out in the dung. From here on the life-history of the fluke is complicated and very interesting. If the egg falls in a damp place, it hatches into a small mobile organism called a *miracidium*,



which swims away in search of a certain snail (*Limnea cubensis*) into which it burrows. It must find this snail within twenty-four hours of hatching or it will die. In the snail's body it develops into a cyst, which in turn produces a number of small organisms called *rediae*, which feed on the snail's flesh. These give birth to 'daughter *rediae*', each of which gives rise to another form called '*cercariae*'. These *cercariae* escape from the snail and attach themselves on to blades of grass. When these blades of grass together with the cysts are eaten by cattle (or sheep), they develop into adult liver flukes in the bile ducts of the liver. The life-history is illustrated on page 913.

Symptoms. These vary greatly, and in many cases quite heavy infestations of liver fluke may cause no harm. After a time, however, the irritation by the flukes to the bile ducts gives rise to thickening of the channels and inflammation of the ducts, which may be blocked up, leading to noticeable jaundice and digestive upsets. Often the first result is that the animal shows a tendency to fatten. This is probably due to an increased flow of bile (caused by the irritation of the liver) giving a better assimilation of fats from the food. After this, digestive upsets with marked constipation occur, and then the usual symptoms of worm infestation follow on—anaemia, meagreness, staring dry coat, swelling under the jaw, and perhaps, eventually, death.

Treatment. At the moment, a new drug—Hexachlorethane (*q.v. seq.*)—is being tried with a good deal of success. Doses are given on the package. Treatment with the liquid extract of Male Fern has proved quite effective (for doses see *seq.*).

The best time to treat dairy cattle is about a month before calving. One or two treatments a year to the whole herd greatly helps control. Carbon tetrachloride is largely used in some places, but it is a dangerous drug to use on cattle, and should only be administered by an experienced person.

Prevention. Frogs, certain fish (goldfish, ticky-ticky, jewel fish) and water birds (gaulins, ducks, coots) may play a part in controlling liver fluke by eating the snails, and it would seem wise to encourage their preservation and multiplication.

Lands should be well-drained and the water from swampy, marshy areas should be pumped into tanks or troughs, rather than let the cattle drink direct from the swamp or ponds. Bluestone (copper sulphate), 1 part mixed with 4 parts of dry sand, can be scattered over the swampy areas at the rate of 20 lb. of bluestone to the acre. Bags containing bluestone may be tied in streams, so that the water dissolves the chemical and thus kills the snails along the stream. This has to be carefully worked out to determine the proper concentration of bluestone in the water.

Drainage of lands, however, is the best practical method of controlling infection.

There are other flukes known as *Paramphistomidae* that live in the large stomach or rumen of cattle and sheep. They are light-red, pear-shaped worms measuring 1 cm. long by ½ cm. thick, and when present in large numbers may suck a great deal of blood from the animal. Carbon tetrachloride is the best drug to use against them. They are, however, not found in Jamaica.

Worms in Sheep and Goats

The worms affecting sheep are very similar to those affecting cattle. The treatment and control are the same. Some worms of sheep are transmissible to cattle and *vice versa*.

The Stomach Worm

As with cattle, the Stomach Worm (*Haemonchus contortus*) is a very common and dangerous parasite in sheep and goats.

Symptoms. Symptoms are the same as in the case of cattle—stunted growth, falling fleece, dropsical swellings on the chest or neck, with severe anaemia and loss of energy. Death may follow.

Treatment. The treatment is the same as for calves. Phenothiazine is very good, so is bluestone.

Prevention. Prevention and control are the same as for cattle. All imported and exotic breeds of goats and sheep very readily contract heavy infestations. Flocks should be dosed not less frequently than every six weeks where good pasture rotation cannot be practised.

Intestinal Worms

Some of these live in the small intestine and others live in the large intestine. They suck blood, reduce the vitality of the animal, and produce the same chain of symptoms that are described for stomach worms, except that with these intestinal worms purging is a very common symptom. One worm, known as the Nodular Worm, which lives in the large intestine, burrows into the wall causing pimples, and hence the name 'pimply gut' that is given to intestines thus affected. Most of these worms are about ½ in. long and very thin, like white hairs.

Treatment. Treatment is with phenothiazine, bluestone or carbon tetrachloride.

Prevention. Prevention is the same as for intestinal worms in cattle.

Lungworms

These are 1 to 4 in. long, milk-white, and live in the bronchi and windpipe of sheep (less commonly in goats). The symptoms, treatment and control are identical with those given under Lungworm in cattle.

Tapeworms

These are the same as those found in cattle, and treatment, etc., are the same.

Liver Fluke

Liver Fluke is common in sheep. Dosing with carbon tetrachloride is much safer in sheep than in cattle, and is very effective in killing the fluke. Other remarks given under cattle liver fluke apply here also. Liquid extract of male fern and hexachlorethane can also be given.

Worms in Horses and Mules

Large White Roundworm of Horses

This is a robust worm about a foot long. It is very closely related to the large white worm of calves. Usually, as in cattle, it is only the young animals that suffer from this worm, and foals are often heavily infested. They may even run a temperature in the early stages, after which they become thin and easily exhausted, with a harsh coat. Often they exhibit digestive disturbances, and many symptoms of colic can be traced to this worm.

Treatment. Piperazine compounds are drugs of choice. Oil of turpentine and raw linseed oil as for calves may be given. Chenopodium can be tried.

Prevention. The dam should be dosed with a piperazine compound about two months before foaling. The foal should run with its dam in a clean pasture. Stables should be cleaned regularly and the manure put in pits or heaps where it can ferment, thus producing heat and killing all the worm eggs.

Palisade or Red Worms

These are multitudinous and are often collectively called the 'Palisade' or 'Red Worms' of horses. Only those species that suck blood are red, those which do not remain white. There is no point in describing each worm separately, as the symptoms, treatment and prevention are very much the same.

It is obvious that the most harmful are those that suck blood. They live in the stomach and throughout the intestines. Most of them are minute and very difficult to see with the naked eye. Three species are about an inch long, the others very much smaller. They may exist in enormous numbers—50,000 to 100,000 in the same animal. Again it is the younger animals that are most susceptible. The dung is often dark and smelly, and diarrhoea may follow. The animal is listless, without appetite; it soon becomes thin and easily tired, and its coat is dry and rough. Since it is losing so much blood from the worms sucking from the intestine walls, the animal

becomes anaemic, and may develop dropsical swellings on its legs and abdomen. Severe cases usually end in death. One of these worms (*Strongylus vulgaris*) burrows into the bloodstream and forms blood clots in the arteries round the intestines. These clots gradually grow bigger, dilating the arterial wall and eventually blocking it. This aneurism, as it is called, cuts off the blood to that part of the intestine, and gives rise to colic and death. 'Verminous aneurysm' is the name given to this disease. Some of the worms produce nodules along the intestine where they attach themselves, or make little red bite marks which can be seen with the naked eye.

Prevention and Control. This is extremely important, and can be divided into three parts.

(a) Control of Grazing

(i) Foals up to three years should be given clean pastures as far as possible, as they are the most susceptible.

(ii) Overstocking should be avoided. It leads to a heavy concentration of worm eggs and larvae on the ground, together with poor grazing.

(iii) Mixed grazing should be practised wherever possible, since the horse worm eggs are destroyed when eaten by cattle or sheep.

(iv) Pastures should be rested every year or two, and it is very beneficial to plough them up from time to time or plant a crop on them, but this will be impracticable for the great majority of property owners in Jamaica. The better the grazing is, the more grass per acre, therefore the fewer the larvae and worm eggs per pound of herbage eaten and the less likelihood of the animal picking up a heavy infection. A rotational system is, of course, best of all wherever it is practicable. Old pastures are the worst. To repeat, 'permanent pastures perpetuate parasites'.

(v) With valuable bloodstock, dung should always be collected daily at pasture and heaped. In the heat of a manure pit the worm eggs are destroyed.

(vi) Damp, shady pastures are, as we have seen, perfect places for worms to live, so these pastures should be drained or avoided.

(b) Care and Nutrition

The more plentiful the food, the better the condition of the animal and the greater its resistance to worms and disease. The less the food, the worse its condition and the weaker its resistance. Therefore food with sufficient nourishment and in adequate quantities is of prime importance in the prevention of worm infestation.

Animals should be cared for—kept well-groomed, and in clean, loose boxes or stables, where the dung is removed regularly and the bedding renewed daily, or when not at work, put out in clean pastures where there is plenty of grazing, water and shade.

(c) **Treatment**

Phenothiazine and Piperazine every two months until two years old should be sufficient to keep the worms in check.

Setaria Equina

This is the worm that lives in the abdominal cavity and scrotum of the horse, and is often seen falling out when the scrotum is cut at castration. It is from 1 to 10 inches long, milk-white, and tapers towards a spirally coiled hind end. It causes no harm to the animal.

The Pin Worm

This worm is of considerable importance and occurs in the large intestine of equines. The females are large and easily seen, being about 3 inches long, white, and having long, narrow tails twice the length of their bodies. The male is very small.

They live in the caecum and the large colon of the animal. The females wander down the intestine and creep out of the anus to lay their eggs under the tail of the horse. The eggs eventually drop off, and when eaten by another horse in contaminated food and water they develop into mature worms again inside the intestine.

Symptoms. Heavy infestations may irritate the intestine and predispose to colic, but the main feature of oxyuriasis is the intense itching and pruritis produced by the females as they lay eggs around the anus. The horse rubs its tail on any suitable object, thus breaking off the hairs and giving the animal an ungroomed appearance. Cream-coloured masses of eggs are easily seen around the anus.

Treatment. Chenopodium at the rate of 4 drams per 1,000 lb. body weight (1 teaspoonful per 200 lb. body weight) is given in a pint of raw linseed oil after starving for 36 hours. Thoroughbred horses and mules should be given a smaller dose of chenopodium than other breeds.

Mercuric or carbolic ointment can be rubbed under the tail to kill the eggs and stop the itching.

Prevention. If the animals are stabled, the stables should be kept clean, and the manure removed constantly. It is essential to ensure that food and water are not contaminated with dung.

Tapeworms in Horses

Not much importance is attached to tapeworms in equines. Three species occur, and in large numbers they cause the usual symptoms of worm infestation.

Bots

These are not really worms, but as they occur in the stomach it is convenient to discuss them in this chapter. 'Bots' are the larvae of the 'Botfly' (*Gastrophilus* spp.), which live for a time in the stomach of horses and mules, and sometimes in other animals, including man. They attach themselves to the wall of the stomach and suck blood, and are often present in large numbers.

The 'botfly' is brown and hairy, somewhat resembling a bee. The female deposits her eggs on the hairs of the horse or mule, usually on the shoulder, leg or around the jaw. A large number of eggs may be laid, and everyone who has to deal with horses is familiar with these little white eggs sticking to the hairs on the horse's shoulder. The fly worries the horse as it darts about laying eggs, and sometimes causes horses to stampede. The horse licks or rubs that part of its body where the egg is laid, and soon the egg hatches. The larvae thus produced are eventually eaten by the horse, and burrow into the walls of the mouth and tongue. From here they migrate to the stomach, and attach themselves to the stomach wall, where they are called 'bots'. After some months they are passed out in the faeces on to the ground, where they develop into adult 'botflies'. The 'bot' is usually bright red when in the stomach, but darker when passed in the dung. They are about half an inch long, and look like red maggots.

Symptoms. The lining of the stomach is irritated as the 'bots' suck blood, and sometimes if present in large numbers they obstruct the passage of food as it leaves the stomach. They excrete poisonous substances which produce a general debility and unthriftiness in the infested animal. It becomes tired easily and looks thin and off-colour. Frequently the appetite of the animal is impaired.

Treatment. Carbon disulphide and carbon tetrachloride are the best drugs. These can be given either by stomach tube or in capsule form. They should be given twice yearly.

Prevention. Bot infection is a sign of careless husbandry. As a preventive measure horses and mules should be groomed daily to remove all the eggs from their coats.

Worms in Pigs

Large White Roundworm

This worm is the commonest and is similar to that described in calves and foals. Although not very dangerous to human beings, it can be transmitted to man from the pig and *vice versa*, and although the pig variety will not live long in man, the larvae of the worm migrating in the bloodstream of the human being sometimes set up a severe pneumonia.

Young pigs are affected chiefly, and in the acute form the piglets have a bad cough, their breathing is jerky and thumpy, and they sometimes die of pneumonia. The condition is sometimes called 'thumps'. The pneumonia is caused by the young worm larva which, after it has been eaten by the pig, burrows into the pig's liver, and then into a blood vessel from where it is transported to the lungs. If there are enough larvae in the lungs at the same time, they set up a severe pneumonia. The larvae then go up to the windpipe into the pharynx and are swallowed into the intestines again, where they develop into adult male or female worms.

The adult worm in the intestine may block the passage of food. Sometimes the worms secrete poisonous substances that give rise to intoxication and nervous symptoms in the pig. Occasionally the worms block the bile ducts from the liver to the intestine and give rise to jaundice and digestive upsets.

Treatment. (i) Piperazines. (ii) Chenopodium at the rate of 1 dram (almost a teaspoonful) per 100 lb. body weight (to a maximum of 3 teaspoonfuls in all) is given in a large dose of castor oil (¼ pint). (iii) Sodium fluoride is also used.

Prevention. This is difficult in Jamaica, as most pigs are left to wander about at will. The 'McLean System', which depends on rotating the pigs in a series of paddocks, moving from one to another every ten days, is very good when the pigs are kept under an intensive system. Young pigs, especially, should be kept off pastures which are known to be infected.

Tapeworms

These are not important in the pig in themselves, but other tapeworms, for instance the 'pork tapeworm' of man, spend a part of their life-cycle in the flesh of the pig.

This 'pork tapeworm' lives in the intestine of man. The eggs are passed out in the faeces. If a pig eats them, they develop into a minute cyst in the flesh of the pig. If a man eats poorly-cooked pork containing these, they will develop into adult tapeworms in his intestine.

Another tapeworm of man—the 'beef tapeworm'—goes through the same development in the flesh of cattle.

The Pimply Gut Worm

This worm which lives in the large intestine is the cause of 'pimply gut' in pigs. This is the only harmful effect that it produces. It is about one-third of an inch long and very fine.

Treatment. Phenothiazine is very effective against this worm.

Kidney Worm of Swine

This worm lives in and around the kidney and ureters. It is one to two inches long and stout. The eggs are passed out in the urine, and hatch into larvae, which are either eaten by the pig or bore through the pig's skin

and reach its liver by way of the blood. After some months of wandering in the liver, they migrate into the peritoneal cavity and enter the kidneys, where they set up cysts in which they develop to adults and live.

It can be seen that damage to the liver may produce serious results, sometimes leading to cirrhosis of this organ and death. Also kidney lesions may in time affect the excretion of urine—but usually the adult worm does not trouble the animal very much.

This worm is much more common in Jamaica than is usually supposed.

Treatment. None.

Prevention. A high standard of hygiene and efficient husbandry should be maintained. Sunlight kills the eggs fairly quickly. Damp, shady places should be avoided.

The Stomach Worm of Pigs

This is a minute red worm, ¼ to ½ inch long. It does not cause a lot of trouble unless the pig is in bad health, or has a great strain put on it, e.g. a lactating sow with insufficient food.

Symptoms. Symptoms, when they do appear, are typical, e.g. anaemia, emaciation, weakness, staggering walk and perhaps diarrhoea.

Treatment. Sodium fluoride or carbon disulphide are used.

Prevention. Hygienic animal husbandry.

The Thorny-headed Worm of Pigs

This worm lives in the small intestine of pigs, and is often seen in Jamaica.

The worms are from four to sixteen inches long, and give the appearance of being rather fat. Their body is wrinkled and they are of a white or pale pink colour. They attach themselves to the wall of the intestine by means of a number of thorn-like hooks on their heads. Sometimes they perforate the wall of the intestine and cause peritonitis and death, but usually a mild infestation may cause slow growth or emaciation, a very serious factor in pig-rearing.

Treatment. No satisfactory remedy is known.

Prevention. The eggs of this worm are passed out in the dung, and are eaten by certain dung beetles in which they hatch and encyst. When the pig happens to eat one of these beetles, the cyst turns into a thorny-headed worm in the pig's small intestine.

The only practicable way of preventing infestation is to remove the dung of pigs kept in sties or small runs frequently, but in general this is impossible in Jamaica.

Lung Worm of Pigs

These worms live in the lungs of pigs and are 1 to 2 inches long. Their life-history is peculiar in that the larval worm must be eaten by an earthworm to continue its development. The pig becomes infected by eating infected earthworms. They do not seem to be as serious as those in cattle and sheep. Verminous bronchitis and pneumonia occasionally occur. Their chief adverse effect is that they retard growth and cause loss of condition.

Treatment. Dictycide is recommended, also provide plenty of good food and the provision of warm dry surroundings.

Control. Keep pigs in clean places and, as far as possible, away from earthworms.

Worms in Dogs and Cats

The Puppy Worm

Dogs sometimes suffer very badly from worms, as every dog owner knows. The first worm to trouble the life of the young dog is called the 'Puppy Worm' or the 'Arrow-headed Worm'. It is up to six inches long, rather translucent, and lives in the small intestines. Puppies contract it at birth, or sometimes before birth while still within their mother's womb if she happens to be infested too.

Symptoms. Symptoms are multitudinous. The puppies do not grow well, have ravenous appetities, are emaciated with big, fat, swollen bellies, and become predisposed to fits. Puppies often vomit up these worms. Intestinal obstruction by the worms may cause death. Dead worms in the gut may liberate toxic products and produce nervous symptoms, and cause epileptiform fits. After the first six months the pups throw the infection off, or even if they do continue to harbour the worm, they show no symptoms.

Treatment. Piperazine is the most effective and least toxic. Chenopodium in castor oil is very good. One drop of chenopodium for every three pounds body weight to a maximum of four drops is sufficient dosage. Tetrachlorethylene is very good too. Capsules can be bought for the different weights of dogs.

Hexylresorcinol can also be used with a great deal of safety.

Prevention. This is difficult, but animals on a good diet will not show effects as much as those on a poor diet.

Toxocara Mystax

This is very similar to *T. canis* but occurs in cats.

Treatment. Santonin $\frac{1}{2}$ grain, and Calomel $\frac{1}{2}$ grain, followed by a purge is better than Chenopodium in cats, as Chenopodium may kill the cat as well as the worms, but Piperazine is best.

Toxascaris Leonina

This occurs in the cat and dog. It is about three inches long. The symptoms, treatment, etc. are the same as for *T. canis* and *T. mystax*.

Hookworms in Dogs

Hookworms are so common in hot countries that almost every dog in the tropics suffers or has suffered from them.

The two important hookworms are:

Ancylostomum caninum—dogs (rarely in man).

Ancylostomum braziliense—dogs and cats (sometimes in man).

Two other hookworms occur, but are not so important in Jamaica, viz.,

Necator americanus—in man (sometimes in dogs).

Uncinaria stenocephala—in dogs and cats.

Hookworms are about $\frac{1}{2}$ inch long and live in the small intestines. As with the human hookworm, the infection in dogs can be picked up through the skin. The larvae after hatching out of the egg on the ground penetrate the skin of the animal, or are eaten by the dog on contaminated food. In the intestine the adult worms attach themselves to the wall and suck blood.

Symptoms. Anaemia, prostration, bloody diarrhoea, dry scruffy coat, pus-filled eyes and nervous fits. The lean, shaggy, mangy dog is only too common throughout the tropical world, a miserable testimony to hook-worm. Cats seem to suffer less from hookworm infestation than do dogs. 'Vermiflex' tablets containing several ingredients are found most effective.

Treatment. Tetrachlorethylene. This is sold in capsules under various trade names by many druggists and the Jamaica Agricultural Society. Different sizes of capsules are made for different ages and breeds of dogs. Dosage is by weight. Hexylresorcinol and oil of chenopodium can also be used.

Control. Desiccation destroys the larvae on the ground, and therefore dry places are safer than damp locations, but the larvae can live a long time even in dry places. Dose regularly three times a year.

Lungworms in Dogs and Cats

These are not very important and need only be considered briefly.

Aelurostrongylus abstrusus in cats.

Angiostrongylus vasorum in dogs.

Oslerus osleri in dogs.

The cat lungworm (*A. abstrusus*) actually lives in the smaller branches of the pulmonary artery in the lung where it lays its eggs. The eggs hatch in the small arteries in the lung tissue and here develop into larvae. The larvae crawl up the windpipe, are swallowed and are passed out in the dung. For further development they now need certain snails and slugs as intermediate hosts. Such transport hosts as frogs, rodents, birds and lizards which eat the infected snail, and in whom the worm larvae encyst, may aid in infecting cats which are notorious lizard eaters. The adult worm is not very harmful.

Angiostrongylus vasorum of the dog resembles *A. abstrusus* of the cat. The other dog lungworm—*Oslerus osleri*—chiefly affects young dogs. The disease is usually chronic and rarely fatal. The worms produce little nodules and tumours in the windpipe (*trachea*) and in the bronchioles of the lung. The dog has a rasping, persistent cough and goes off colour.

The worms usually die off after a bit and treatment is purely symptomatic. Honey in small doses and expectorants may help. It is wise to dose for intestinal worms so that the dog may increase its resistance against the lungworm.

Heart Worms in Dogs and Cats

(*a*) *Dirofilaria immitis.* This worm lives in the heart and pulmonary artery of dogs and cats. It is as much as ten inches long, slender and white. This blood parasite is transmitted by nearly all mosquitoes, inside which part of its development occurs.

Symptoms. Symptoms are varied. A dog may have heart worm and show no symptoms at all. Inflammation of the heart may give rise to blood clots and stoppage in the various arteries. The usual clinical signs are a cough, tendency to tire easily and shortness of breath. Blockage of the blood vessel may cause oedema and ascites. Sudden death is common.

Treatment. Treatment is a long and difficult process, and should be undertaken by a veterinarian. Among drugs used are 'Fuadin'; 'Stibophen' (Intramuscular), 'Banocide'—'Hetrazan' orally.

(*b*) *Spirocerca lupi.* This worm lives in the walls of the aorta (the main artery) near the heart, and it is often found in the stomach and oesophagus (food pipe). It is common in dogs in all tropical and subtropical countries, and Jamaica is no exception.

The worms are coiled in a spiral and are red in colour. They are fairly stout and measure $\frac{1}{2}$ to 1 inch in length. They burrow into the walls of the aorta and oesophagus, forming caverns and eventually kill the animal by rupturing the aorta. Sudden deaths in dogs in good condition, especially while engaged in strenuous exercise, may be due to this worm.

The life-history of *Spirocerca* is complicated, but it is known to develop in certain beetles, especially the 'tumbler' beetles and those that are attracted by light at night, and possibly also in frogs, lizards and birds. The dog becomes infected by eating the infected beetle or other animal in which the worm is developing.

Diagnosis during life is very difficult. Sometimes the eggs of the worm may be seen in the faeces of the animal, but this seems to be an unreliable method, and usually the disease is only discovered on post-mortem.

Tapeworms in Dogs and Cats

There are many different kinds of tapeworms in dogs and cats, but the

treatment and symptoms are the same for all of them, so consideration here need only be given to the most common one, *Dipylidium caninum*. This, like other tapeworms, consists of numerous barrel- or banana-shaped segments, each containing eggs that are passed out singly in the faeces of the dog. From now on the life-cycle involves the dog flea, human flea, cat flea or dog louse, the young flea or louse swallowing the eggs. After developing in this ectoparasite, the final host (dog, cat or man) contracts infection by swallowing the infected flea or louse. Young children playing with dogs may accidentally swallow a flea and become infected in this way.

The real importance of tapeworms of dogs and cats lies not so much in their danger as worms in these animals, but because of their intermediate stages in other animals and man. For instance, the intermediate stage of the tapeworm *Multiceps multiceps* of the dog produces cysts (*Coenurus cerebalis*) in the brain of sheep and other domestic animals, including man, which if not removed surgically are fatal. *Echinococcus granulosus*, another tapeworm of dogs, is of importance, because when man (or other domestic animal) eats the egg of this worm it may develop into what is known as a 'hydatid cyst' in the liver. This can only be treated by surgical means, and so is extremely dangerous. It is for this reason that control of tapeworms in dogs and cats is so important.

Symptoms. Seldom are tapeworms injurious, unless present in large numbers in young dogs or in badly-nourished animals. As the segments wriggle out of the anus they irritate the dog, who may drag his tail along the ground (although usually this is from a completely different cause). Emaciation with the usual train of symptoms, especially nervous fits and convulsions, can be seen in badly infested young animals.

Treatment. Proprietary vermifuges are put out by reputable firms, and usually contain arsenic and arecoline. Tetrachlorethylene, as for hookworm, gives satisfactory results.

Worms in the Fowl and other Birds

Many worms occur in the fowl. The commonest is the tiny tapeworm *Davainea proglottina* which lives in the small intestine and is only half a millimetre long. It uses slugs and snails for its intermediate host and so control of these pests will control this worm. Of the round worms *Heterakis gallinae*, which lives in the caeca (large intestine) of fowls, is very common. They are about half an inch long. They are not very harmful in themselves, but they can transmit the organism of 'Blackhead Disease' in turkeys, which is a great scourge in some countries.

Ascaridia galli which lives in the small intestine of chickens and reaches a length of 5 inches is very important. These worms burrow in the wall of the intestine and by sucking blood produce anaemia and a severe enteritis. Symptoms usually occur in young birds under three months old and it has been shown that if a diet sufficient in Vitamins A, B and D is fed, the young bird has much more resistance to the worm.

Treatment. Phenothiazine at the rate of 0·5 gm. per bird. (Very effective against *Heterakis gallinae* and other caecal worms.)

Oil of Chenopodium—4 drops per kilo body weight in 4 c.c. of raw linseed oil or mixed with a moist mash at the rate of one teaspoonful of oil for every 12 birds.

Tetrachlorethylene (effective against *Ascaridia galli*)—0·5 c.c. per bird over two months old.

Nicotine compounds. A stock mixture can be made of 6·6 c.c. of 40% Nicotine sulphate and 16 gm. fuller's earth. Each fowl can be given 0·5 gm. of this mixture in a capsule.

Piperazine Compounds, either in the food or drinking water is very effective against fowl ascarids.

Gapeworm (Syngamus trachea)

This is the lungworm of birds. It occurs in fowls, geese, turkeys and some wild birds as well. The worm lives in the windpipe, is bright red and reaches a length of up to two centimetres. Earthworms help in the transmission of gapeworms, and the gapeworm can live in the earthworm for as much as two years. The gapeworm as the name suggests, produces 'gapes', or difficult breathing, and gasping breaths.

Treatment. The worms can be wound out of the trachea on a fine piece of wire, or the birds treated with Barium antimonyl tartrate. Barium antimonyl tartrate has recently been introduced as an anthelmintic dust for the treatment of gapes, and has proved remarkably successful when used in the following way:

The affected chicks are placed in a bucket or similar container and a teaspoonful of the powder is sprinkled over them. The bucket is then covered with a sack and the chicks kept there for ten minutes, the powder being blown up into the air at two or three minute intervals during that time. A pair of bellows or an inflated bladder may be used for this purpose, care being taken that the powder is not inhaled by those who are carrying out the treatment, as it is very irritating to the human lungs.

Control. Kill infected birds and burn their heads, windpipes and lungs. Wild birds and earthworms can transmit the worm, but this is probably not important in Jamaica.

Thread Worms (Capillaria spp.)

These live in the crop, oesophagus and, small intestine of birds and may produce many deaths. They are about a quarter to half an inch long and very slender, although half of their body is much thicker than the other half.

In small numbers they are harmless, but when present in large numbers they produce an inflammation of the oesophagus, crop and intestine, emaciation, anaemia and death.

Treatment. Tetrachlorethylene (see page 926).
Phenothiazine (see page 926).

Diseases caused by Protozoal Parasites

Coccidiosis

Coccidiosis, which affects many species of animals and birds, is the name given to an infestation with a small parasite called a *coccidium*.

Like many other parasites, the *coccidium* spends part of its life-cycle on the ground where, given the requisite warmth and moisture, it 'ripens' and becomes infectious to any bird or animal that picks it up. At this stage it is known as the oocyst or egg, and its structure rather resembles a seed-pod, consisting of a number of young parasites contained in a tough skin. When susceptible birds or animals swallow it, its outer case is dissolved by the digestive juices, and thus the parasites are set free in the gut. They make their way to the cells lining its walls, where they multiply very rapidly and, by breaking down the tissues, cause the characteristic symptoms. After a short period they give rise to male and female forms which unite and the fertilized ova are dropped on the ground in large numbers with the faeces of the animal, and, under favourable conditions, 'ripen' in from two to fourteen days. Then the cycle recommences.

To show the speed at which the parasites multiply and the damage they cause, one oocyst was introduced into a pen of thirty healthy cockerels and resulted in the death of all of them from coccidiosis within five weeks.

Oocysts are only harmful to the species which drops them, so that those from poultry are not dangerous to cattle, nor those from rabbits to poultry. Fowls, turkeys, pheasants, and occasionally ducks, may harbour the same kind of coccidium and so infect one another. Usually, therefore, there is no risk in giving poultry free range with cattle or vice versa. Wild birds are not likely to affect domestic poultry except in so far as they may carry oocysts on their feet from an infected property to a clean one.

Coccidiosis in Poultry (Eimeria avium)

Coccidiosis in its acute form usually affects chicks between two and ten weeks old. When the birds first become infected they may eat ravenously, but rapidly lose appetite and become dull and listless. A greyish-white (frequently blood-strained) diarrhoea is then noticeable, often within two or three days of the first symptoms being shown.

Losses from coccidiosis only occur after the tenth day from hatching—an important point in distinguishing it from bacillary white diarrhoea where deaths occur rather earlier (from seven to fourteen days after hatching). This, however, is not a reliable distinction, and further examination is necessary for a definite diagnosis.

On opening a dead bird, characteristic changes are usually found in the caeca or blind pouches of the gut. These are normally thin-walled, about an inch long, greyish in colour, and containing semi-liquid faecal material. When *coccidia* are present, the walls become enlarged and thickened, and have a core of yellowish material mixed with blood.

If there is the slightest doubt, diagnosis should be made by a veterinary surgeon or in a laboratory, when microscopic examination can identify the actual parasite in the gut wall or droppings.

The chronic form of the disease, which is commoner in older birds, usually has a lower death rate. It is nevertheless serious since the infected birds are continually dropping fresh oocysts. It is sometimes referred to as the 'duodenal' form, as it affects the intestine rather than the caeca.

The symptoms are generally anaemia, general unthriftiness and loss of flesh, with only an occasional death here and there, though deaths are sometimes frequent.

Professional diagnosis is even more important in this form of coccidiosis, since it has to be distinguished from other wasting diseases such as tuberculosis.

Coccidiosis in Rabbits (Eimeria steidae)

With rabbits, coccidiosis affects the liver as well as the gut. For this reason the symptoms are rather different from those in birds. Besides the usual wasting and general loss of condition, jaundice appears, being particularly noticeable in the eye, and on the skin when the fur is parted. The abdomen becomes enlarged and dropsical, and as with chickens there is diarrhoea which causes extensive matting of the fur round the vent and hind legs. The rabbit is unsteady in its walk, and the legs become progressively weaker until the hind legs are completely paralysed. Death occurs, usually in convulsions, after a period varying from two days to three months according to the severity of the infection.

Post-mortem examinations reveal a marked enlargement of the liver, particularly in advanced cases, and numerous white patches are visible dotted over its surface. If pricked or cut, these exude a milky fluid containing large numbers of oocysts, which can only be seen under a microscope. An enlarged liver is often the only abnormality, though in many cases the intestine is highly inflamed, with white spots on its inner surface.

As with chickens, veterinary or laboratory assistance should be sought if there is any doubt as to the nature of the disease.

Coccidiosis in Cattle (Eimeria zurnii)

Coccidiosis in cattle is also known as 'Red Dysentery of Cattle'.

Usually only young calves become infected badly enough to show symptoms, although adult cattle can often harbour coccidia and act as carriers.

The disease starts suddenly with diarrhoea in which some blood may be seen. The animal may recover quickly if of sufficient age to throw off the infection, but in young calves the symptoms usually get worse. The dung becomes liquid and foul smelling, the animal is anaemic and unthrifty and may die. Sometimes coccidiosis assumes epizootic proportions in calves, especially those that are crowded together in a pen and where sanitation and hygiene are faulty.

Treatment. Certain of the Sulphonamide group of drugs such as Sulphamezathine, Sulphamerazine, Sulphaguanidine, Sulphasuxidine, etc. are now used with a lot of success against coccidiosis.

In Poultry. When an outbreak occurs in poultry the whole flock should be treated, not just the sick ones. The most useful and convenient way to do this is by means of the drinking water, and for this purpose there is on the market a Sulphamezathine solution which can be conveniently added to the drinking water to make a 0·2% solution.

Sulphamezathine powder can be added to the mash instead at the rate of 1 to 2 gm. per pound of mash. Treatment lasts from 3 to 5 days in each case.

In Rabbits. Sulphaguanidine seems to be the drug of choice at the moment, although it is possible that some of the others in the Sulphonamide group will prove to be more effective. The dose is 1 gm. per 20 lb. body weight daily for 3 weeks, or 5 gm. per 20 lb. body weight daily for 8 days.

Treatment should be started as soon as possible after symptoms are seen.

Prevention. Since the dung or droppings of the infected animals and birds contain thousands of the coccidial oocysts, steps must be taken to see that it is removed and does not contaminate the food or water supply.

Disinfection of stalls, drinking buckets, food troughs, etc. should be carried out with a 10% solution of Ammonia in water. This has a very lethal effect on the oocysts.

Good hygiene and sanitation, a pure water supply, warmth and good food are the best preventives.

The Tick Fevers

Both the tick fevers, Anaplasmosis (Gall sickness) and Piroplasmosis (Red Water fever or Texas fever) are caused by protozoal parasites that live in the red blood corpuscles. These are dealt with in Extension Circular No. 35.

Trichomoniasis

As far as we know, this disease does not occur in Jamaica at the moment, but since it may easily be introduced at some future date it is well to be on the alert for its appearance and know how to control it. The first sign of its introduction into a herd is usually a period of unsatisfactory breeding. The disease may cause abortion in cows, usually in the first four months of pregnancy, but it is an entirely different condition from contagious abortion.

Cause and Symptoms. The disease is caused by a minute parasite—*Trichomonas foetus*—hence the name, 'trichomoniasis or trichomonas disease'.

The bull becomes infected by serving an infected cow; once infected, a bull is capable of transmitting the disease to all the animals he may serve. Natural recovery in the bull is very rare, even with prolonged rest from service. An unusual discharge nearly always occurs a few weeks after infection, but nothing amiss may be observed until the cow or heifer expected to be in calf comes into season two or three months, or even later, after service.

In cows the disease may take one of several courses. Some cows throw off the infection quickly; others remain infected and may even carry their calves until the full term, although this is rare. Abortions also occur, usually between the second and fourth month of pregnancy. At this early stage the aborted calf is so small that it is often overlooked, or abortion is not suspected and the animal is thought to have broken service.

Danger Signals. When several cows or heifers fail to hold to repeated service, it is advisable to suspect the existence of trichomonas disease.

Similarly, trichomoniasis may be the cause when a cow or heifer comes in season two to four months after service, whether or not an aborted calf has been seen. Abortions at a later stage are usually due to ordinary contagious abortion.

The presence of the disease may be further shown by the discharge mentioned under 'Cause and Symptoms'; in a few cases where the womb is severely affected, however, no discharge may appear until the expected time of calving.

Immediate Action. Once the disease is suspected all breeding should be stopped pending diagnosis by a veterinary surgeon.

Definite diagnosis, following expert examination of the animals and the discharge, is necessary for effective control and treatment. The disease is spread in a different way from contagious abortion and needs different methods of control.

Eradication of the Disease. Treatment of an infected bull is difficult and at present it is hardly worth trying, except with a very valuable

animal. In the female, however, except in a few cases where the organs are seriously damaged, the prospects of success are good. But the treatment requires skilled handling and should only be attempted by an expert.

Some cases are more easily cured than others, but no animal in an infected herd should be served until the veterinary surgeon is satisfied that she is entirely free from any suspicion of infection. Only then may a clean bull be used, otherwise there may be grave danger of this bull also becoming infected.

Precautions. The following are the main points to bear in mind as against an outbreak:

Accurate breeding records should always be kept.

It is unwise to buy an old bull unless he is from a clean herd.

A bull should not be allowed to serve a neighbour's cow that has a suspicious breeding history.

Similarly, a cow should not be sent to a neighbour's bull for service if there is any breeding trouble in his herd; it may be due to trichomonas disease.

If cows and heifers are returning, a second bull should not be tried before finding out the cause of failure, it may be trichomonas disease, and the second bull would then become infected.

If practicable, a clean bull should be kept for the service of heifers only.

This is a venereal disease of cattle which, if unchecked, can spread rapidly; neither the farmer nor the country can afford the serious production losses that may result from lack of prompt control. A veterinary surgeon should be called in at the first suspicion of this scourge.

Worm Remedies

Phenothiazine

For the treatment of stomach worms and intestinal worms in cattle, sheep and goats; red worms in horses; 'pimply gut' worm in pigs; and caecal worms in poultry.

Administration. Phenothiazine is sold either as a green powder or as green tablets. The powder is usually given, shaken up in water, as a drench. It will not dissolve. It can be given in other ways either in food or honey, but drenching is usually the most convenient. If it is bought in tablets, these can be given by a balling gun or ground up in water and given as a drench.

Animals should be dosed every month in areas where worms are plentiful, and at least once every two months in other areas.

In animals in very poor condition only give half the dose, and follow with the other half in one or two weeks' time, and then continue full dose treatment at monthly intervals thereafter.

N.B. Do not dose calves under two months old, lambs or kids under one month old, in-lamb ewes, or foals under four months old.

As a rule horses are more susceptible to the harmful effects of this drug than are other animals, and therefore extra care should be taken to see that they do not get an overdose.

Phenothiazine sometimes turns the urine a reddish colour. This is of no importance, but is well to remember.

It is unnecessary to starve the animal before or after dosing or to give a purgative after the drug. The doses are always marked on the package and are approximately as follows:

(i) **Cattle.** (Stomach worms and intestinal worms.)

Calves, 3–6 months old	¼ to ½ ounce
Calves, 6–12 months old	½ to 1 ounce
Calves, 12–18 months old	1 to 1½ ounces
Cattle over 18 months old	1½ to 2½ ounces

Administered as a drench in 1 pint of water.

(ii) **Sheep and Goats.** (Stomach worms and intestinal worms.)

Lambs and kids, 25–50 lb. wt. (4–8 mths. old), ⅙ to ⅓ oz. (5–10 gm.)
Lambs and kids, 50–100 lb. wt. (8–15 mths. old), ⅓ to ½ oz. (10–15 gm.)
Sheep and goats over 100 lb. wt. (adult), ½ to 1 oz. (15–30 gm.)

Administered as a drench in ½ pint of water.

(iii) **Horses.** (**Palisade** or **Red Worms.**)

Foals, 6–18 months old	¼ to ½ ounce
Adults over 18 months old	not more than 1 ounce

Administered as a drench in ½ to 1 pint of water.

(iv) **Pigs.** ('Pimply gut' worm.)

Not more than one gramme for every 4 lb. body weight.

Approximate doses:

Pigs one year old	⅓ to ½ ounce
Large sow or boar	1 to 1½ ounces

Administered in molasses or a little dry feed.

(v) **Poultry.** (Caecal and intestinal worms.)

0·5 gm. per bird

It is best to give it in a mash. For every 10 birds mix 5 gms. of phenothiazine (1 level dessert spoonful) in the mash as evenly as possible, so that each bird will get an equal amount of the powder.

Copper Sulphate (Bluestone)

For treatment of the large roundworms, stomach worms, intestinal worms and tapeworms of cattle, sheep and goats.

Administration. Copper sulphate is a blue (sometimes white), crystalline chemical. It is used as a 1% solution, and this is made by dissolving one ounce of the crystals in 5 pints of clean water just before commencing to dose.

The animals should be starved of all food and water for twelve hours before the treatment, which is best carried out early in the morning. Food and water should be withheld for three hours following treatment.

Doses are as follows:

(i) **Cattle.** (Roundworms, stomach worms, intestinal worms and tapeworms.)

Calves, 1–2 months old	½ to 1 fl. oz. of the 1% solution
Calves, 3 months old	1½ fl. oz. of the 1% solution
Calves, 4 months old	2 fl. oz. of the 1% solution
Calves, 6 months old	3 fl. oz. of the 1% solution
Calves, 9 months old	4 fl. oz. of the 1% solution
Calves, 12 months old	6 fl. oz. of the 1% solution
Calves, 18 months old	8 fl. oz. of the 1% solution
Adult cattle	10–12 fl. oz. of the 1% solution

(ii) **Sheep and Goats**

Lambs and kids, 3–6 mths. old	1–1½ fl. oz. of the 1% solution
Lambs and kids, 6–12 mths. old	1½–3 fl. oz. of the 1% solution
Adult sheep and goats	3½ fl. oz. of the 1% solution

N.B. One tablespoonful equal ½ fl. oz.

Treatment should be repeated monthly, and the same rule applies to animals in poor condition as mentioned in regard to phenothiazine.

Copper Sulphate (Bluestone) and Nicotine Sulphate 40%

For the treatment of tapeworms and stomach worms in sheep and goats (**not** cattle).

The solution is made up by dissolving one ounce of bluestone in two quarts of water, and then adding one ounce of a 40% commercial nicotine sulphate solution (sold under various trade names).

Doses are:

Lambs and kids, 3–6 months old	(20–40 lb.)	½ to 1 fl. oz.
Yearlings	(60 lb.)	2 fl. oz.
Adult sheep and goats	(80–100 lb.)	3 fl. oz.

Animals should **not** be starved beforehand, and should be let out to graze immediately afterwards.

Cattle should not be given this mixture, as they are very susceptible to nicotine poisoning.

Bluestone—Phenothiazine—Nicotine Mixture. 'B.P.N.'

This is an excellent worm remedy for cattle, sheep and goats, and has given good results in Jamaica. It must, however, be used judiciously, and on no account must the stated dose be exceeded.

It is made up as follows:

Copper sulphate (Bluestone)	54 grams
Sodium arsenite	26 grams
Ammonium carbonate	20 grams
Sodium bicarbonate	675 grams
Phenothiazine powder	450 grams
Gelatin powder	20 grams
Nicotine sulphate 40%	20 c.c.

Mix and add water to make 7½ pints (150 fl. oz.).

Dose:

Give one fluid ounce per 100 lb. body weight in a quarter pint of water. Repeat monthly.

Calves under three months old and sheep and goats under two months old should not be dosed.

Tetrachlorethylene

This is a clear, colourless fluid, and is usually sold in capsules of various sizes or in bottles.

Administration. Animals should be fasted overnight, fatty foods should be avoided as far as possible for a few days before treatment, and all food and water should be withheld for 2–3 hours after dosing. Purgatives are not usually necessary. Administration varies with the animal.

The drug can be given as a mixture with equal parts of mineral oil, or diluted in four times its volume of water. If given in capsules, care should be taken to see that the animal swallows them whole. When giving Tetrachlorethylene as a mixture in oil or water to cattle, sheep and goats, it is best to immediately precede the dose with 5 c.c. of a 2% solution of copper sulphate, squirted down the inside of the cheek by means of a syringe. When this is swallowed the copper salts close what is known as the 'oesophageal groove', so that the Tetrachlorethylene when swallowed immediately afterwards passes straight into the second stomach, missing out the large first stomach or rumen in which few harmful worms exist.

Doses:

(i) **Sheep and Goats.** (Stomach worms, intestinal worms and liver fluke.)

Lambs and kids over 4 months old	2·5–5 c.c.
Sheep and goats, 9 months old and over	5–7·5 c.c.

(ii) **Horses.** (Bots, Red Worms.)

About 15 c.c. for 1,000 lb. horse.

Given by capsule or stomach tube.

(iii) **Dogs and Cats.** (Hookworms.)

0·1 c.c. per lb. body weight.

Capsules containing the correct dose according to weight of the dog or cat are sold under various trade names.

Puppies under three weeks and kittens under two weeks old should not be dosed.

(iv) **Cattle.** (Liver, fluke, stomach and intestinal worms.)

As a general rule Tetrachlorethylene is not often used in cattle, as it is regarded as being rather toxic. However, if given according to the maker's directions it should prove a safe and useful anthelmintic.

Doses:

Calves, 6 months old	2 drams (8 c.c.)
Calves, 1 year old	3 drams (12 c.c.)
Adults	5 drams (20 c.c.)

(v) **Poultry**

See page 932.

Carbon Tetrachloride

This is more toxic and dangerous than Tetrachlorethylene, but it can be used for the same purposes save in cattle, in which animals it should **not** be used. The same precautions apply as for Tetrachlorethylene, and the mode of administration is the same.

Doses are as follows:

(i) **Sheep and Goats**

Lambs and kids	½ c.c.
Sheep and goats	1–2 c.c.

(ii) **Horses.** (Red Worms and Bots.)

10 c.c. per 250 lb. body weight

Given by stomach tube.

(iii) **Dogs.** (Hookworms.)

Dogs over 3 months old	½–1½ c.c.

Turpentine and Raw Linseed Oil

Cattle. (Large Roundworms in calves.)

Calves, 1–3 months old—Oil of turpentine	1 to 2 teaspoonfuls
Raw linseed oil or castor oil	2 to 4 ounces

Give on two successive mornings, after an all-night fast.

Oil of Chenopodium

(i) **Pigs.** (Large roundworms and stomach worms.)

1 dram (almost a teaspoonful) per 100 lb. body weight in ¼ pint of castor oil.

Never give more than 3 drams to any pig.

(ii) **Horses.** (Pinworms and large white roundworms.)

1 dram per 250 lb. body weight in 1 pint of raw linseed oil.

Thoroughbreds and mules should be given rather smaller doses than for other breeds.

Starve for 24 hours before dosing.

(iii) **Dogs.** (Puppy Worms.)

Approximately 1 minim per every 3 weeks of age, maximum 3 minims, in a tablespoonful of castor oil. Toy breeds should not be treated before 4 weeks old, and then only given the minimum dose.

A good stock solution consists of:

Ol. Chenopodii	15 m.	2 teaspoonfuls are given to a 6-week-old puppy on an empty stomach.
Ol. Terebinth	30 m.	
Chloroformum	7 m.	
Ol. Ricini	14 drms.	

(iv) **Poultry**

See page 932.

Carbon Disulphide

(i) **Horses.** (Bots and Large Roundworm in foals.)

1 dram per 200 lb. body weight to maximum of 6 drams for 1,000 lb. animal.

Administered in a capsule or by stomach tube.

When given for bots, it is best to precede dose with a drench of a 2% solution of sodium bicarbonate.

Starvation over-night gives better results. No purgative is necessary.

(ii) **Pigs.** (Stomach Worms.)

4 to 5 c.c. per 50 lb. body weight given in a capsule.

Starve overnight. No purgative necessary.

Liquid Extract of Male Fern

(i) **Cattle.** (Liver Fluke.)

Calves, 3 months old	½ dram
Calves, 6 months old	1 dram
Calves, 9 months old	1 dram
Calves, 12 months old	2 drams
Adults over 18 months old	3 to 6 drams

Give in 1 pint of milk, thin gruel or flour pap, on three successive mornings. Repeat four times a year.

(ii) **Sheep and Goats.** (Liver Fluke.)

Lambs and kids, 3–9 months old	(25–65 lb.)	½ to 1 dram
Older animals	(75–125 lb.)	1 to 1½ dram

Give in six times its volume of milk, and repeat following morning.

Treatment should be repeated four times a year.

Hexachlorethane

For Liver Fluke in cattle, sheep and goats.

This drug is usually made up in a suspension with bentonite. Doses are approximately:

	Grammes	*Drams*	*Ounces (approx.)*
Cattle	60–100	15–25	2 –3½
Yearlings	40– 50	10–12	1½–1¾
Calves	20– 30	5– 8	¾–1
Sheep	30– 40	8–10	1 –1⅓

A second dose in three weeks' time helps to complete the eradication of the flukes.

Sodium Fluoride

Pigs. (Roundworms, Whipworms, Stomach Worms and Nodular Worms.)

Dose. 0·15 gm. per lb. body weight. This works out at 1 oz. for 8 pigs weighing 25 lbs., or 4 pigs weighing 50 lbs.

It is always administered in a **dry** mash.

Treatment is best carried out by dosing the whole herd as follows:

(1) Divide pigs into groups of equal individual weights.
(2) Measure **dry** food for each group for one day.
(3) Weigh the sodium fluoride and mix the dry powder evenly into one day's dry ration for each group.
(4) Put mixture into dry trough.
(5) Starve pigs for 24 hours. Start treatment in the morning, and discard any unused meal on the following morning, and thereafter feed normally.

N.B. Never use wet sodium fluoride or wet meal, and do not dose sick pigs.

Where large numbers of pigs of different weights are being dosed, sodium fluoride may be added to the dry feed in the proportion of not more than 1% of the total weight.

Lead Arsenate

Horses (Bots)

0·2 gm. per lb. body weight.

Goats and cattle (Tapeworms)

Kids 1–9 months—1 pill

Goats over 9 months—2 pills

Calves 1–3 months—1 pill
Cattle over 3 months—2 pills
Repeat if necessary after 3 weeks
Each pill contains 0·5 gm. lead arsenite.

Hexylresorcinol

This drug is usually put up in 0·1 gm. or 0·2 gm. pills. It is a safe drug, and is used for treating dogs of all ages and breeds.

Dogs. ('Puppy Worm' and Hookworm.)

~~Very young puppies,~~ (*a*) ~~small breeds~~	0·2 gm.
(*b*) larger breeds	0·4 gm.
Dogs 10 to 12 lb. weight	0·6 gm.
Dogs over 20 lb. weight	1·0 gm.

The dog should be starved for 12 hours before and 4 hours after treatment, and a dose of castor oil given on the day following the treatment.

'Piperazine' Compounds

These are marketed under various names, the most common of which are 'Coopane' and 'Verban'.

They are highly effective against roundworms in all species of domestic animals. In addition, there is evidence to indicate that some species of strongyles in horses are susceptible.

~~Pyperazine is non-poisonous and practically tasteless and odourless~~ and so can be safely given with food with the assurance that the medicated food will be readily eaten. Soluble compounds for use in drinking water especially for poultry are also available.

Dosage as recommended by the manufacturers.

Dictycide (Cyanacethydrazide) is a white powder which is soluble in water and used for subcutaneous injection. It is effective against the common lungworms of cattle, sheep, goats and pigs. A single dose will remove a large proportion of worms and larvae present in the air passages (bronchioles, bronchi and trachea).

Where there is natural re-infestation repeated dosing is necessary. The following schedule of dosing is recommended:

(i) At the commencement of an outbreak inject all affected and in-contact animals.
(ii) On the fifth day repeat the treatment.
(iii) On the twenty-first day again repeat the treatment.

Dosage (using ~~25%~~ w/v solution).

Dictycide is administered by subcutaneous injection.

Cattle: 3 c.c. per cwt. body weight up to a maximum of 20 c.c.
Sheep, goats and pigs: 0·4 c.c. per 14 lb. body weight up to a maximum of 4 c.c.

The maximum dose must not be exceeded.

Other Formulations

For oral administration two formulations of Cyanacethydrazide are available: 'Helmox', a 10% powder in a water soluble base. 'Elimix' a combination of Cyanacethydrazide and 'Piperazine'.

Advice to Farmers

Protect your Animals from Worms by:

1. Giving sufficient food, especially to young growing animals.
2. Keeping young animals away from worm-infested pastures, damp places, and small paddocks.
3. Keeping the young animals warm and dry.
4. Regular dosing with worm remedies (anthelmintics).

Remember:

1. Worms multiply very fast.
2. Worms love wet, shady places.
3. Worm eggs can live on pastures for fairly long periods, up to four months if the conditions are favourable.
4. Worms suck blood or irritate the stomach, intestine, lungs or wherever they live, causing various harmful effects, devitalizing the animal and eventually killing it unless steps are taken to kill the worms first.
5. The young animal is very susceptible to worm infestation, especially just after weaning.
6. There is no short cut to worm control. Constant and careful pasture management, regular dosing, and thoughtful organization are all essential.

Common Diseases of Poultry and their Prevention

One of the severest handicaps of poultry rearing in Jamaica at present is that of infection by diseases and parasites. These infections are very often complicated by the effects of unsound breeding practices, poor husbandry, and poor nutrition. A knowledge, therefore, of the causes and prevention of such infections will be of more value to the poultry keeper in helping him to ~~locate~~ unfavourable conditions than in curing sick fowls.

Curing sick fowls has many disadvantages. In many cases the individual bird is not worth the time, trouble and cost of the remedy involved in the treatment. Even if the sick bird is cured it may serve to spread disease while being treated. In the third instance the few cures that are effective tend to minimize in the minds of poultrymen the necessity for maintaining proper preventative measures. Successful poultry rearing, therefore, is dependent on a knowledge of preventative practices. It cannot be left to chance or medicine.

Minor Disorders

Cannibalism. Chickens and adult birds kept in a confined space sometimes develop the habit of pecking each other until blood pours from the torn flesh. This is referred to as cannibalism. The trouble is generally started by one member of the flock becoming injured in some way; the others peck at the wound until, in many cases, the entire chick is devoured. In the process a taste for blood is developed, other chickens getting smeared with blood are attacked, and soon the trouble becomes widespread. Lack of sufficient minerals in the feed, insufficient animal protein, overcrowding, high temperature, and insufficient feed are factors which often contribute largely to this practice. Mixing of age groups may also cause this trouble.

Control. To control cannibalism, remove the injured bird immediately from the flock. Provide the birds with more space and, if possible, remove the ringleaders or cut a small portion off the end of the upper beak of such birds. This should be so small as not to hinder the bird in feeding.

In some cases two tablespoons of common salt may be added to a gallon of water, and this solution only given for half a day. This is then replaced by regular drinking water. Keeping plenty of green feed before the birds will also aid in controlling cannibalism.

Crop Bound. The accumulation of feed in the crop due to obstruction of the opening to the lower oesophagus, or to paralysis of the walls of the crop, may cause the crop to become impacted and relief must be given the bird.

Treatment. By first giving water and then holding the head downward, it is sometimes possible to massage the crop and force the food out through the mouth. It is also a good practice to pour a teaspoon of castor oil down the throat and manipulate the crop until it becomes loosened. In case this fails the only other method of relief is to make a one-inch incision through the skin and the wall of the crop. This should be done on the upper front surface of the crop. The crop should be washed with warm water, and the incision in the wall of the crop and the skin sewn separately. No feed or water should be given for several hours after the incision. The first feed after that should be well moistened before it is given to the bird.

Prolapsus

Fowls in their first year of laying occasionally suffer a protusion of the oviduct, due no doubt to overstraining on the part of the bird in her effort to lay. This condition is often caused by inflammation of the oviduct, coccidia and intestinal worms.

Treatment. Cases of prolapse should be treated by washing the tissue

with warm water and gently pushing the organ back in place with fingers dipped in carbolized vaseline. The birds should be removed from the flock as soon as discovered, otherwise cannibalism may develop. Inject clean ice water three or four times daily into the cloaca to relieve the congestion and to contract the muscles of the organ. Such birds, when cured, should be used as meat rather than be replaced in the flock.

Heat Prostration

On very hot days poultry may suffer heat prostration when the humidity is high and shade is inadequate. In such a case the birds will breathe rapidly, hold the wings away from the body, become exhausted and collapse.

Treatment. Plenty of shade and abundance of clean water and ample housing are essential in preventing losses from heat prostration during the hot months. Prompt removal of affected birds to a cool place and immersion in cold water will bring recovery to some, but in spite of what may be done others will die. Where trapnests are used the hens must be released very often, and fowls in batteries should be sprayed with water if the day is very hot.

Bumble Foot

Bumble Foot.

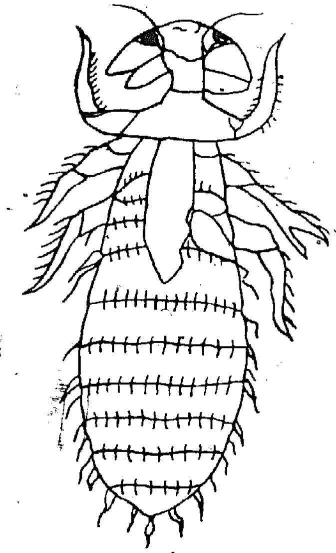
When the bottom of the foot is badly bruised or cut, an abscess may develop. A fluid or a cheesy matter may accumulate in the spaces between the toes or on the ball of the foot, forming swellings and later abscesses with core-like centres.

Treatment. The only treatment is to open the abscesses with a sharp knife and force out the pus. Treat the opening with an antiseptic, tincture of iodine, Jeyes solution, or five per cent carbolic solution. The foot should be properly bandaged and the bird placed in a coop by itself. The wound should be disinfected at intervals of two to three days until cured.

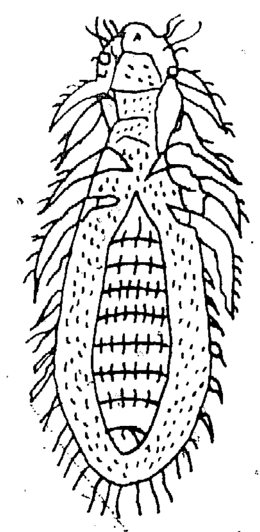
Vent Gleet (Cloacitis)

This is often seen among laying birds. It is an ulcerated condition of the cloaca and vent, and is accompanied by a foul-smelling watery discharge and cankerous patches on the affected area. Fowls usually peck at the reddened surface, which encourages cannibalism. The cause of the disease is not known, but the disease does not seem to be infectious. Affected birds should be removed from the flock.

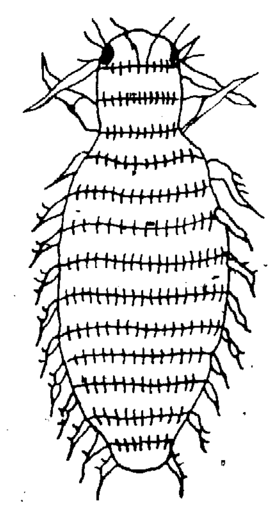
Treatment. Wash the vent with warm water, then apply a three per cent silver nitrate solution with a cotton swab, or with a three per cent solution of chromic acid. If there is no improvement in ten days, kill the bird, because in some cases the condition is incurable.



Body Louse



Head Louse



Feather Louse

External Parasites

Lice. Lice are small yellowish- or greyish-coloured insects with cutting or biting mouths. There are at least seven different species of lice affecting poultry. Generally, each species confines itself to a different part of the body and feathers, by which they are commonly described as head louse, body louse, wing louse, etc. They lay their eggs in clusters, which are hatched in five to seven days. In ten to fifteen days they are fully grown. They irritate the skin of birds, causing great discomfort.

Control. The first step, as well as the most efficient method of controlling these parasites, is to clean the coops and keep them clean, and dust the birds with an insecticide. When the coops are cleaned they should be

whitewashed or re-painted, so as to destroy any eggs which may be in the cracks and crevices of the building. Sodium fluoride, Black Leaf 40, paranaph, and proprietary insecticides containing gammexane, agrocide, or D.D.T. are very effective against lice. Lice can also be controlled if a lime dust bath is made available to the birds. A box fourteen inches wide, eighteen inches long, and ten inches deep, placed in one corner of the coop, half filled with sawdust or sand to which two pounds of D.D.T., gammexane, or agrocide-containing dust are added, will be effective in controlling nearly all types of external parasites. A box of similar size in the coop with lime will be found helpful in controlling some parasites.

Dipping of fowls is practical because it is more rapid than dusting, less material is required, and irritation of the nose and throat by dusting materials is avoided. When dipping choose a bright sunny day when there is not much wind, and make sure the birds are dipped early enough so that they can become thoroughly dried before sunset. Lukewarm water should be used and the solution made up at the rate of 1·5 ounces of sodium fluoride to one gallon of water. Each fowl to be dipped should be held by the wings close to the back, submerged in the liquid, and held for a few seconds while the feathers are thoroughly ruffled so that the solution may penetrate to the skin. The head is then ducked under once or twice, and the fowl lifted out and allowed to drain. To be effective the solution must be freshly prepared.

In administering an insecticide pour it into a flit gun, raise the feathers and spray the body of the bird, or rub it into the feathers with the hand.

Mites. There are several kinds of mites affecting poultry, but the red mite, feather mite, scaly-leg mite, and fowl tick are the only ones which will be mentioned, because they are more common in tropical climates.

Red Mite. This is a small blood-sucking insect. It gorges itself with the blood of the birds during the nights and crawls into the crevices in the nests, dropping boards, and other parts of the building where the eggs are laid. During the warm months the eggs hatch in two to three days, and adult life is reached in four to six days. After hatching the red mite is also able to live for several months without food, and because of this all control measures must be directed to the places where it hides during the day.

Control. Painting or spraying the roosts, nests, and the internal walls of buildings with kerosene oil, coal tar, nicotine sulphate, or crank case oil from motor cars will destroy them. Here again dusting powders containing D.D.T., agrocide, and gammexane are very effective.

Feather Mite. The feather mite resembles the red mite, but it spends most of its time on the bird. Infected birds lose weight and egg production decreases. In many cases large portions of the body are denuded of feathers.

Treatment. One of the most effective treatments is to dip each bird in a tub of tepid water containing two ounces of flowers of sulphur, one ounce of laundry soap, to each gallon of water. The solution should be thoroughly worked into the feathers of each bird. Birds should be dipped on warm days only to prevent chills or pneumonia. The treatment of the buildings and equipment is the same as for the red mite.

Scaly-leg Mite. The scaly-leg mite, or mange as it is sometimes called, is a very small mite which burrows under the scales of the shank and toes of poultry causing severe irritation. By the action of the mites a spongy or powdery substance is formed and the scales become raised, giving an enlarged and roughened appearance. The bird becomes lame, and the feet may bleed.

Treatment. Treatment consists of dipping the toes and shank in a solution of one pint of kerosene oil mixed in one quart of linseed oil. Buildings and equipment should be thoroughly cleaned and treated as in the case of red mite.

Fowl Tick. The fowl tick often becomes a serious pest. It is a blood-sucker and feeds only at nights, hiding by day in cracks and crevices.

Treatment. It can be controlled by painting or spraying the roosts and dropping boards with carbolineum paint or a mixture of two quarts of kerosene oil to one quart of coal tar.

Internal Parasites. Internal parasites cause stunted growth, weakness, lowered egg production in laying hens, and eventually death.

Gapeworms. These are thin, small, and reddish worms which attach themselves to the windpipe or trachea of poultry. By sucking blood from the walls of the windpipe the gapeworm causes inflammation and accumulation of mucus resulting in death by suffocation. Infected birds sneeze, cough, and gasp for air.

Treatment. Successful treatment is extremely difficult, and prevention is the only safe practice. To prevent gapeworm infection, the house and drinking and watering vessels should be cleaned and kept clean. In addition, the birds should never be fed on the ground, because they are likely to pick up the worm eggs.

To give relief to infested birds wrap the end of a piece of stick or wire with cotton and dip the wrapped end in turpentine or kerosene oil. Insert it into the throat of the bird gently and rotate it for a few minutes. One such treatment each day for three days will dislodge most of the worms from the throat.

Roundworms. The large intestinal roundworms which infest the small intestines of poultry cause poor growth, low egg production in laying birds, emaciated condition, lameness in the feet, and death in severe infection.

Treatment. A common method of treatment is to add two per cent of ground tobacco to the mash and feed this mixture for about ten days.

Another method is to give each bird one of the reliable brands of worm capsules. For a single-dose mass treatment, one teaspoonful of oil of chenopodium mixed thoroughly in three pounds of mash will be sufficient for each twelve hens. The mixture should be dampened with water. Hygienic practices are, however, more effective than any treatment so far known.

Tapeworms. Tapeworms are one of the most injurious groups of parasites affecting poultry. They are flat, segmented, white, and often twelve inches long. The head is the smallest and oldest portion. New segments continue to form just behind the head, and only the terminal segments are matured and contain fertilized eggs. As the worm grows the end segments are detached, pass out in the droppings of the fowl, and may be eaten by a variety of beetles, flies, snails, worms, and other insects capable of acting as intermediate hosts, which incubate them. When these insects are eaten by poultry the tapeworms attach themselves to the lining of the intestinal wall, where they grow to maturity and the life-cycle is completed.

Treatment. Treatment is not always successful, therefore it is best to aim at prevention. Remove conditions which are favourable to the hosts of the tapeworm and maintain a high standard of sanitation. Lye is reported as giving good results in some cases. The lye is prepared and administered in the following way: One tablespoonful of lye is added to three quarts of mash and mixed thoroughly; the mixture is then covered with water and cooked for two hours. The flock is starved for twelve hours before they are fed the treated mash. Plenty of clean drinking water should be provided when feeding the treated mash. For two hours after feeding the treated mash no other feed should be given.

Contagious Diseases

Fowl Pox. Fowl pox, sometimes called 'yaws', 'sore head', and 'canker', is a very infectious disease which exists in all countries where poultry are kept. It is caused by a filterable virus, and fowls and turkeys are attacked by the same agent. The virulence of the disease increases with the concentration of the poultry population, and it is often spread by mosquitoes, rats, infected birds, by fighting, and by individuals who carry the organism on their clothing or on equipment.

Symptoms. A cold is usually the first symptom of the disease. The eyes water and the nasal passage discharges mucus. The disease generally assumes one of three forms.

(i) A wart-like lesion of the comb, wattles, eyelids and face, with eruptions in some cases on the legs and feet, about the vent or under the wings.

(ii) Localization of the infection on the membrane of the mouth.

When the mouth becomes involved the opening of the windpipe (larynx) may become affected and breathing difficult.

(iii) Localization of the infection in the nasal passages with a thick cheesy matter. First the deposits are thin and yellowish in colour, gradually becoming thicker.

Treatment. In the early stages of an outbreak affected birds should be isolated, care being taken not to spread the disease to other pens. As an aid in preventing the spread of the disease, drinking water should be changed frequently each day and one-third teaspoonful of permanganate of potash added to each gallon of drinking water. If, however, there is an outbreak, rub affected parts with tincture of iodine, carbolated vaseline, Jeyes, sulphur ointment, or lime and common salt. Care should be taken not to allow any of these substances to get into the eyes of the birds.

Prevention. *To prevent an outbreak of fowl pox in the flock, each chicken should be vaccinated when they are six weeks old.* Immunity developed at this age will last a long time when good husbandry is practised. The vaccine is inexpensive, and easily given under the wing or on the leg with the aid of a small brush or sewing needle. Birds to be vaccinated must be in good physical condition.

Newcastle Disease. This disease is caused by a virus, and is so named by the research worker who discovered it in 1927 on farms in Newcastle-on-Tyne. It is dangerous to birds of all ages, but severest to chickens under twelve weeks of age. The disease usually appears suddenly and spreads rapidly. It takes about three to five days after the bird is exposed before the symptoms develop.

Symptoms. Symptoms are droopiness, ruffled feathers, sneezing, rattling sounds in breathing, sleepiness, yellow frothy diarrhoea, and fever. The crop is usually distended with sour-smelling grayish-brown fluid. The most characteristic symptom is the altered respiration, in which there is a long gasping inhalation through the half-closed mouth. There is a thick discharge of mucus from the nostrils, and the neck, wings, and legs may be paralyzed. The combs, wattles and face may become dark, and there is no desire for food. Once the symptoms are seen, death takes place in less than forty-eight hours.

Treatment and Control. There is no known treatment for this disease, and because of the rapid spread of the infection attempted treatment is not only futile but dangerous, because of the time lost before instituting the drastic measures required to cope with such highly infectious maladies. So far, this disease has not occurred in Jamaica, but since there is a large annual importation of day-old chickens from the United States, and since the disease often affects the flocks there, every possible care should be taken to prevent its introduction here.

In the event of an outbreak the following practices will be useful:

(i) Use a non-poisonous disinfectant in the bird's drinking water each day, such as potassium permanganate or one of the proprietary compounds for this purpose.
(ii) Receive as few visitors as possible on the farm, and see that they disinfect their shoes on arrival.
(iii) Quarantine all incoming stock.
(iv) Disinfect water vessels and wet mash hoppers daily, and all other equipment once weekly.
(v) Double the vitamin A content of the feed.
(vi) Burn thoroughly or bury deeply all dead birds.
(vii) Destroy all sick birds, and those looking suspicious should be isolated.
(viii) Lime the run and put it into a catch-crop before putting the birds on the same spot again.
(ix) Maintain strict sanitary conditions at all times.
(x) Immediate notification should be sent to the Ministry of Agriculture when any of the above symptoms appear.

Fowl Pest (Fowl Plague). This is a highly acute, infectious disease of fowls, characterized by an extremely rapid course and high mortality. The disease is very similar to Newcastle disease.

Symptoms. In some cases the course of the disease is so rapid that affected birds die without exhibiting any symptoms. However, as a rule, the course of the infection is from two to seven days. The disease is first indicated by depression and droopiness. Affected birds stand in one place with head drawn in and eyes closed, and are not easily aroused. The nostrils and mouth discharge a sticky exudate. As the disease progresses the bird is unable to stand, and the comb and wattles may become bluish-red in colour and swollen.

Control. Medicinal treatment is of no avail. The same measures taken in outbreaks of Newcastle disease should be taken with fowl pest.

Fowl Paralysis (Range Paralysis). This is considered to be of virus origin. It is common among birds between the ages of three and ten months old. All breeds of fowls will contract the disease, and symptoms are slow in developing.

Symptoms. This will depend upon the part of the body affected. Lameness in one or both legs followed by drooping of one or both wings is usually the first indication of the disease. The severity increases until the bird cannot stand. Limpness of the legs and wings are sometimes the only symptoms, in which case the birds move about with a staggering gait. A peculiar jerking or twitching of the affected limbs may also be noted.

The eyes may change colour from the normal to the so-called 'white' eye, 'grey' eye, 'pearl' eye, or 'fish' eye. In severe cases the pupil fails to respond to light and remains fixed or bulged. In some cases the eye changes are the first indications of the disease, and may be the only visible symptoms. During the early stages of the disease appetite may be good, but eventually lameness or blindness will prevent the bird reaching the food supply. Diarrhoea is sometimes present. The birds seldom recover, death being caused by starvation or by ill-treatment by other members of the flock.

Treatment. At present there is no effective treatment for the disease. Clean quarters, runs, and equipment are the most effective preventative measures. Each year rear the young flock on clean soil. Isolate all birds showing any of the symptoms mentioned above and control intestinal parasites.

Roup (Coryza). A severe inflammation of the mucous membranes of the upper respiratory tracts, commonly called 'cold' or catarrh. It is usually the result of overcrowding, dampness, insanitary conditions, and reduced vitality.

Symptoms. In its mildest form the disease occurs with a nasal discharge, which may be of a relatively short duration or may persist for a long time. In the more severe form of the disease it is complicated by other manifestations, including swelling of the face, inflammation of the sinus, trachea, and bronchial tubes, infection of the air sacs, gasping, and coughing. As the disease progresses a foul-smelling discharge from the nostrils and eyes may develop. This soon becomes thick and cheesy, with a tendency to dry in a yellowish crust around the nasal opening. As the inflammation extends, the adjacent sinuses become filled with mucus. This, being unable to drain away, accumulates in such quantities as to cause prominent bulging about the eyes. When the air passages are involved, breathing is accompanied by a rattling sound. In the advanced stages affected fowls sit quietly with ruffled feathers, have very little appetite, and shake their heads frequently in an effort to dislodge the mucus. Yellowish patches may form in the mouth, and these add to the difficulty of breathing.

Treatment of affected fowls is rarely successful. In case of an outbreak, isolate all affected birds. Clean and disinfect the poultry house and feeding and drinking vessels thoroughly. Provide plenty of green feed, and add one pint of cod liver oil to each hundred pounds of mash. The oil should be thoroughly mixed into the mash before it is fed. Destroy all birds which are seriously affected, clean and disinfect the house and trough thoroughly.

Tuberculosis. Tuberculosis is a chronic infectious disease which affects almost all species of domestic birds. There are three recognized kinds of tubercle germs—human, which causes tuberculosis in men; bovine, which causes tuberculosis in cattle, and sometimes in man ; and

avian, which causes tuberculosis in poultry. Avian tuberculosis is also of interest to farmers, because it is easily transmitted from poultry to swine.

Symptoms. Fowls of any age are susceptible to avian tuberculosis, but because of the slow way in which the disease develops, it is generally not observed until the fowls are about a year old. In the advanced stages there is loss in weight, dullness, dry appearance of the feathers, and diarrhoea with greenish or yellowish droppings. Lameness and swelling of the joints of the legs and wings are often observed.

Testing. In the early stages tuberculosis can be diagnosed by the tuberculin test, as in the case of cattle. Tuberculin fluid is injected into one wattle, and the other wattle is left untreated as a check. If the treated wattle becomes swollen in forty-eight hours, it is an indication of tuberculosis in the fowl.

Prevention is the only safe course to follow, because there is no known cure for tuberculosis in fowls. Birds should not be fed on bare land, in filthy houses, or with dirty utensils. All water puddles or mud holes in the yard should be filled up. Newly purchased birds should be quarantined for at least two weeks, and tested before they are allowed to mingle with the flock. Once tuberculosis has occurred on the premises constant care should be exercised to prevent its recurrence. Burn or bury deeply all dead birds and destroy all sick ones.

Typhoid. Avian typhoid (fowl sick) is an infectious disease of poultry. It is readily communicable and very acute in character, and found in all countries where poultry are kept. Outbreaks are quite frequent here during the rainy season.

Symptoms. As with many other diseases, positive indications of typhoid can only be made by laboratory diagnosis. The disease attacks the blood stream and internal organs. Affected fowls show loss of appetite, and appear dull and listless with high fever and head drawn close to the body. The comb and wattles are usually pale, feathers dry and ruffled, and there is a profuse greenish or yellowish diarrhoea. The course of the infection is from two to ten days.

Treatment is of no practical value. Strict sanitary measures comprise the most effective method of controlling and preventing avian typhoid. Vaccination against the disease is effective if properly given. Remove all affected birds and kill them.

Fowl Cholera. Locally called 'Fowl Sick', this is an acute and highly infectious disease, which is caused by a germ that multiplies rapidly in the blood and various organs of the body. Infected birds pass great numbers of the germs in the droppings, which are picked up by other birds. The disease is spread also by sick birds, recently recovered birds, wild birds, infected poultry equipment, or by persons carrying the germs on their clothing.

Cholera Infection—Swelling of Wattle

Symptoms. When the disease is acute the first indication of the infection is the finding of dead birds under the roost or in the nests. Extremely fat fowls are particularly susceptible. In the less acute stage of the disease a greenish or yellowish diarrhoea is the first indication. As the disease advances the birds become droopy, feverish, breathe rapidly, and are very thirsty. The comb and wattles are often swollen or may become purplish in colour. In the chronic stage of the disease fowls show lameness and swelling of the joints of the legs and wings. These swollen areas usually contain a creamy-like substance.

Treatment. Medicinal treatment of the disease has not proved very successful because the disease acts so quickly. As soon as any bird shows symptoms of the disease it should be removed from the flock. Dead birds should be burned or buried deeply. Buildings, runs, and utensils must be thoroughly cleansed and disinfected daily. If the protein content of the diet is high it should be reduced by half. Lock all the birds in during and after rains until the ground is dry before allowing them outside, and maintain a high standard of sanitation at all times.

Pullorum Disease (Bacillary White Diarrhoea). This is a contagious disease affecting chickens and adult fowls, which is generally transmitted from the hen through the egg to the chickens. In the mature hen

the seat of the disease is in the ovary, and nearly all eggs laid by infected hens contain the pullorum germ. Chickens hatched from such eggs are affected by the disease germs in the egg. The disease is generally observed during the first day of hatching, and losses may continue for three to four weeks after.

Symptoms. Infected chickens are droopy, have a tendency to crowd together and appear very dejected. They do not eat, but chirp continuously as if in pain. The eyes are kept closed and breathing is irregular. The droppings may be whitish and sticky, and may cling to the down and vent in such a way as to block the vent. Affected chickens which survive appear weak and unthrifty, with enlarged abdomen. If such chickens reach maturity and are used as breeders, they spread the disease as carriers without showing any visible symptoms. Chilling, over-heating, faulty feeding, and rough handling will also produce many of the symptoms and effects of pullorum disease.

Control. No successful treatment for pullorum has yet been found. Incubators, buildings, and equipment should be kept very clean. All breeding hens should be blood-tested for pullorum disease before their eggs are used for hatching. Importers of day-old chickens should make sure they buy them from reputable hatcheries.

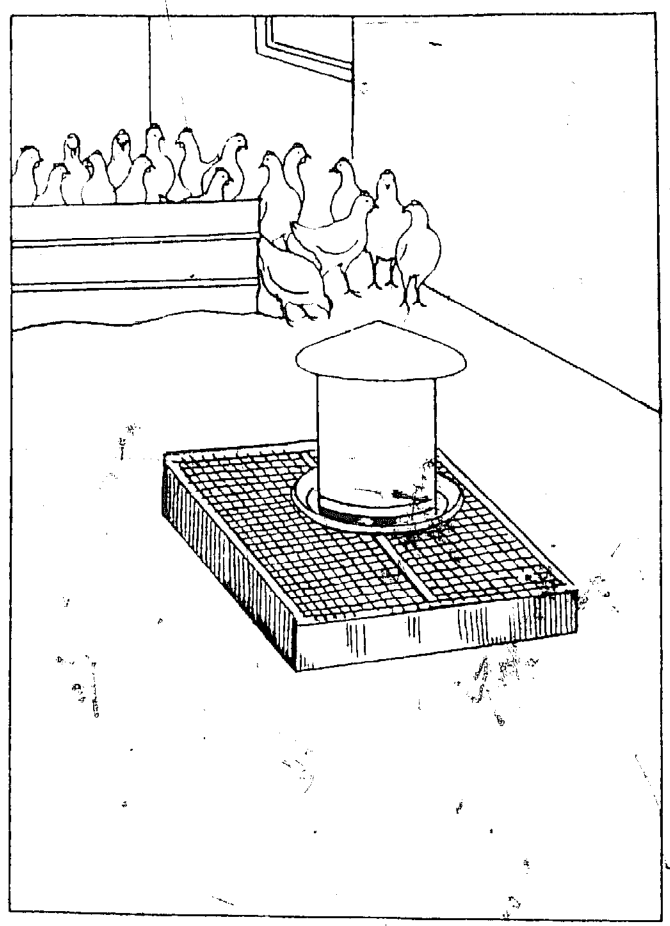
Coccidiosis. A common and infectious disease of poultry caused by a single-cell parasite called a 'coccidium'. The disease is spread by contamination of feed water, and soil with the droppings of infected birds. There are eight species of coccidia which may cause different forms of the disease in poultry.

The disease occurs in chickens from three weeks of age to maturity, but the acute form is especially destructive to young chickens from four to twelve weeks of age. Mature fowls are frequently affected, and in them the disease often assumes a chronic form. Outbreaks are more frequent and severe during periods of wet weather and among chickens hatched during the summer months.

Symptoms. Chickens suffering from coccidiosis are droopy and depressed. They stand huddled together with drooping wings, ruffled feathers and closed eyes. Diarrhoea is commonly present, and the loose droppings are frequently mixed with blood. Although the birds eat very little, the crop is often full. Despite this, however, emaciation follows, and death in three or four days. In the acute stages there is paleness of the comb, wattles, beak, and shank, with lameness in the feet. Mortality may be very high, but with proper management the disease can be checked and the chickens will recover quickly.

Treatment. The most effective treatment is good sanitation. At the first sign of disease remove suspected birds, clean and disinfect the house, as well as all feeding and drinking utensils. To treat the chickens mix one pound of *sulfaguanidine* in one hundred pounds of dry mash (or one ounce of *sulfaguanidine* to each six pounds of mash), and feed this to the chickens as soon as the symptoms are observed. *Sulfamaezathine* mixed in the same proportion as sulfaguanidine is equally effective.

To make a uniform one per cent mixture of the drug, mix one pound of sulfaguanidine thoroughly in ten pounds of mash. Then add about twenty pounds of mash, and after mixing add forty pounds more and mix again, finally adding the remainder of the hundred pounds of mash and again mixing thoroughly.



A Drinking Fountain

Do not start treatment until the first symptoms appear, then feed the medicated mash for one full day. If treatment is started in the afternoon continue through the following day, then feed the regular mash for four days and feed the medicated mash for another day. Two such one-day treatments will usually check an outbreak, but it is advisable to give a third one-day treatment with the medicated mash after another four days.

The use of milk, dried and fluid, is also recommended. Avoid damp spots in the run and around the drinking vessels, because dampness is necessary for the disease to develop.

Deficiency Diseases

A lack of vitamins or minerals or a proper balance between the two may cause serious physical disorders. In poultry feeds there must be an adequate amount of each vitamin for good growth, health, and egg production. The common names of these vitamins are A, B, C, D, E, and G.

If vitamin A is lacking in the diet of chickens, growth will be very poor after the third week, because up to the third week they are able to get along on the quantity absorbed from the yolk before hatching. When there is vitamin A deficiency there may be paralysis of the legs, soreness of the eyes, small pimple-like spots inside the mouth and throat, loss of appetite, emaciation, loss of weight and death. In mature fowls the symptoms are similar to those of the chicken, but the eyes become more swollen. There is a cheesy deposit under the eye-lids, swelling under the throat and on the face, excessive mucus in the mouth and cankerous growth in the roof of the mouth, also extreme paleness of the skin, beak, and shank followed by death. Vitamin A is found in green feeds, in yellow corn, and in cod liver oil. Feeding these will prevent a deficiency in the ration.

Vitamin B_1. Chickens have a high and continuous requirement for vitamin B_1. If there is a deficiency of this feed there will be nervous disorder, poor growth in chickens, and paralysis of the peripheral nerves. 'Polyneurites', a condition in which the chicken carries its head pulled back, can often be cured in a few minutes by injection of Vitamin B_1. Vitamin B_1 is found in fair amounts in nearly all the grains used in poultry feeds, and its deficiency is not common in flocks which are properly fed.

Vitamin B_2 (*riboflavin*) contains two factors needed in poultry diets. One is needed for growth in chickens and layers. Without it chickens will not thrive, and their legs will become weak or paralyzed, and the toes will curl inside. Eggs from layers deficient in this vitamin will not hatch healthy chickens. Nearly all the embryos will die between the twelfth and eighteenth days of incubation, and those which do hatch will have defective joints.

The second factor prevents the disease called pellagra. Chickens and adult birds fed diets deficient in vitamin B_2 will develop scaly sores in the corners of their mouths, sticking together of the eye-lids, and cracking between the toes. Skimmed or whole milk and an abundance of green feeds will prevent a vitamin B_2 deficiency.

Vitamin C. Absence of vitamin C in the feed will not affect poultry because they are able to synthesize it in their body, and do not, therefore, suffer from scurvy.

Vitamin D. Poultry of all ages have a high requirement for vitamin D. If sufficient vitamin D is not in the feed, and the birds do not have access to direct sunlight, rickets will develop. In case of rickets the bones fail to harden (calcify), and the birds walk with a staggering gait. If birds are locked up for over two weeks without access to sunlight, add a half pint of cod liver oil to each hundred pounds of mash. This will prevent rickets.

Vitamin E is necessary in the feed of grown birds for normal reproduction and hatchability of eggs. Many green plants and grains used as feeds for poultry are good sources of Vitamin E. When the diet is deficient in Vitamin E, egg production will be very low and the eggs laid will not hatch. The male birds will become sterile. Deficiency of this vitamin in chickens will cause a nutritional malady commonly called 'crazy-chick disease', in which the brain is infected.

Common Disinfectants

A good disinfectant is one which destroys germs of contagious diseases and some types of external parasites, and is very necessary in helping to control the growth of bacteria and maintaining proper sanitation. It should be borne in mind, however, that a disinfectant is useless when applied to an accumulation of dirt, filth, and straw, so that it is necessary to clean the house and equipment thoroughly before applying it. To do a good job use a force pump to enable the disinfectant to get into all the cracks and crevices. Treat the ceiling, sides, walls, floors, nests, dropping boards, perches, drinking fountains, and feed hoppers thoroughly. Use a brush where a pump is not available. Throwing it here and there in a hit-and-miss fashion about the house is a waste of time and disinfectant.

The following are some of the common effective disinfectants and the average proportions of each which may be used:

(i) Carbolic acid, used in a 5% solution.
(ii) Jeyes, used in a 2% solution.
(iii) Liquor Cresotis Compositus, used in a 3% solution.
(iv) Creolin, used in a 4% to 6% solution.
(v) Lye, used at the rate of 12 ounces to 10 gallons.
(vi) Lysol, used in a 3% solution.
(vii) Sodium hypochloride, used in a 5% solution.
(viii) Whitewash, made by dissolving one pound of commercial lye containing about 94% of sodium hydroxide and two and a half gallons of water. This solution is cheap, odourless, and effective in destroying most disease germs. Also scatter the dry white lime in litter, on the floor, and in the run.

A Plan for Disease Prevention

Before any plan for disease prevention can be put into practice we must know how infection is spread. Over a period of years investigations have shown that poultry diseases are spread largely by:

(i) Exposing healthy birds to diseased birds.
(ii) Contaminated water and feed.
(iii) Infected soils.
(iv) Filthy quarters.
(v) Unbalanced diets.
(vi) Faulty management.
(vii) Insect carriers.

The problem, then, is to prevent, in so far as possible, the spread of disease by any of the means mentioned above. The following are ten practices to follow as practical steps for disease prevention:

(i) Raise chickens on uncontaminated ground. By a rotation of pens, and planting catch crops in each one as the birds are changed, it is possible to keep the ground disease free.
(ii) Clean and disinfect the poultry houses and all equipment frequently.
(iii) At all times keep young birds separated from the old hens.
(iv) When purchasing hatching eggs or baby chicks, insist that the eggs and chicks are from flocks in which there is no contagious disease.
(v) Purchase mature stock only if absolutely necessary, and then quarantine it before introducing it into your flock.
(vi) Cull sick and diseased birds as soon as detected, for they may be carriers of diseases or parasites.
(vii) Do not overcrowd chickens or adult fowls, overcrowding lowers the vitality of the stock.
(viii) Feed a well-balanced diet at all times.
(ix) Keep only stock possessing high vitality and ability to produce.
(x) Guard against the dissemination of disease by means of rodents, wild birds, insects, contaminated feed bags, infected chicken crates, humans who may carry disease organism on their clothing.

When in doubt contact your local Agricultural Officer.

Turkeys

Blackhead. Blackhead, technically known as infectious enterohepatitis, frequently causes extremely high mortality in flocks of growing birds, particularly among poults between one and three months of age.

Blackhead centres its attack on the liver and ceca. The disease is caused by a tiny animal parasite, which passes out of infected turkeys in the droppings. Alone, these organisms are destroyed rather rapidly by sunlight or dry conditions. But when they are harboured by eggs of the caecal worm, a common intestinal parasite of chickens and turkeys, they can live for a lengthy period. After lying in the litter, feed, or water for a time, the embryonated egg and its tiny parasite may be consumed by a susceptible bird, which then may become infected.

Symptoms. Turkeys which contract blackhead become droopy, sleepy, and weak. Their heads hang down or are held over their backs. Closed eyes and hanging wings are common symptoms. Feathers become ruffled, the birds lose flesh, and have little appetite. Sulphur-yellow droppings, which often soil the vent fluff, are quite characteristic of the disease.

Prevention and Treatment. Segregate poults from old turkeys and chickens, keep the bird on clean range, and follow a good system of range rotation.

Other preventative practices should include the following: regular cleaning and disinfecting of equipment, the use of low wire platforms under feeders and waterers to keep birds away from heavily contaminated materials, and the periodic moving of range shelters and feeding and watering utensils.

Rabbits

Rabbits, properly bred and cared for, are hardy, and not inclined to contract many diseases.

It is often believed that high-production stock is delicate and more apt to acquire diseases than stock not so productive. This theory does not hold true.

Diseases, however, will enter the rabbitry in spite of the best of care and precautions. Perhaps the greatest losses are suffered through coccidiosis and bloat disease.

Administering Medicine. The rabbit, which is not used to handling, will provide a problem. Care and patience must be exercised. Grasp the rabbit by the back of the neck with one hand, and place the other under the rabbit's hips. Then gently lay it on its back. Sit down in administering medicine and place the rabbit on the lap, resting it between the legs. Liquids can best be given by using an eye dropper. In dropping medicine into the nostrils turn the rabbit quickly on its feet, after it has been injected, to permit it to catch its breath, and also to prevent the medicine from entering the lungs. Powder may be given by gently pressing the jaws apart with the thumb and finger and then placing the powder well back on the tongue.

Snuffles. The symptoms of this disease are generally those associated with a bad cold. It is one of the most dreadful diseases, and unless the rabbit so affected is removed as soon as the symptoms are discovered the

disease may spread throughout the rabbitry. Neglected colds generally bring on snuffles and end in death.

The first indication of cold is a thin watery discharge from the nostrils. Sneezing and coughing are generally present, and later the discharge from the nostrils will become thicker. The rabbit will wipe its nose with its forepaws, and in time the fur on them will become matted and soiled. A droopy appearance, loss of appetite, and a general disinterest in things are the final stages of the disease.

As soon as the symptoms of a cold or snuffles are noticed, the rabbit should be removed to clean, dry quarters and void of draughts. Give it clean, wholesome feed and plenty of greens. In the treatment of colds and snuffles use oil of eucalyptus. Place a drop or two (with an eye-dropper) in each nostril, and rub some of it on the forepaws. This treatment may be given twice or three times a day. Another remedy is three drops of oil of eucalyptus mixed with one ounce of olive oil applied to the nostrils and forepaws. After the mixture has been applied to the nostrils, the rabbit should be placed on its feet quickly to avoid getting any of it into its lungs. A sneezing rabbit should not be considered as having a cold or snuffles. The sneezing might be caused by getting fine particles of dust into its nose, but, nevertheless, it should be watched. In very severe cases of snuffles the rabbit should be destroyed, and in all cases where the rabbit has been removed from its hutch, the hutch should be thoroughly cleaned and disinfected before it is used again.

Coccidiosis. The rabbitry where cleanliness is a habit is not apt to be troubled by this destructive disease which, should it gain a secure foothold in the rabbitry, will cause its owner to age prematurely. In advanced stages of the disease the rabbit will present a very droopy appearance, suffer loss of appetite, lack energy, its fur will become dull, and it may have abdominal dropsy. Young stock will die following convulsions. Post-mortem examinations may show small blood-shot areas about the size of pin-points on the inner side of the intestines. The mortality rate from this disease among young stock from six to eight weeks of age runs very high. The cure lies in prevention and the destruction of all suspected cases. The difficulty in recognizing this disease, and the greater difficulty in contending with it, suggests that the services of a veterinary surgeon be employed. Be cautious in introducing new stock to your rabbitry and cultivate cleanliness in its highest degree, and this dread disease will remain a stranger to you.

Bloat Disease. Diarrhoea and a distinct bloated appearance are the symptoms of this disease. Post-mortem examination will show an excessive amount of gelatinous mucus in the intestines. The exact cause of this disease is unknown, although some producers believe it to be caused by vitamin deficiencies. No doubt feeding methods are at fault, and a balanced ration should be used which should include a reasonable amount of green food. The symptoms suggest a treatment which will assist in keeping the digestive tract open. Yellow carrots with tops will serve well as a tonic and regulator. As in all other cases of disease, infectious or not, the affected rabbit should be isolated.

Vent Disease or Rabbit Syphilis. This disease is caused by the same germ which produces human syphilis, namely *Treponema cuniculi*. The disease is rapidly spread by the buck, if bred to an infected doe. Always examine the doe before placing her with the buck. Some breeders always wash the sexual organ of the doe before breeding her—not a bad practice, but not always necessary. The cheapest treatment is to kill all stock so affected.

Eye Trouble. The trouble that is caused by dirty conditions. Manure, when allowed to accumulate in hutches, or even on the rabbitry floor, may give off gases which are injurious to the eyes, and sometimes tiny red pimples occur around the eyelids. The young stock may become totally blind.

Treat by dissolving one tablespoonful of boric acid in one pint of warm water. Allow to cool, and wash the eyes of affected animals with it.

Diarrhoea. Over-feeding of greens or feeding with wet grass will produce diarrhoea very quickly, especially in young stock. Many producers, in order to avoid the danger of diarrhoea, feed no greens whatever. However, a judicious use of green feed will do no harm, and will help to keep the animal in good condition. Diarrhoea is sometimes caused by food being left in the feed dishes to become stale and musty. Young stock are most easily attacked through various causes, of which weaning too soon is one. Greens should never be fed to young stock.

Treatment consists in withholding all greens. Avoid the excessive use of bran, and feed only dry grains and well-dried hay. Scalded milk may be given or mash bread in scalded milk. Boiled rice is also good. In advanced stages a little powdered arrowroot on the grain may be used; also powdered cinnamon on the hay with good results.

Failure to Breed. When a doe fails to conceive it is most often caused by the doe being too fat, in which case she is not in proper breeding condition. Avoid over-feeding, especially starchy foods. Proper feeding, and weighing the rabbit from time to time, will assist the producer in keeping his stock in breeding condition. Giving the doe too long a rest between period is very often responsible. Trying a different buck will sometimes help. Drugs should never be used. If the doe is too fat, reducing the ration, and a few days run on the rabbitry floor, will bring her into condition. When all efforts have failed, she should be put on the market as meat.

APPENDIX A

Weights and Measures, Tables, etc.

Lineal Measure

4 Inches	= 1 Hand	$5\frac{1}{2}$ Yards	= 1 Rod, Pole or Perch
9 Inches	= 1 Span	4 Poles	= 1 Chain
12 Inches	= 1 Foot	10 Chains	= 1 Furlong
3 Feet	= 1 Yard	8 Furlongs	= 1 Mile
5 Feet	= 1 Pace	3 Miles	= 1 League
6 Feet	= 1 Fathom		

1·151 Miles	= 1 Nautical Mile
1 Link	= 7·92 Inches
1 Chain	= 100 Links = 22 Yards
80 Chains	= 1 Mile = 1,760 Yards

Cubic or Solid Measure

Cubic Foot	= 1,728 Cubic Inches
Cubic Yard	= 27 Cubic Feet = 21·033 Bushels
Stack of Wood	= 108 Cubic Feet
Shipping Ton	= 40 Cubic Feet Merchandise
Shipping Ton	= 42 Cubic Feet of Timber

Square or Land Measure

144 Sq. Inches	= 1 Sq. Foot	4 Roods	= 1 Acre
9 Sq. Feet	= 1 Sq. Yard	640 Acres	= 1 Sq. Mile
$30\frac{1}{4}$ Sq. Yards	= 1 Sq. Pole	An Acre	= 4,840 Sq. Yards
40 Poles	= 1 Rood		

1 Sq. Link	= $62\frac{3}{4}$ Sq. Inches (approx.)
1 Sq. Chain	= 10,000 Sq. Links = 484 Sq. Yards
10 Sq. Chains	= 1 Acre = 100,000 Sq. Links = 4,840 Sq. Yards
33 Sq. Yards	= 1 Rod of Building
100 Sq. Feet	= Square of Flooring or Roofing
$272\frac{1}{4}$ Sq. Feet	= Rod of Bricklayer's Work

Hydraulic Memoranda

Gallon of Water	= 10 Lb.	Crude Petroleum	= 8¼ Lb.
1 Cubic Foot of Water	= 6¼ Gals. (approx.) = 62½ Lb.		
1 Inch of Rainfall	= 22,622 Gals. per Acre = 100 Tons (approx.)		
Milk	= 10·3 Lb./Gal.	Turpentine	= 8·7 Lb./Gal.
Sperm Oil	= 8·8 Lb./Gal.	Alcohol	= 8 Lb./Gal.
Kerosene	= 8 Lb./Gal.	Petrol	= 7·5 Lb./Gal.
Sulphuric Acid	= 18·5 Lb./Gal.	Nitric Acid	= 15·3 Lb./Gal.
Hydrochloric Acid	= 12·1 Lb./Gal.	Molasses	= 12 Lb./Gal.

Avoirdupois Weight

16 Drams	= 1 Ounce (437·5 gr.)*
16 Ounces	= 1 Lb.
14 Pounds	= 1 Stone
28 Pounds	= 1 Quarter
112 Pounds	= 1 Hundredweight (cwt.)
20 Hundredweights	= 1 Ton

* *A grain is the same in all weights.*

Measures of Capacity — Dry Measure

1 Minim	= 1 Drop
1 Dram	= 1 Teaspoon
2 Drams	= 1 Dessertspoonful
4 Drams	= 1 Tablespoonful
60 Minims	= 1 Dram
8 Drams	= 1 Ounce
20 Ounces	= 1 Pint (0·567 litre)
4 Gills	= 1 Pint (34·659 c. in.)
2 Pints	= 1 Quart (1·134 litre)
2 Quarts	= 1 Pottle
4 Quarts	= 1 Gallon (277·274 c. in.)
2 Gallons	= 1 Peck
4 Pecks (8 Gall.)	= 1 Bushel (1·2837 c. ft.)
1 Bushel	= 1 Strike
4 Bushels	= 1 Coomb
8 Bushels	= 1 Quarter
12 Sacks	= 1 Chaldron
5 Quarters	= 1 Wey or Load (51·347 c. ft.)
10 Quarters	= 1 Last

A wineglass holds about 2 oz., a teacup about 7 oz.

A Simple Method of applying Farmyard Manure and Lime at Specified Rates

The material should be heaped in rows 5 to 10 yards apart, with like distances between the heaps. This arrangement permits of easy and uniform application, and, incidentally, fits in with the system of ridging practised in various parts of the country.

The following combinations are possible:

(1) 10 by 10 — 100 sq. yd. — 50 heaps per acre approx.
(2) 5 by 10 — 50 sq. yd. — 100 heaps per acre approx.
(3) 5 by 5 — 25 sq. yd. — 200 heaps per acre approx.

Lime Dressings

(*a*) 10 by 10 or 50 heaps per acre:

Weight of heap	*Weight per acre*
45 lb.	20 cwt.
56 lb.	25 cwt.
67 lb.	30 cwt.
90 lb.	40 cwt.
112 lb.	50 cwt.

(*b*) 5 by 10 or 100 heaps per acre:

Weight of heap	*Weight per acre*
67 lb.	3 tons
90 lb.	4 tons
112 lb.	5 tons

Applications of Farmyard Manure

5 by 5 or 200 heaps per acre:

Weight of heap	*Weight per acre*
½ cwt.	5 tons
¾ cwt.	7½ tons
1 cwt.	10 tons
1½ cwt.	15 tons
2 cwt.	20 tons

SOME AGRICULTURAL TABLES

The following table shows the number of plants to the acre at distances of 1 to 50 ft. apart, and the area in square feet available for each plant.

Distance apart in feet	*Area for each plant, in sq. ft.*	*No. of plants to the acre*	*Distance apart in feet*	*Area for each plant, in sq. ft.*	*No. of plants to the acre*
1 × 1	1	43,560	15 × 15	225	193
1½ × 1½	2¼	19,360	16 × 16	256	170
2 × 2	4	10,890	17 × 17	289	150
2½ × 2½	6¼	6,970	18 × 18	324	134
3 × 3	9	4,840	19 × 19	361	120
3½ × 3½	12¼	3,556	20 × 20	400	108
4 × 4	16	2,722	22 × 22	484	90
5 × 5	25	1,742	24 × 24	576	75
6 × 6	36	1,210	26 × 26	676	64
7 × 7	49	889	30 × 30	900	48
8 × 8	64	680	32 × 32	1,024	42
9 × 9	81	537	35 × 35	1,225	35
10 × 10	100	435	37 × 37	1,369	32
12 × 12	144	302	40 × 40	1,600	27
13 × 13	169	257	45 × 45	2,025	21
14 × 14	196	222	50 × 50	2,500	18

Gestation Table

Date Bred	Date Due			
Date	*Mare*	*Cow*	*Sow*	*Ewe*
Jan. 1	Dec. 6	Oct. 8	April 22	May 27
Jan. 10	Dec. 15	Oct. 17	May 1	June 5
Jan. 20	Dec. 25	Oct. 27	May 11	June 15
Feb. 1	Jan. 6	Nov. 8	May 23	June 27
Feb. 10	Jan. 15	Nov. 17	June 1	July 6
Feb. 20	Jan. 25	Nov. 27	June 11	July 16
Mar. 1	Feb. 3	Dec. 7	June 21	July 26
Mar. 10	Feb. 12	Dec. 16	June 30	Aug. 4
Mar. 20	Feb. 22	Dec. 26	July 10	Aug. 14
Apr. 1	Mar. 6	Jan. 7	July 22	Aug. 26
Apr. 10	Mar. 15	Jan. 16	July 31	Sept. 4
Apr. 20	Mar. 25	Jan. 26	Aug. 10	Sept. 14
May 1	Apr. 5	Feb. 6	Aug. 21	Sept. 25
May 10	Apr. 14	Feb. 15	Aug. 30	Oct. 4
May 20	Apr. 24	Feb. 25	Sept. 9	Oct. 14
June 1	May 6	Mar. 9	Sept. 21	Oct. 26
June 10	May 15	Mar. 18	Sept. 30	Nov. 4
June 20	May 25	Mar. 28	Oct. 10	Nov. 14
July 1	June 5	Apr. 8	Oct. 21	Nov. 25
July 10	June 14	Apr. 17	Oct. 30	Dec. 4
July 20	June 24	Apr. 27	Nov. 9	Dec. 14
Aug. 1	July 6	May 9	Nov. 21	Dec 26
Aug. 10	July 15	May 18	Nov. 30	Jan. 4
Aug. 20	July 25	May 28	Dec. 10	Jan. 14
Sept. 1	Aug. 6	June 9	Dec. 22	Jan. 26
Sept. 10	Aug. 15	June 18	Dec. 31	Feb. 4
Sept. 20	Aug. 25	June 28	Jan. 10	Feb. 14
Oct. 1	Sept. 5	July 9	Jan. 21	Feb. 25
Oct. 10	Sept. 14	July 18	Jan. 30	Mar. 6
Oct. 20	Sept. 24	July 28	Feb. 9	Mar. 16
Nov. 1	Oct. 5	Aug. 9	Feb. 21	Mar. 28
Nov. 10	Oct. 14	Aug. 18	Mar. 2	Apr. 6
Nov. 20	Oct. 24	Aug. 28	Mar. 12	Apr. 16
Dec. 1	Oct. 14	Aug. 17	Mar. 23	Apr. 27
Dec. 10	Nov. 5	Sept. 8	Apr. 1	May 6
Dec. 20	Nov. 24	Sept. 27	Apr. 11	May 16

Periods of Gestation in Normal Cases

Ass	12½ months, 380 days	
Mare	11 months, 340 days	
Cow	9½ months, 40 to 41 weeks, or 281 to 285 days	
Ewe and Goat	5 months, 20 to 21 weeks, or 140 to 147 days	
Sow	less than 4 months, but over 16 weeks, 112 to 120 days	
Bitch	9 weeks, 63 to 65 days	
Cat	7 to 8 weeks, 50 to 56 days	
Hen	sitting on eggs of the Hen	21 days (19 to 24 days)
Hen	sitting on eggs of the Duck	30 days (28 to 32 days)
Duck	sitting on eggs of the Duck	30 days (28 to 32 days)
Goose	sitting on eggs of the Goose	30 days (28 to 33 days)
Turkey	sitting on eggs of the Turkey	26 days (24 to 30 days)

In the Gestation Table the periods given are 340 days for the Mare; 284 days for the Cow; 152 days for the Ewe; 116 days for the Sow.

Oestrum (Heat) Periods

	Duration of Oestrum	*Return after Parturition*	*Return if not Impregnated*
Mare	5–7 days	7–10 days	2–3 weeks or more
Cow	1 day	21–28 days	3–4 weeks or more
Ewe	1–2 days	4–6 months	17–20 days
Sow	2–4 days	5–6 weeks	20–21 days
Bitch	1–3 weeks	5–6 months	5–6 months

Normal Rectal Temperatures of Farm Animals

Animal	*Temperature* *Average Degrees F.*	*Range Degrees F.*	*Animal*	*Temperature* *Average Degrees F.*	*Range Degrees F.*
Stallion	99·7	99·0–100·6	Goat	103·8	101·7–105·3
Mare	100·0	99·1–100·8	Pig	102·5	101·6–103·6
Beef Cow	101·0	98·0–102·4	Dog	101·5	100·5–102·5
Dairy Cow	101·5	100·4–102·8	Cat	101·5	100·5–102·5
Sheep	102·3	100·9–103·8	Rabbit	103·1	101·5–104·2
			Chicken	107·1	105·0–109·4

APPENDIX B

Ground-Water Supplies by Borehole Wells in Jamaica

Apart from certain dry areas in the plains, the districts which suffer most from scarcity of water are the Tertiary White Limestone areas. The thick White Limestone formation covers more than one-half of the island's surface, and the water-supply problem is most urgent in the hills and plateaux forming the higher ground. Owing to its honeycomb structure, with numerous fissures and cavities, this formation rapidly absorbs all the rainfall.

There is no superficial drainage and the surface is waterless apart from a few ponds which are retained by residual clay in depressions. Most of the water goes underground, and only in lower regions nearer the coast some of this water is discharged from springs and rises. A considerable quantity, however, never reappears at the surface, but makes its way through underground channels to the sea.

It appears that there are only two ways to supply the deficiency of water in these areas, either by direct collection of rain-water by means of catchments and tanks, or by the development of underground sources by wells and boreholes.

Borehole wells for water-supply have been brought into considerable use only since the 1920's. Very few were sunk before that time and the old method of withdrawing underground water was by hand-dug or excavated wells. The so-called Spanish wells, lined with stone masonry, which were sunk as deep as 200 to 300 feet in some cases were so good that some of them are still in use in several parts of the island. Most of them have, however, been abandoned for the more convenient borehole wells.

In 1922, on the recommendation of the late Dr. C. A. Matley,* several borehole wells were sunk in Lower Trelawny for investigating the possibilities of obtaining underground water in White Limestone districts. Some of them, as for instance the 119 feet boring in the interior valley at Duanvale, gave fairly satisfactory results. The others were not successful

* C. A. Matley, Report on the work of the Government Geologist and on the progress of the Geological Survey in Jamaica for economic purposes, Supplement to the *Jamaica Gazette*, Vol. XLVI, No. 9, 4 July 1923, Kingston.

but demonstrated that the hydrological conditions in limestone areas are complicated, and differ greatly in the various districts.

Start of Development

The actual development in the use of borehole wells started in 1928 when it was realized that the plains provided much more favourable conditions for withdrawing underground water by this method. Since then a great number of borings have been sunk in the Liguanea Plains in and around the city of Kingston as well as in the South Clarendon and other plains. As a result there are now about 200 borehole wells in use in the whole island, withdrawing a large amount of water for domestic supplies and irrigation purposes, as well as for supplies for townships, etc.

Three boreholes augment the gravity supply of water for the Kingston city in dry seasons. These are the wells at Montgomery Corner (250 feet deep), Race Course (200 feet) and Long Mountain (70 feet), capable of yielding together nearly six million gallons per day.

Wells of Liguanea

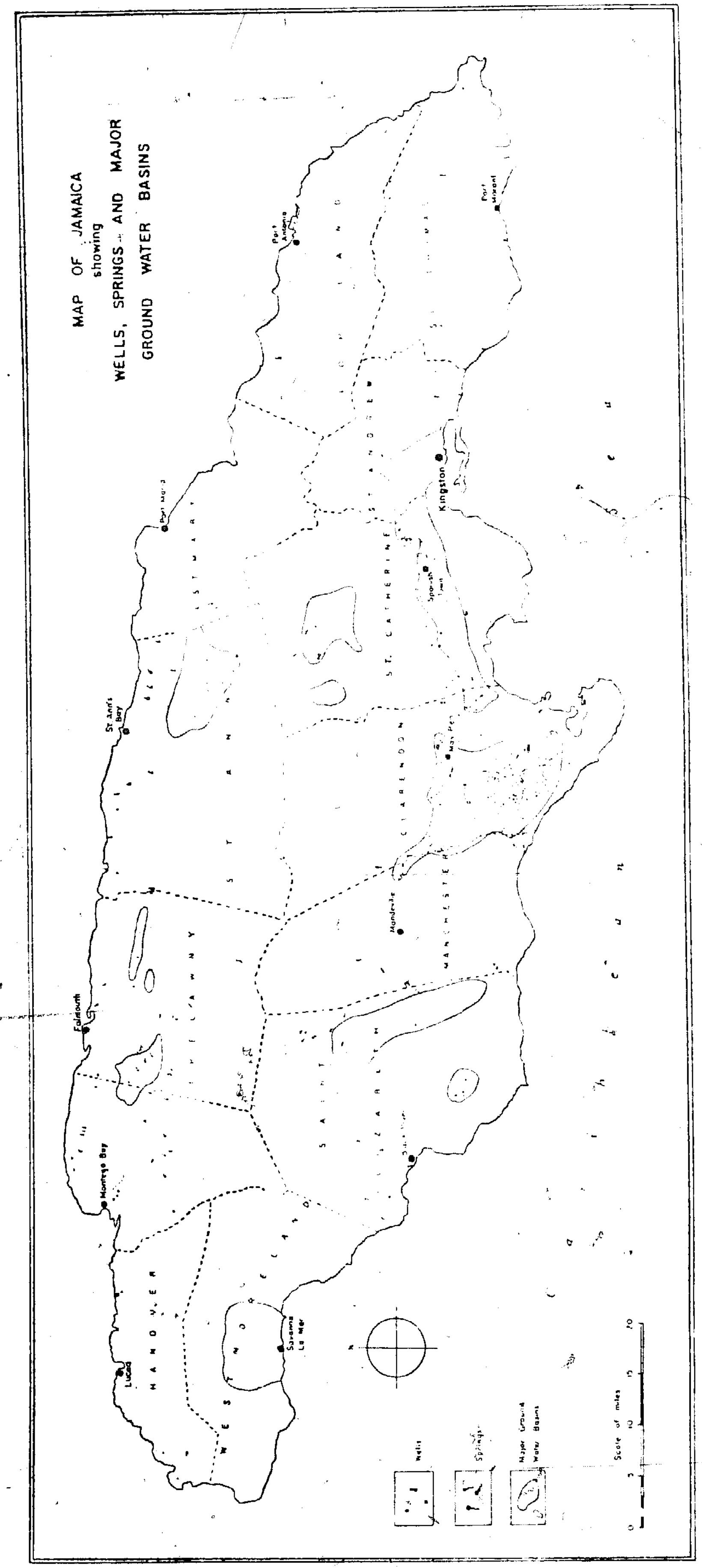
The wells on the Liguanea Plain usually tap water at a depth of a few feet below sea-level in beds of sand and gravel confined below the clay. The water rises to a static level at about 3 to 6 feet above sea-level. Thus, if the ground-level of a place is known it is quite easy to calculate the depth at which the water can be struck. The yield varies in different wells from a minimum of 6,000 to a maximum of 45,000 gallons per hour. In a few borings near the Kingston water-front, real artesian conditions have been encountered, as for instance in the test boring made in the sea off the No. 1 Railway Pier, where a supply of fresh water was struck which rose over 2 feet above the sea in the well casing.* The catchment areas for these water sources are the adjoining White Limestone hills from which a considerable flow of subterranean water feeds the alluvial sandy and clayey sediments in the plain.

Lower Clarendon Conditions

Similar conditions prevail in the plains of Lower Clarendon. In 1929 the West Indies Sugar Co. Ltd. drilled a well on Caswell Hill Estate which, although discouraging in the earlier stages, leading to scepticism in some quarters, finally met with such success that encouragement was given for larger development.

At a depth of 174 feet this well tapped a very large supply which rose from a fissure in the underlying white limestone to a static level of about 16 feet above sea-level. The yield was found to be 1,200 to 1,500 cubic yards per hour and the well is still one of the richest in the island.

* S. Taylor, 'The Underground Water Supply of the Kingston and Spanish Town Areas' in Matley's *Geology and Physiography of the Kingston District, Jamaica*, London, 1951, pp. 114–18.



The other wells in the same area provide a good supply although the yield is not always as high as in the first successful one. There are now about 70 wells in operation in this plain yielding more than 35,000 cubic yards per hour most of which is used for the irrigation of cane-fields. This supply will be further increased by the Mid-Clarendon Irrigation Scheme which is now under construction.

The hydrogeological conditions in this plain are quite well known and provide no difficulties apart from some irregularities in Vere and in places along the Rio Minho where certain old embayments filled with clay sediments have been encountered. In some of the deepest wells an inflow of brackish water has taken place. This is due mainly to the rising of mineral water along fault-lines from beds underlying the White Limestone formation and to a lesser extent to the inflow of sea-water.

Water-level. The water-level usually encountered in the wells of Lower Clarendon stands about 16 to 20 feet above sea-level. Nearer to the limestone hills, however, it is somewhat higher and more fluctuating than further down in the plains.

As has been pointed out by G. M. Stockley* loose sediments overlying the down-faulted White Limestone bed in the Clarendon Plains can be divided into two series, the division being marked by a quite widespread clay bed probably of marine origin. This subdivides two different zones of underground water flow under the plain. The upper zone above the clay obtains its water from rainfall and by seepage from the Rio Minho, while the lower zone is fed by rich water resources from the adjoining White Limestone hills. This lower zone is actually the more important zone and consequently contributes the larger volume of water.

Shallow Depth Supplies

The deltas which form plains at the mouths of the bigger rivers contain good underground water supplies in loose gravel and sand sediments at shallow depths. Thus, for instance, the borehole well at Lloyd's Pen on the Yallahs Delta (ground-level 84 feet) struck quite a good supply at a depth of 70 feet below the surface. A yield of 30,000 gallons per hour was obtained, with a drawdown of 35 feet after 10 hours' pumping. Similar conditions may be expected in other deltas such as that of Morant River, and in the alluvial plains and terraces along the lower reaches of the Plantain Garden River in St. Thomas.

White Limestone Supplies

In contrast to the conditions on the plains, it is much more difficult to obtain borehole well supples in White Limestone areas, especially on higher grounds. Although the rainfall ranges from 40 to 90 inches per

* G. M. Stockley, 'Hydrology of the Plains of Clarendon,' *Jamaica Agric. J.*, September 1924.

annum, most of these areas suffer badly from shortage of water especially in the dry seasons.

The drainage is here mainly underground, the precipitated water disappearing rapidly through the fissures and sinkholes into underground channels and cavities. These are known scientifically as 'Karst' conditions due to the fact that limestone is soluble in rainwater so that large cavities and channels are formed along the fissures and fault-lines. Large sinkholes, cockpits and glades are the typical surface features.

In such districts, where karst conditions are highly developed, it may be difficult or even impossible to obtain good underground supplies, and the only possible method of water supply remains the collection of rainwater by artificial catchment in tanks.

Under certain structural and topographical conditions, it is, however, possible to tap profitably underground water resources in the lower parts of the White Limestone beds. The main factor governing the underground water conditions is the underground topography of the impermeable basal beds formed by clays and shales of the so-called Yellow Limestone formation and by shales of Cretaceous age.

Limestone Terrain Types

From the hydrological point of view two types of limestone terrains can be distinguished in Jamaica: (1) Limestone areas with upfolded or tilted structure of the impervious base, and (2) those with synclinal or down-faulted underground structure.

In the areas of the first type where the impervious base has a comparatively steep gradient, the underground water flow in the conduits of the labyrinthic fissure system is comparatively rapid and there is no available storage of underground water. Complete underground river systems are developed showing many of the features of ordinary surface streams. One can hardly speak of a definite water-table in such areas, as the water-level in different parts of the labyrinthine conduits varies greatly and is subject to considerable fluctuations according to the rainfall. Development of large caves results from those fluctuations. It is evident that such areas are not favourable for the obtaining of ground water supplies by borehole wells, as the result of such a well will be negative unless it happens to strike directly into one of the channels, and even then the yield would be uncertain and variable due to the enormous fluctuations in the flow between the rainy and dry seasons. Unfortunately most of the high limestone hills and plateaux inland belong to this type. The Cockpit Country in the upper parts of St. James and Trelawny and in St. Ann provides a typical example, with its pock-marked topography of large conical sinkholes and elongated deep glades where only occasionally in the bottom of the deepest glades some underground water is available.

The impervious base of this area slopes down towards the north at a gradient of from 1 : 66 to 1 : 32, and complete underground rivers, which can be traced for more than 10 miles, flow down this slope. Especially in the upper part of the Cockpit Country, the underground labyrinthine system of inter-connected conduits acts like a typical canalization system beneath a city. Nevertheless these areas have their practical value in that they represent a large catchment for the lower lying districts with synclinal or downwarped structure.

In the second type of area most of the underground water collects in the lower part of the limestone beds, and large underground reservoirs exist in synclines where water is consequently more accessible. These are storage areas, all the cavities and fissures are filled to a certain level, and the water-table, although subject to certain fluctuations, is more continuous and more constant. The underground flow following the pitch of the downfolds or synclines is usually relatively slow and consequently these are more favourable areas for retaining underground water for supply by borehole wells. The problem is to discover these favourable areas, and the Geological Survey Department has been concentrating on this question in the course of its work. The location of several suitable reservoirs has already been brought to light in the survey of the White Limestone areas of Lower Trelawny (Queen of Spain's Valley) and Lower St. Ann, and promising sites for boreholes wells have been indicated.

Estimating Volume of Water

In order to estimate the volume of water available in the underground reservoirs it is highly desirable to set up an organization for the regular recording of the runoff of rivers and springs and the fluctuations of water-level in existing wells. Apart from the amount of rainfall, which is fairly well known, these factors greatly affect the recharge and discharge of underground reservoirs and this information, as well as estimates of the loss by evaporation and transpiration is necessary to enable a reasonably correct estimation of the potentialities of underground sources to be made. A few examples will be quoted to illustrate the results obtained in recent drilling in White Limestone areas.

In 1945 Jamaica Bauxites Ltd. drilled an exploratory borehole, 1,574 feet deep, located in a depression near Shooter's Hill, about half a mile south of Kendal Railway Station in Manchester. Up to the present this is the deepest borehole drilled in the island, and apart from valuable stratigraphic information, it has furnished much evidence about water conditions in the higher White Limestone regions.

The ground-level was 1,335 feet, and after penetrating 70 feet of bauxite the borehole passed through the total thickness of the White Limestone formation (Lower Miocene to Upper Eocene) the thickness of which was found to be 1,308 feet. From 1,378 to 1,560 feet the Yellow Limestone beds (Middle Eocene) were encountered consisting of soft limestone, shales and clays with tar-sands, some lignitic beds and another limestone series at the base. The lowest beds from 1,560 to 1,574 feet were grey clay, probably of Lower Eocene age. Water was struck in White Limestone at 937 feet below the surface, and again in several deeper horizons as well as in the Yellow Limestone. In December 1945, immediately after the rains, the static level was 665 feet below the surface or 670 feet above sea-level, but it was found that the water-level was subject to considerable fluctuations, falling extraordinarily in the dry season two years later. Owing to the great depth of the water-table and the enormous fluctuations it was not considered economic to convert this into a supply well. Similar conditions prevail elsewhere in high limestone areas, or near the watersheds in limestone.

Owing to these circumstances, the company selected another site, at a much lower elevation in a deep gully, a tributary of Milk River, about a mile west of Porus. Here several boreholes were drilled and an underground flow was struck which it is hoped will meet the needs of the Company, but the water has to be piped a distance of 5 miles, and lifted several hundred feet.

The borehole well drilled by the Public Works Department at Lansquinet in Lower Trelawny, at a ground elevation of 200 feet penetrated 343 feet of chalky White Limestone, tight and rich in flints, and encountered a quite reasonable yield. The static water-level in May 1950 was at 95 feet below the surface, and pumping tests with a maximum yield of 168 gallons per minute caused a drawdown of 126 feet.

In the rainy season, 1951, static water-level was observed to have risen 28 feet, to a depth of 67 feet below the ground. The same or even more favourable conditions can be expected in other interior valleys in Lower Trelawny, as for instance in Queen of Spain's Valley. This valley, close to the base of the large natural catchment area of the Cockpit Country, and separated from the sea-coast by another anticlinal structure, forms a basin in which good underground supplies could certainly be obtained. Several promising sites for borehole wells have already been located, and drilling will start soon.

Similar conditions prevail in north-eastern St. Ann where the syncline between the island's main watershed in Upper St. Ann and the coastal range constitutes a well-defined basin, below which a considerable underground reservoir exists filling the cavities in the lower White Limestone. The natural discharge of the reservoir is towards the east, to the White River, and some overflows towards the north, through the coastal ridge, may also occur. Three borehole wells, recently drilled, obtain a good supply from this reservoir.

The 350 foot borehole well sunk by Reynolds Jamaica Mines, in the depression at Belmont, ground-level 1,100 feet, struck water at 228 feet on 25 July, 1950. On 7 October, the water had risen at 220 feet below ground-level, or 880 feet above sea-level. The second well, by the same Company, about a mile south-west of the first one, at a ground-level of 1,150 feet reached water-level at a depth of 268 feet or 882 feet above the sea. Thus both wells indicate the same static level. The third well, drilled for the Public Works Department by Antonsanti Drilling Company, 1 mile N.N.E. of Moneague, at a ground-level of 1,010 feet, to a total depth of 300 feet struck water at 135 feet and at 275 to 285 feet below ground-level. The water rose to the static level at 111 or 899 feet above the sea. The output of this well is about 14,000 gallons per hour with drawdown of 13 feet.

Water-Table Fluctuations

The fluctuations of the water-table in reservoirs like this range about 20 to 30 feet between normal dry and rainy seasons. In years of exceptionally heavy rains the fluctuations are certainly still more pronounced, and much higher levels may be expected. In this connection the remarkable rise of the temporary ground-water lake in a deep depression in the limestone area east of Moneague should be mentioned. The rise of the lake has been recorded at several periods in the past, following exceptionally heavy rainy seasons and provides an indication of the maximum amount of fluctuation of the water-table in this reservoir. The lake has risen to different heights at different times, according to the rainfall in the catchment area of the syncline, the highest stages having been encountered in 1863–4 and again, more recently, in 1933–4 when the annual rainfall in St. Ann reached 98·15 inches, exceeding the average of 66 inches by nearly 50%. The lake lasted then for nearly three years, sinking gradually in the same way as it had risen. The highest strand-line of the last rise can still be traced on the hill-slopes. It is at 956 feet above sea-level, which in comparison with the present static level in Moneague borehole, indicates a rise of water-level about 60 feet.

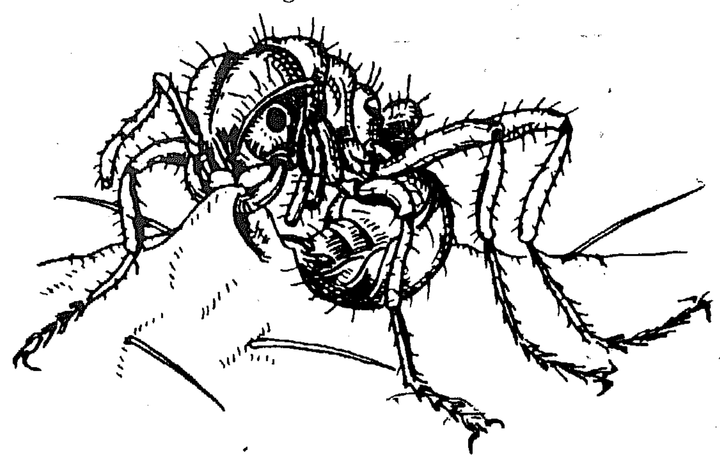
Generally the locating of underground water supplies in limestone districts is a highly technical problem. Some knowledge of the hydrogeological conditions in surrounding areas is essential and it is always necessary to obtain the advice of an experienced hydrogeologist or hydraulic engineer before any boring or any water-supply scheme is attempted. Drilling and construction of deep borehole wells is an expensive business, costing as much as £10 per foot in the deeper wells, and so it is advisable to be as certain as possible that the borehole location is a suitable one before the expense is incurred.

APPENDIX C

Insect Identification

ACKNOWLEDGMENT

Thanks are due to Esso Standard Oil S. A. Ltd. and to their representative in Jamaica, Mr. Nigel Ince, for kind permission to reproduce this article, and also to Hercules Powder Company for use of the insect drawings and illustrations.



Imported Fire Ant

In addition to spiders and nematodes, there are many insects which cause damage to agriculture or to farm animals and it is therefore of interest for the farmer to understand where these enemies are classified in the zoological scale, their common and scientific names, principal biological characteristics and the methods used in their control or extermination.

The progress achieved by chemical science along with the incentive given to technical research by government offices as well as private enterprises, has made it possible to place at the farmer's disposal numerous substances which give effective pest control. Again, studies relative to the biology of insects and other associated parasitic animals have led to the discovery of natural enemies as a means of combating different pests which are difficult to eradicate by chemical means.

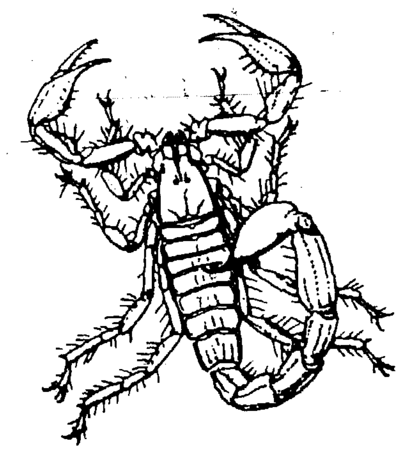
In common idiom insects are referred to as 'bugs', 'grubs', 'vermin', etc., and these are terms which give very little identification to their true classification and nomenclature. The use of these inadequate designations

is generally accompanied by an unrealistic idea about the damage to agriculture caused by insects; such as destruction of crops, loss of produce, poor quality fruit as well as the harm done to certain species of livestock and fowls.

Studies carried out in different countries to determine the amount of loss caused by the ravages of insects reveal extremely high figures. This is why many far-seeing governments have made all resources available to control existing pests and have established quarantine measures to avoid the introduction of new, harmful pests.

Insects cause damage to crops and plants in a variety of ways:

(*a*) Destroying leaves, parts of the stem or stalk, bark, buds or fruits (masticator or chewing insects).
(*b*) Drawing out the sap from plants and trees (sucking insects).



Scorpion

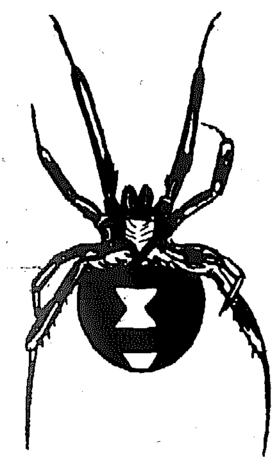
(*c*) Burrowing in the bark, stems or branches (boring insects); in fruits and seeds (worms and weevils); and between leaf surfaces (leaf miners).
(*d*) Causing abnormal development of tissues, forming excresences known as gallnuts.
(*e*) Carrying and introducing into plants disease agents (virus, bacteria, protozoa, fungus).
(*f*) Attacking and destroying roots.

It should be borne in mind that not all insects are harmful, since there are numerous beneficial ones which render valuable assistance to agriculturists as predators or parasites of the harmful species, and in general act as agents in the fertilization of plants. The Smyrna fig, for example, could not be cultivated successfully were it not for the help of the fig wasp (*Blastophaga psenes*) since this plant only has female flowers. For its fertilization it relies on the pollen produced by another variety known as the Capri or wild fig which is transported by the female *Blastophaga* wasp to the female flowers of the cultivated fig which produces the edible fruit.

Other insects like the bee (*Apis millefica*) and the silk worm (*Bombyx mori*) produce useful substances. In this group the lac insect (*Laccifer lacca*) which inhabits the forests of Burma and India can also be included.

In the soil, especially where stable manure has been applied, enormous amounts of insects, earth-worms, nematodes, spiders, arachnidae and other invertebrates develop, and contribute toward increasing the earth's organic matter, thus improving its physical condition.

Insects, spiders and other lower animals, which are of interest to the



Black Widow Spider

agriculturist in one way or another, are so numerous that it is practically impossible to list them completely, that is to say, compilation of a list including all the species to be found in any one agricultural area. A work of this nature would require a great deal of space considering the different climates and countries which would have to be covered. However, the fact remains that there are numerous species having similar habits to which similar control methods can be applied.

In the accompanying glossary a group of insects has been selected, including spiders and nematodes, which may be considered to be of interest since, in many respects, they represent the pests affecting crops in certain regions. Some useful species have also been included in the glossary.

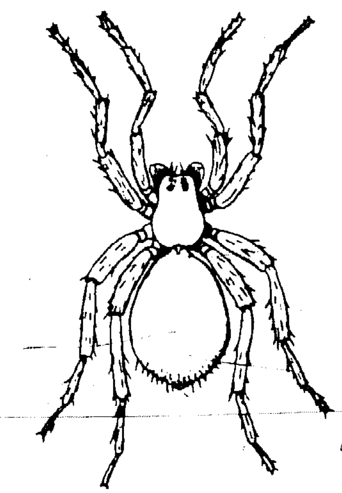
Many of the insects listed constitute serious pests in North America and have been the subject of research for control purposes. In a number of cases tests have been carried out with modern insecticides.

In view of this, it becomes very important that the common and scientific names of these insects be known, so that when the agriculturist or farmer reads information relative to pest control methods, or instructions published by manufacturers of insecticides, he may evaluate the possibilities of applying proper treatment to his crop.

Since the problem of pests in agriculture is so complex, it is recommended that advice be sought from local agricultural technicians, entomologists or agronomists, to avoid unnecessary expenses and possible losses due to insect damage. Insecticide salesmen generally have their own technicians to help the farmer identify pests and advise the most economical and appropriate method of control.

Insects comprise a very important order in the Phylum of *Arthropoda*. The number of species (approximately 700,000) and their economic interest, contribute toward making their study one of the most attractive specialities in the field of natural science.

The adaptation of insects to different ecologic conditions is amply demonstrated by their permanence on the earth's surface, which dates from far distant epochs in the geological history of this planet. No other group of living beings have so maintained themselves, in such numbers and



Spider

with such unchanging character, as insects. Quite surprising changes have been produced in other types of animals and plants and of many groups that were dominant in past geological ages only fossils remain. This really means that they are powerful enemies, difficult to combat, against which ingenious methods of extermination are necessary, derived from a perfect knowledge of their anatomy, physiology, reproduction cycles, feeding systems, enemies and natural barriers, etc.

The body of an adult insect is divided into three parts: the head, thorax and abdomen, each of which is made up from a certain number of segments. Its exterior is hard due to a substance which covers it known as chitin which forms what might be called an outer skeleton.

The eyes are located in the head, and in numerous species, consist of a very complicated structure. The mouths of insects have different modifications, according to the way in which they feed. In other words, whether it is a chewing, sipping, sucking or boring type of insect. The thorax is composed of three segments to each of which is attached a pair of legs. The wings, generally four, in those species that have them, extend from the mesothorax and metathorax. In this regard the characteristics of the veins and nervures are used as important data in their classification. The abdomen is composed of various segments, in the end of one of which the anus and sexual organs are located.

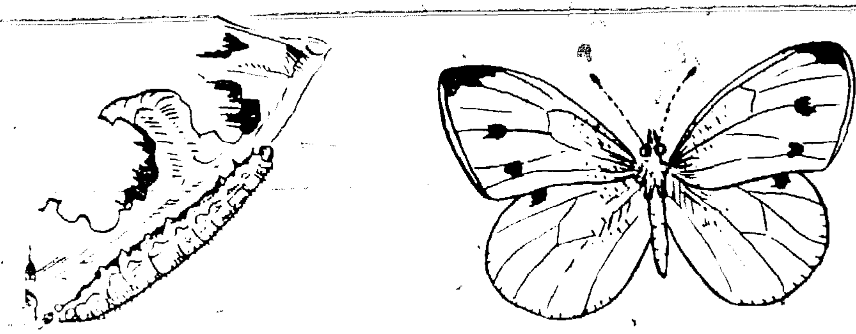
Methods of insect reproduction vary enormously. Apart from the transformation or changes that take place from the egg stage until the insect becomes an adult, the most important thing to be aware of is that each generation produces an ever growing number of individual insects, and that this multiplication is being accomplished at an astounding rate. If there was not in nature what may be called a law of biological equilibrium or balance, insects would soon turn into a very grave menace to mankind and other species of animals and vegetation. However, in limited regions insect populations may decline sharply through lack of food availability. Climatic conditions, types of predatory insects and parasites as well as birds are their principal natural enemies and these tend to retain the insect population within certain limits. The activities of mankind in defending crops is an added controlling influence of those of nature.

It is of interest to have some idea of metamorphosis or transformation, since in such changes, insects present themselves in different forms, and it is easy for the farmer to become confused and imagine they belong to other species. It doesn't always seem logical to think that an ugly caterpillar will transform itself into a beautiful butterfly, attractively coloured, flitting from flower to flower. Notwithstanding this, the truth is that the caterpillar or worm, as it is generally called, is a phase through which the insect is passing, known as the larva or larval stage. The adult stage is a butterfly or moth.

There are insects which do not undergo metamorphosis, but instead the little creature born from the egg continues to grow until reaching adulthood. The *Collembolla*, *Tisanura* and *Anoplura* orders pertain to this group. In other cases transformation is gradual where the insect adopts the form of a pupa or nymph on emergence from the egg and continues its development until reaching the adult stage. The *Orthopterous*, *Hemipterous* and *Homopterous* groups represent gradual transformation. Complete metamorphosis is characterized by the appearance of the larval stage assumed by the insect when born. Afterwards this larva becomes transformed into a *pupa* (the pupal stage), and finally from the pupa the adult emerges. The *Coleoptera*, *Diptera*, *Hymenoptera*, *Lepidoptera* and *Siphonaptera* undergo complete metamorphosis.

The cabbageworm (*Pieris rapae*) serves as a useful example of complete metamorphosis. Eggs are laid by the adult (butterfly) on the leaves of

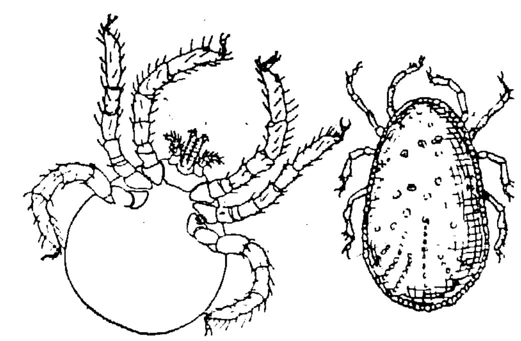
plants that will serve the larva as food (cabbage, turnip, etc.). If the eggs were laid on the leaves of other plants, the larva might die through lack of sustenance, so consequently the butterfly is selective in this regard. As soon as the larvae are born they begin to devour the plant leaves. It is interesting to note that these worms have a similar colour to the leaves upon which they feed, giving them protection from natural enemies like birds. Once the larva has attained complete development it adheres to the underside of



Imported Cabbageworm **Cabbage Butterfly**

the leaf, or other convenient place, where it becomes transformed into a green coloured *pupa*. During this stage it does not eat—the damage to the plant only being inflicted during the larval stage—but it now undergoes great modifications until it reaches the adult stage, emerging as the familiar white cabbage butterfly. Unless these changes are carefully followed, it isn't easy to believe that this butterfly is the same worm which previously caused so much damage to the cabbage.

The acari, or mites and ticks, compose a group of creatures belonging to the *Acarina* order of the *Arachnida* class in the phylum of *Arthropoda*. They



Fowl Tick

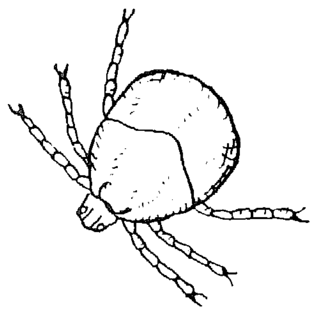
are comprised of numerous species which are harmful to plants and farm animals. Their bodies are short and fat with little indication of regions or segments. In the small or larval stage they have three pairs of legs and as an adult four pairs. Included in this group are ticks as well as scab mites.

Nematodes pertain to the phylum *Nemathelminthes* and are unsegmented, rounded worms. In this particular case the word 'worm' is well applied, though it is incorrect when referring to the larvae of insects.

Notwithstanding this, general custom has justified its use in the vulgar or common names of many insects. As soon as the word 'worm' is mentioned before a farmer, he immediately visualizes an image of the larval stage which is frequently known as 'caterpillar' as well.

Nematodes, which abound in the earth, are considered important agents in the soil's biological activity, although, at the same time, there exist several species which are harmful to crops. They are round worms, thin as threads, which live independently of other biological organisms or as parasites of animals and plants. They are colloquially known as 'eel-worms' or 'angleworms'.

Every species of insect has one or more fixed periods when it makes its appearance. In cold climates this appearance coincides with that of plants.



Cattle Tick

From this it may be deduced that where there is rapid reproduction of plants, the same occurs with insects.

Concluding these general considerations, which have been prepared as an introduction to the glossary of insects, it should be mentioned that the scientific names, established according to taxonomic classification, should always be used in referring to a specific species, since the common or vulgar names are almost always used in very limited regions, and different names may be used to describe the same species.

When the scientific name is written after the common name, it is very easily understood, even when different languages are involved, as it is in Latin and the nomenclature is international. Sometimes changes occur in the scientific names, due to adjustments in classifications, variations in the genus, etc., but at least, the use of these names makes understanding possible, not only among technicians and others who have studied natural science, but also by farmers located in distant regions of the same country or in different countries.

It is very easy to accustom oneself to use scientific names. For instance, in speaking to a North American farmer, and the species *Dialeurodes citri* is mentioned, he would understand that reference is being made to the common citrus whitefly.

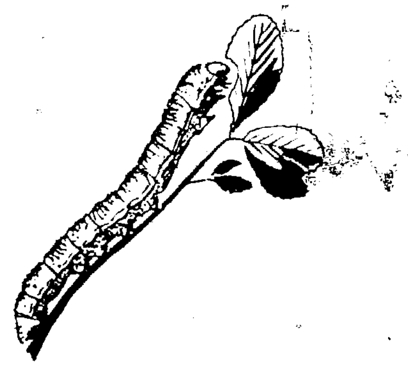
Naturally, it is impossible to remember all the scientific names of importance in farming, but if the habit of using them is acquired, it provides a key which will be of great benefit in reading and interpreting the results of much in relation to pest control, insect customs, their natural enemies and ecologic relationship, etc.

INSECT GLOSSARY

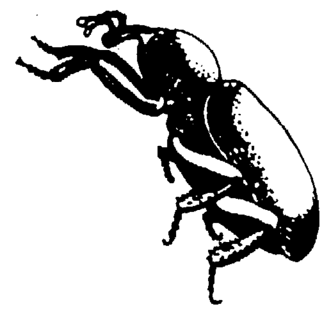
The common and scientific names of some hundreds of insects, mites and nematodes of commercial or economic importance are presented alphabetically. In each case the technical or scientific name is printed in italics followed by the names of the plants or animals they attack. Under each illustration appears the common name and the normal length of the insect, except in the case of moths and butterflies where the measurement indicates wing span.

ABBOT'S BAG WORM, *Oiketicus kirbyi*. Forest trees, fruit trees, plum trees.

ALFALFA CATERPILLAR, *Colias philodice eurytheme*. Alfalfa, clover, leguminous plants.



Alfalfa Caterpillar



Alfalfa Weevil

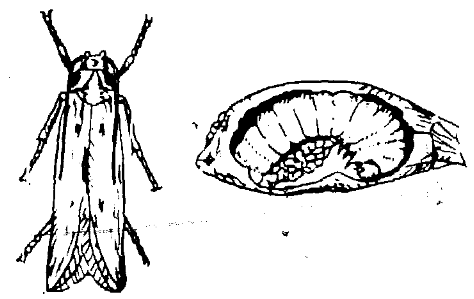
ALFALFA WEEVIL, *Hypera postica*. Alfalfa, clover.

ALMOND MITE, *Bryobia praetiosa*. Apple trees, pear trees, cherry trees.

AMAZONA FLY, *Metagonistylum minense*. Parasite of the sugar cane borer.

AMERICAN GRASSHOPPER, *Schistocerca americana*. Gramineous plants, legumes, fruit trees, etc.

ANGOUMOIS GRAIN MOTH, *Sitotroga cerealella*. Stored grain.



Angoumois Grain Moth

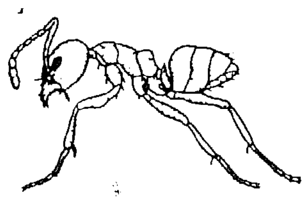
Apple Leaf Aphid, *Aphis pomi*. Apple, pear and medlar trees, etc.

Apple Leafhopper, *Empoasca fabae*. Apple trees (nursery).

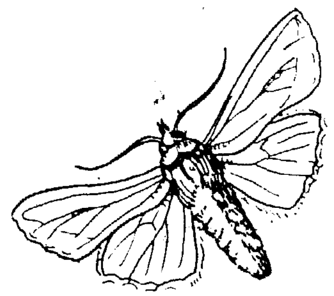
Apple Maggot, *Rhagoletis pomonella*. Penetrates apples, pears, quince, nuts, etc.

Apple Red Bug, *Lygidea mendax*. Apple and pear trees.

Argentine Ant, *Iridomyrmex humilis*. Various crops. Transports aphid. House pests.



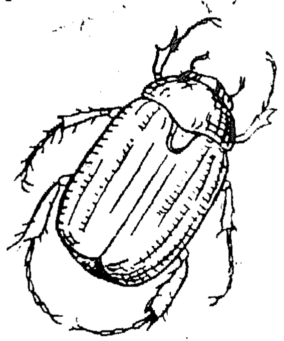
Argentine Ant



Army Worm

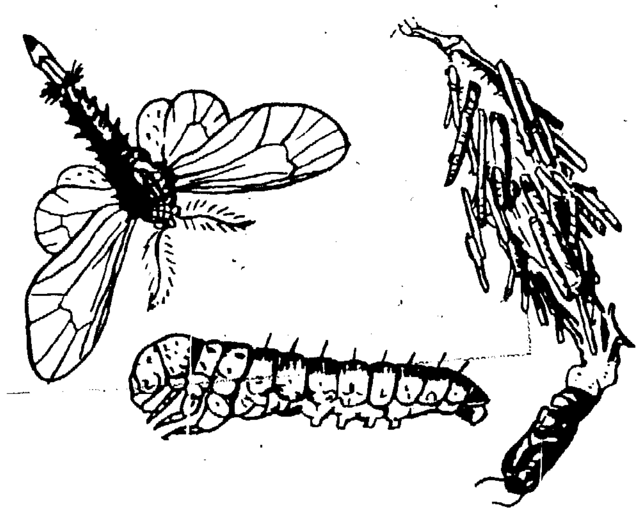
Army Worm, *Cirphis unipuncta*. Sorghum corn, gramineous plants, pastures.

Asiatic Garden Beetle, *Autoserica castanea*. Vegetables, ornamental plants, peach and cherry trees, etc.



Asiatic Garden Beetle

Asparagus Beetle



Bagworm

Asparagus Beetle, *Crioceris asparagi*. Shoots, hearts and leaves of asparagus plants.

Aster Leafhopper, *Macrosteles divisus*. Aster and other plants.

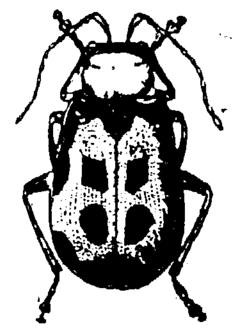
Australian Wheat Weevil, *Rhyzopertha dominica*. Dry grain, seeds and roots. Stored cereals.

Bag Worm, *Nygmia phaeorrohoea*. Apple, pear, plum and other trees.

Bag Worm, *Thyridopteris ephemeraeformis*. Adheres to the leaves of the host plant. Attacks sandarach and juniper trees.

Bean Aphid, *Aphis fabae*. Beans, lima beans, beets, etc.

Bean Leaf Beetle, *Cerotoma trifurcata*. Leguminous plants, beans, peas, soybeans, corn.



Bean Leaf Beetle

Bean Weevil

Bean Leaf Folder, *Urbanus proteus*. Legumes and plants of the mustard family.

Bean Leaf Roller, *Urbanus proteus*. Legumes and plants of the mustard family.

Bean Thrips, *Hercothrips fasciatus*. Beans, peas, alfalfa, peanuts, citrus, apricot and peach trees.

Bean Weevil, *Acanthoscelides obtectus*. Lima beans, cowpeas (in the fields); beans, peas and lentils in storage.

Beet Leafhopper, *Circulifer tenellus*. Beets, beans, tomatoes, cantaloupes, ornamental plants, etc.

Black Blow Fly, *Phormia regina*. Sheep.

Black Cutting Worm, *Agrotis ypsilon*. Potatoes, peppers, beets, squash, etc.

Black Horse Fly, *Tabanus astratus*. Horses.

Black-Legged Tortoise Beetle, *Jonthonota nigripes*. Sweet potatoes and other convolvulaceous plants.

Black Scale, *Saissetia oleae*. Olive, citrus, fig and coffee trees; cotton and ornamental plants.

Black Sugarcane Weevil, *Anacentrinus saccharidis*. Burrows into sugar cane, affecting lower shoots and impeding new sprouts.

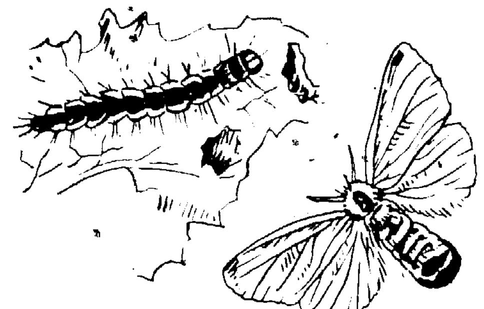
Bluebug, *Argas persicus*. Domestic fowl.

BOLL WEEVIL, *Anthonomas grandis*. Burrows into cotton, flower buds and bolls.

BOT FLY, *Gasterophilus intestinalis*. Equines.

BOXWOOD LEAF MINER, *Monarthropalpus buxi*. Boxwood, ornamental plants.

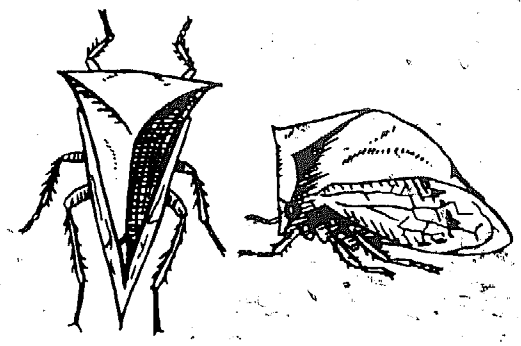
Boll Weevil



Brown-Tail Moth

BROWN TAIL MOTH, *Nygmia phaeorrhoea*. Apple, pear, cherry and other trees.

BUFFALO TREE HOPPER, *Ceresa bubalus*. Apple, pear, peach, quince and cherry trees; corn, leguminous and gramineous plants (larva).



Buffalo Treehopper

Cabbage Looper

BULB MITE, *Rhizoglyphus echinopus*. Plant bulbs.

BULB NEMATODE, *Dytylenchus dipsaci*. Greenhouse plants (stems and bulbs); wheat.

CABBAGE APHID, *Brevicoryne brassicae*. Cabbage, cauliflower, turnip.

CABBAGE BUTTERFLY, *Pieris rapae*. Cabbage, cauliflower, radishes, lettuce and plants of the mustard family.

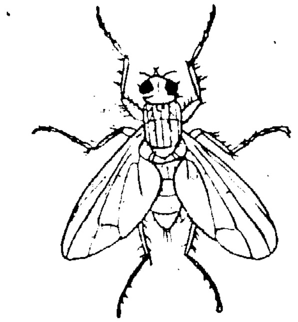
CABBAGE LOOPER, *Trichoplusia ni*. Cabbage, lettuce, spinach, celery, peas, beets, tomatoes.

CABBAGE MAGGOT, *Hylemia brassicae*. Cabbage, cauliflower, broccoli, radishes, peas, celery, plants of the mustard family.

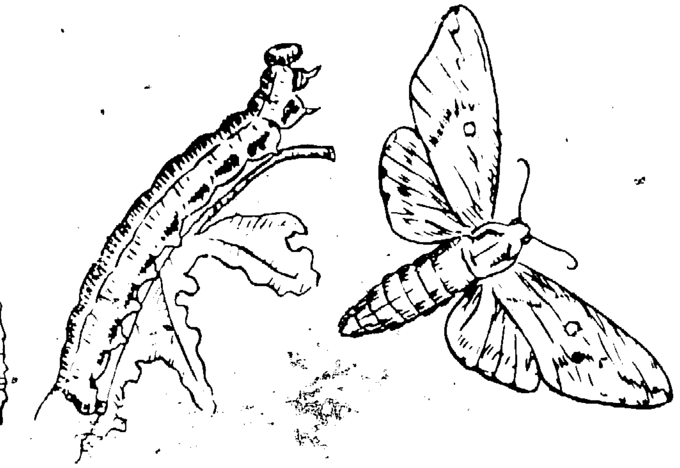
CABBAGE MAGGOT, *Pieris rapae*. Cabbage, lettuce, spinach, celery, peas, beets, tomatoes.

CABBAGE WEBWORM, *Hylemia brassicae*. Cabbage, cauliflower, broccoli, radishes, peas, celery, plants of the mustard family.

CACAO THRIPS, *Selenothrips rubrocinctus*. Cacao.



Cabbage Maggot



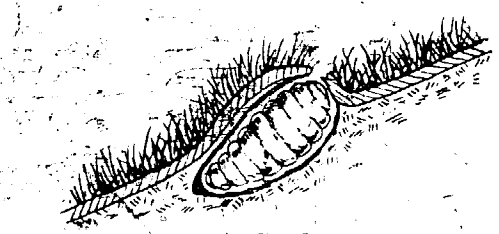
Catalpa Sphinx

CALIFORNIA OAK WORM, *Datana integerrima*. Oak leaves.

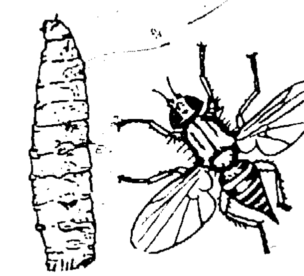
CALIFORNIA RED SCALE, *Aonidiella aurantii*. Citrus, white mulberry, figs, grapevine, etc.

CATALPA SPHINX, *Ceratomia catalpae*. Catalpa and ornamental plants.

CATTLE GRUB, *Hypoderma lineatum*. Cattle.



Cattle Grub



Cherry Fruit Fly

CATTLE TICK, *Boophilus annalatus*. Attacks cattle and transmits diseases such as piroplasmosis.

CELERY LEAF TIER, *Phlyctaenia rubigalis*. Greenhouse plants, celery, spinach, beans, beets, etc.

CHANGA, *Gryllotalpa hexadactyla*. Roots of several plants, tobacco, potatoes, etc.

CHERRY FRUIT FLY, *Rhagoletis cingulata*. Chery, pear, plum trees.

CHRYSANTHEMUM APHID, *Macrosiphoniella sanborni*. Chrysanthemum.

CHRYSANTHEMUM GALL MIDGE, *Diarthronomyia hipogaea*. Ornamental plants.

CHRYSANTHEMUM MIDGE, *Diarthronomyia hipogaea*. Ornamental plants.

CIGARETTE BEETLE, *Lasioderma serricorne*. Stored tobacco.

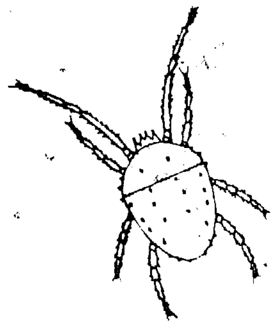
CITRUS BLACK FLY, *Aleurocanthus woglumi*. Citrus, other fruit trees.

CITRUS BUD MITE, *Aceria sheldoni*. Citrus, especially the lemon tree.

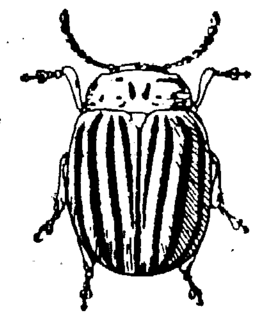
CITRUS WOOLLY WHITE FLY, *Aleurothrixus floccosus*. Citrus leaves and other plants.

CLOVER LEAF HOPPER, *Aceratagallia sanguinolenta*. Leguminous plants; clover.

CLOVER MITE, *Bryobia praetiosa*. Apple, pear and cherry trees.



Clover Mite



Colorado Potato Beetle

CODLING MOTH, *Carpocapsa pomonella*. Apple, pear, quince, walnut trees.

COFFEE BEAN WEEVIL, *Araecerus fasciculatus*. Dry grains, seeds and roots. Stored cereals.

COFFEE LEAF MINER, *Leucoptera coffeella*. Coffee leaves.

COLORADO POTATO BEETLE, *Leptinotarsa decemlineata*. Potato, tomato, egg-plant, tobacco, pepper.

COMMON CATTLE GRUB, *Hypoderma lineatum*. Cattle.

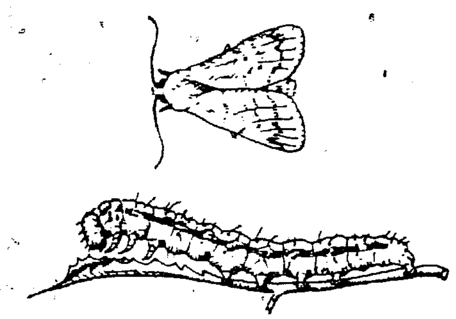
COMMON CITRUS WHITEFLY, *Dialeurodes citri*. Citrus plants.

COMSTOCK MEALY BUG, *Pseudococcus comstocki*. Grapevines, citrus, ornamental plants, cotton.

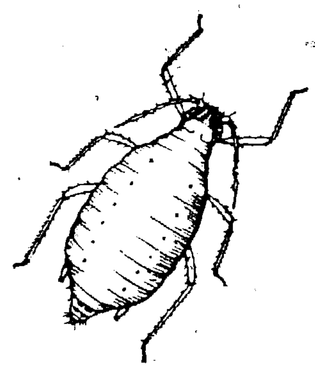
CORN EAR MAGGOT, *Carpolonchaea pendula*. Pepper, tomato, corn, yucca.

CORN EARWORM, *Heliothis armigera*. Corn (stem and tassel); cotton (bud); sunflower (seeds); flax, tomato, chickpea (pod).

CORN FLEA BEETLE, *Chaetocnema pulicaria*. Burrows into corn and transmits Stewart disease.



Corn Earworm

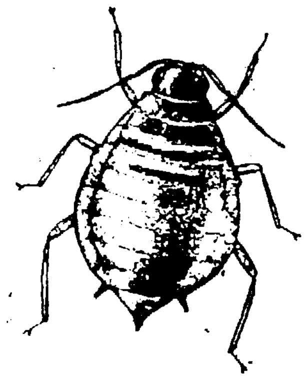


Corn Leaf Aphid

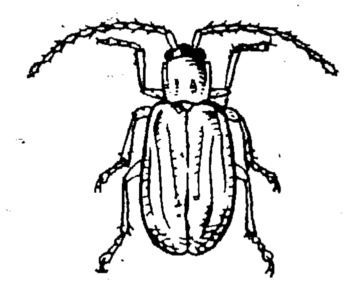
CORN LEAF APHID, *Aphis maidis*. Corn, sorghum, gramineous plants.

CORN ROOT APHID, *Anuraphis maidi radicis*. Corn, cotton.

CORN ROOT WEBWORM, *Crambus caliginosellus*. Tobacco, corn.



Corn Root Aphid



Corn Rootworm

CORN ROOTWORM, *Diabrotica longicornis*. Destroys young corn roots and burrows into the old ones. Transmits bacterial wilt.

CORN WIRE WORM, *Horistonotus uhlerii*. Corn and cotton roots.

COTTON APHID, *Aphis gossipii*. Cotton, citrus, grapevine, leguminous and cucurbitaceous plants.

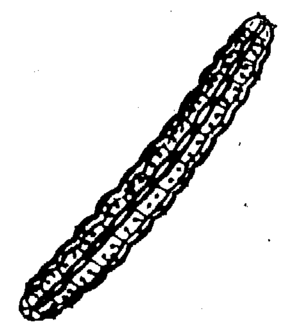
COFFEE BEAN WEEVIL, *Stephanoderes hampei*. Coffee beans.

COTTON BOLL-WORM, *Heliothis armigera*. Corn (stem and tassel); cotton (bud); sunflower (seeds); flax, tomato, chickpea (pod).

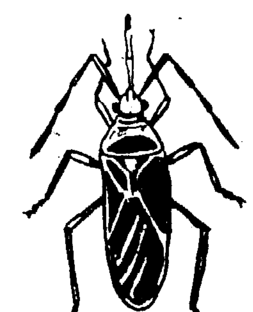
COTTON CUTWORM, *Prodenia ornithogallis*. Cotton and other plants.

COTTON FLEAHOPPER, *Psallus seriatus*. Cotton, malvaceous plants.

COTTON LEAF WORM, *Alabama argillacea*. Cotton leaves. Ripe fruits.



Cotton Leafworm



Cotton Stainer

COTTON SQUARE BORER, *Strymon melinus*. Cotton.

COTTON STAINER, *Dysdercus ruficollis*. Cotton, malvaceous and solanaceous plants.

COTTON WIRE WORM, *Horistonotus uhlerii*. Corn and cotton roots.

COTTONY-CUSHION SCALE, *Icerya purchasi*. Citrus, walnut, rose bushes and ornamental trees.

CROWN GIRDLER, *Brachyrhinus ovatus*. Strawberry and other berries; green-house plants.

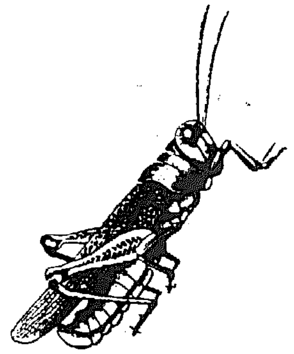
CUBAN FLY, *Lixophaga diatraeae*. Parasite of the sugar cane borer

Cyclamen Mite, *Tarsonemus pallidus*. Greenhouse plants of the primrose family.

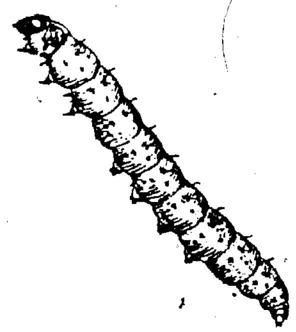
Diamond-Back Moth, *Plutella maculipennis*. Cabbage, ornamental and greenhouse plants. Cruciferous.

Dictyospermum Scale, *Chrysomphalus dictyospermi*. Citrus, olive, cycad, laurel.

Differential Grasshopper, *Melanoplus differentialis*. Corn, other crops.



Differential Grasshopper

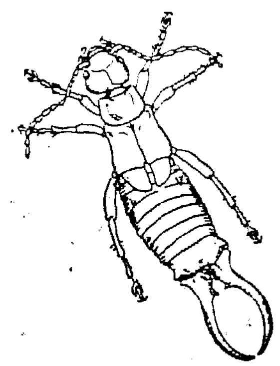


European Corn Borer

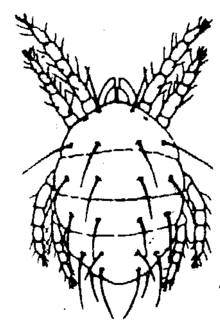
Dried Fruit Beetle, *Carpophilus hemipterus*. Dried fruits; fruits being fermented; partially dry figs, dates and raisins.

European Corn Borer, *Pyrausta nubilalis*. Corn, herbaceous plants in general.

European Earwig, *Forficula auricularia*. Fruits, cereals and legumes.



European Earwig



European Red Mite

European Red Mite, *Paratetranychus pilosus*. Citrus, cotton, fruit trees and ornamental plants.

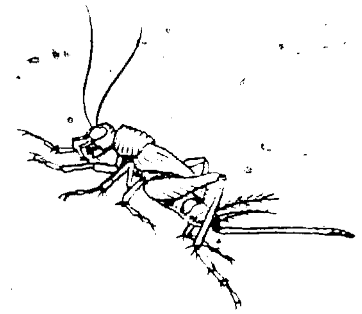
Eastern Tent Caterpillar, *Malacosoma americana*. Apple, peach, plum and cherry trees.

Fall Army Worm, *Laphygma frugiperda*. Potato, tomato, pepper, cotton, sugar cane, corn, legumes, etc.

Field Cricket, *Acheta assimilis*. Potato, tomato, tobacco, cotton, grass, alfalfa, cereals, legumes, etc.

Fig Thrips, *Graphidothrips stuardoi*. Fig tree.

Fig Wasp, *Blastophaga psenes*. Expedites pollinization of smyrna figs.



Field Cricket

Flower Thrips

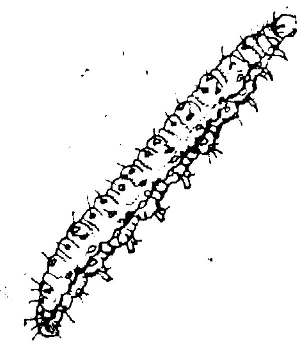
Fire Ant, *Solenopsis geminata*. Legumes, other plants, poultry.

Flat Grain Beetle, *Laemophloeus pusillus*. Grains.

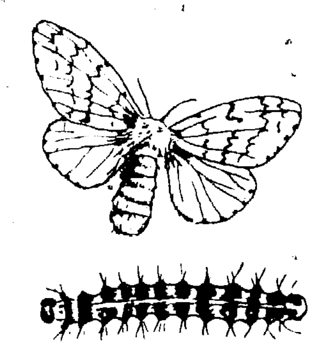
Flower Thrips, *Frankliniella tritici*. Flowers. Grapevine.

Fowl Tick, *Argas persicus*. Poultry.

Garden Centipede, *Scutigerella immaculata*. Garden plants. Legumes.



Garden Webworm



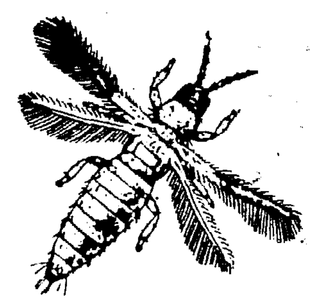
Gipsy Moth

Garden Root-Knot Nematode, *Heterodera marioni*. Greenhouse plants, tomato, pepper, potato, cotton, coffee, grapevine.

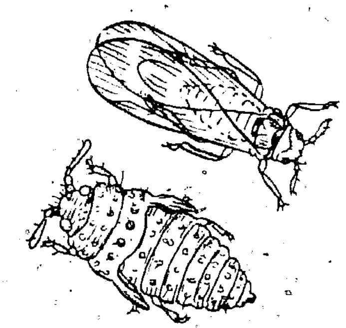
Garden Webworm, *Loxostege similalis*. Alfalfa, clover, beans, soya, cowpea, beets, etc.

Gipsy Moth, *Porthetria dispar*. Various trees.

Gladiolus Thrips, *Taeniothrips simplex*. Gladiolus.



Gladiolus Thrips



Grape Phylloxera

GRANARY WEEVIL, *Sitophilus granarius*. Cereals, grains in general. Flour, alimentary pastes, dried fruits.

GRAPE LEAF BLISTER MITE, *Eriophyes vitis*. Grapevine leaves.

GRAPE PHYLLOXERA, *Phylloxera vitafoliae*. Grapevine.

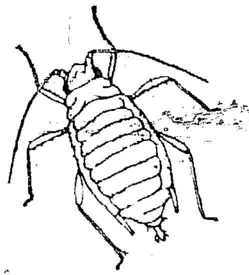
GRAPE ROOT WORM, *Fidia viticida*. Grapevine.

GREASY CUTWORM, *Agrotis ypsilon*. Potato, pepper, beets, pumpkin, etc.

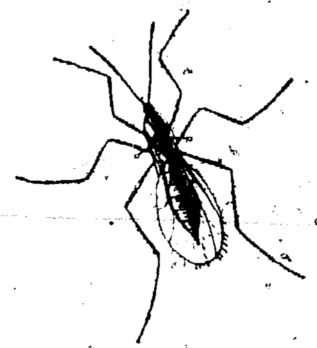
GREEN APHID, *Toxoptera graminum*. Cereals (wheat, oats, rye, barley, etc.); sorghum, gramineous, etc.

GREEN APPLE APHID, *Aphis pomi*. Apple, pear, medlar trees, etc.

GREEN BUG, *Nezara viridula*. Ornamental plants; legumes.



Greenbug

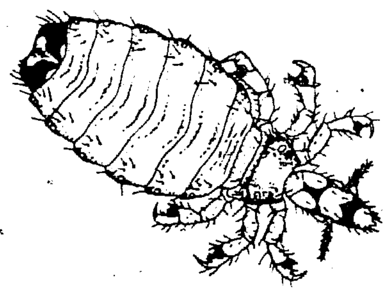


Hessian Fly

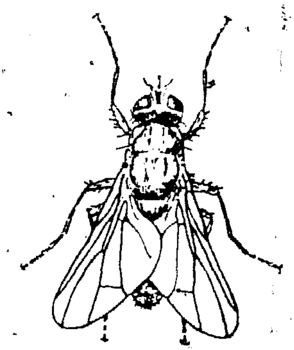
GREEN BUG, *Toxoptera graminum*. Cereals (wheat, oats, rye, barley); sorghum, gramineous plants, etc.

HARDBACK ROOT BEETLE, *Strategus anachoreta*. Sugar cane and other plants.

HEMISPHERICAL SCALE, *Saissetia hemisphaerica*. Citrus, olives, medlar, coffee, ornamental plants, begonia, fern, etc.



Hog Louse



Horn Fly

HORN FLY, *Siphona irritans*. Cattle.

HORSE BOT FLY, *Gasterophilus intestinalis*. Equines.

HESSIAN FLY, *Phytophaga destructor*. Wheat, rye, barley. Larvae live and feed on the leaves until annihilation.

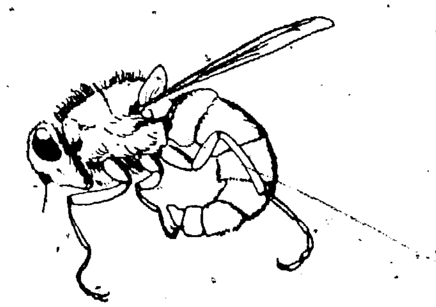
HOG LOUSE, *Haematopinus adventicius*. Swine.

IMPORTED CABBAGEWORM, *Pieris rapae*. Cabbage, cauliflower, radishes, lettuce and plants of the mustard family.

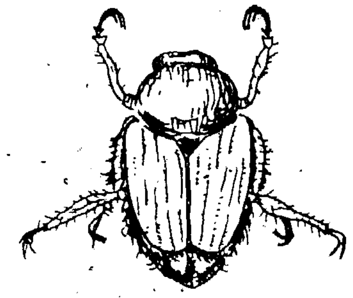
IMPORTED FIRE ANT, *Solenopsis saevissima*. Quail, especially the young.

JAPANESE BEETLE, *Popillia japonica*. Shade and fruit trees, corn, soybean, garden and nursery plants, legumes, grass.

KED, *Melophagus ovinus*. Sheep.



Horse Bot Fly



Japanese Beetle

LEAF AND BUD NEMATODE, *Aphelenchoides fragariae*. Greenhouse plants (leaves and shoots); strawberry.

LEAF-CUTTING ANT, *Atta insularis*. Crops in general.

LEAF-FOOTED BUG, *Leptoglossus zonatus*. Tomato, potato, pepper, cucurbitaceous plants, etc.

LESSER CORNSTALK BORER, *Elasmopalpus lignosellus*. Corn and sugar cane. Peanuts, beans, peas, cowpeas, forage.

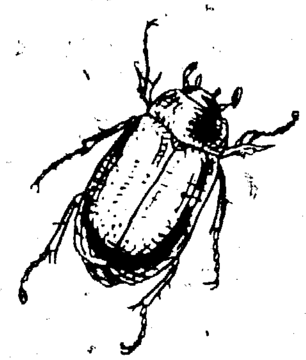
LESSER GRAIN BORER, *Rhyzopertha dominica*. Dry grain, seeds and roots. Stored cereals.

LIMA BEAN POD BORER, *Etiella zinckenella*. Lima beans, peas, beans (green pods).

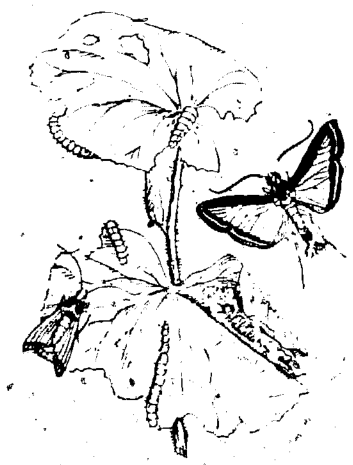
LONG-HEADED FLOUR BEETLE, *Latheticus oryzae*. Wheat, flour, other grains in storage.

LOUSE FLY, *Melophagus ovinus*. Sheep.

MAY BEETLE, *Melolontha vulgaris*. Legumes, various trees and crops.



May Beetle

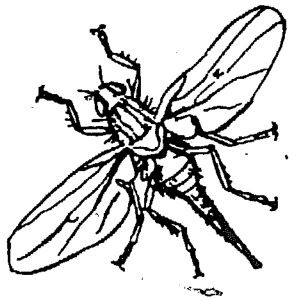


Melonworm

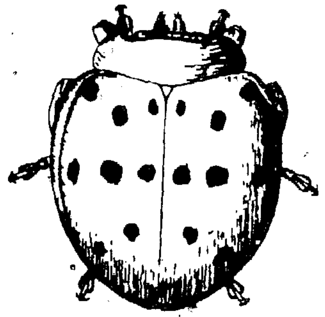
MELON FLY, *Dacus cucurbitae*. Cucurbitaceous plants.

MELON WORM, *Diaphania hyalinata*. Water melon, cucurbitaceous plants, squash.

MEXICAN FRUIT FLY, *Anastrepha ludens*. Various fruits.



Mexican Fruit Fly

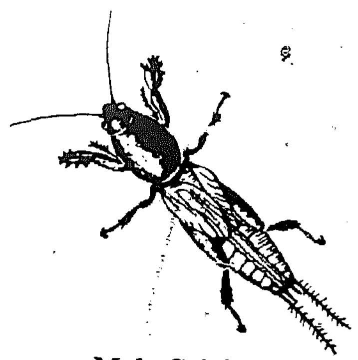


Mexican Bean Beetle

MEXICAN BEAN BEETLE, *Epilachna varivestis*. Leguminous and cucurbitaceous plants.

MINOR CABBAGEWORM, *Plutella maculipennis*. Cabbage, ornamental and greenhouse plants; cruciferous plants.

MOLE CRICKET, *Gryllotalpa hexadactyla*. Roots of several plants, tobacco, potato, etc.



Mole Cricket

MOUND-BUILDING ANT, *Atta insularis*. Crops in general.

NEW GUINEA SUGAR CANE WEEVIL, *Rhabdoscelus obscurus*. Sugar cane.

NORTHERN CATTLE GRUB, *Hypoderma lineatum*. Cattle.

NOSE BOT FLY, *Gasterophilus haemorrhoidalis*. Equines.

NOSE FLY, *Gasterophilus haemorrhoidalis*. Equines.

OLEANDER SCALE, *Aspidiotus hederae*. Olive, laurel, citrus, avocado, grapevine, etc.

ONION MAGGOT, *Hylemia antiqua*. Onion, beans. Squash, stems and base.

ORIENTAL FRUIT MOTH, *Grapholita molesta*. Peach, apple, pear, apricot, quince and cherry trees.

OX-WARBLE-FLIES, *Hypoderma lineatum*. Cattle.

PALM SCALE, *Chrysomphalus dictyospermi*. Citrus, olive, laurel, cycad.

PALM WEEVIL, *Rhynchophorus palmarum*. Palm and coconut trees.

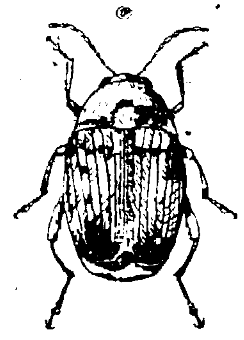
PAPAW LEAFHOPPER, *Empoasca papayae*. Papaw leafscale.

PARASOL ANT, *Atta sexdens*. Crops in general.

PEA APHID, *Macrosiphum pisi*. Peas and leguminous plants.

PEA LACE BUG, *Gargaphia torresi*. Beans (pod); lima beans, cotton, fruit trees, malvaceous and garden plants.

PEA WEEVIL, *Bruchus pisorum*. Peas and chickpeas in the fields and in storage.



Pea Weevil

Pear Psylla

PEPPER WEEVIL, *Anthonomus eugenii*. Pepper, tomato, eggplant.

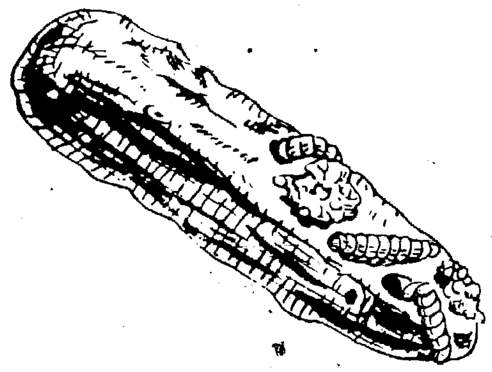
PEAR LEAF BLISTER MITE, *Eriophyes pyri*. Pear and apple leaves.

PEAR PSYLLA, *Psylla pyricola*. Pear tree.

PEAR THRIPS, *Taeniothrips inconsequens*. Pear tree.

PERUVIAN BOLLWEEVIL, *Anthonomus vestitus*. Cotton, malvaceous plants.

PICKLE WORM, *Diaphania nitidalis*. Cucurbitaceous plants (stems and fruits).



Pickle Worm

Pink Boll Worm

PINK BOLL WORM, *Pectinophora gossypiella*. Cotton borer.

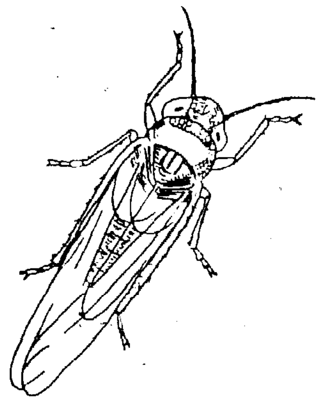
PINK SUGAR CANE MEALYBUG, *Pseudococcus sacchari*. Sugar cane.

PLUM CURCULIO, *Conotrachelus nenuphar*. Plum, cherry, apple, peach trees, etc.

POTATO APHID, *Macrosiphum solanifolii*. Potato, pepper, tomato, eggplant, citrus, etc.

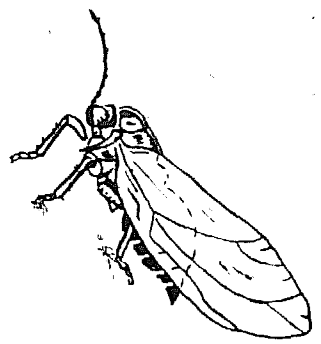
POTATO LEAF HOPPER, *Empoasca fabae*. Apple trees (nursery).

Plum Curculio

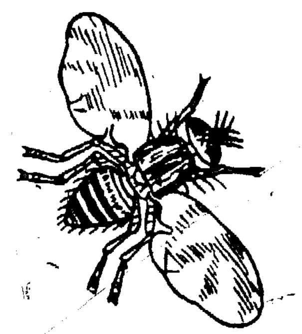


Potato Leafhopper

Potato Psyllid, *Paratrioza cockerelii*. Potato.
Praying Mantis, *Mantis religiosa*. Eats other insects.
Railroad-Worm, *Rhagoletis pomonella*. Enters apples, pears, quince, nuts, etc.

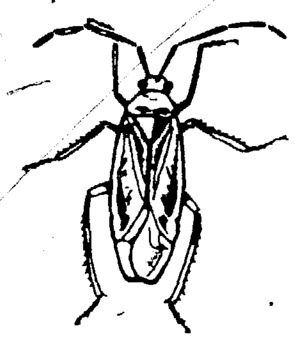


Potato Psyllid

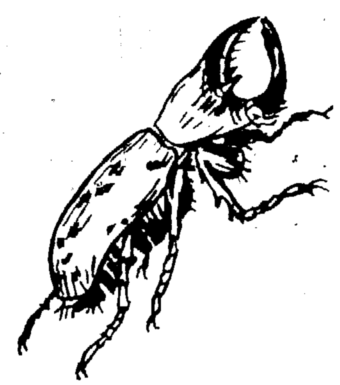


Railroad Worm

Rapid Plant Bug, *Adelphocoris rapidus*. Cotton.
Raspberry Fruit Worm, *Byturus rubi*. Leaves and shoots of cranberry. Deposits eggs on the tender fruits.



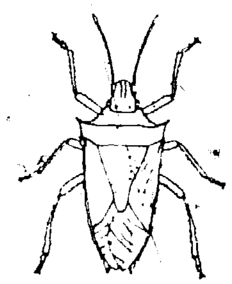
Rapid Plant Bug



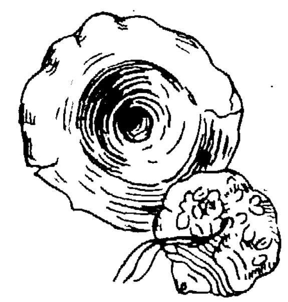
Rhinoceros Beetle

Red-Legged Grasshopper, *Melanoplus femur-rubrum propinquus*. Corn, oats, barley, rye, sugar cane, etc.

Red Tailed Bot Fly, *Gasterophilus haemorrhoidalis*. Equines.
Rhinoceros Beetle, *Strategus anachoreta*. Sugar cane and other plants.
Rice Stink Bug, *Solubea pugnax*. Rice and gramineous plants.



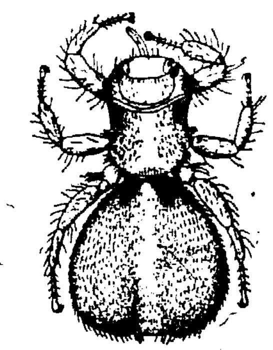
Rice Stink Bug



San Jose Scale

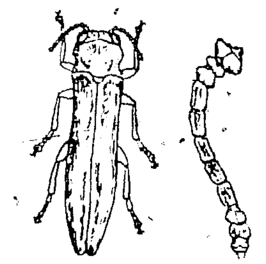
Rice Weevil, *Sitophilus oryzae*. Stored grains, flour, pastes.
Rose Chafer, *Macrodactlyus subspinosus*. Rose bushes, grapevines, etc.
Rose Scale, *Aulacaspis rosae*. Rose bushes, pear, ailanthus, cycad, etc.
Rosy Apple Aphid, *Anuraphis roseus*. Apple and pear trees.
Rotten Cane Stalk Borer, *Metamasius hemipterus*. Cane and banana fields; old plantings.
San Jose Scale, *Aspidiotus perniciosus*. Apple, pear, peach, cherry, plum and various trees and bushes.
Saw-Toothed Grain Beetle, *Oryzaephilus surinamensis*. Dried fruits, grains and food produce.
Screw Worm, *Callitroga americana*. Produces screw worms in wounds.
Screw-Worm Fly, *Callitroga macellaria*. Produces screw worms in animals.

Screw-worm Fly

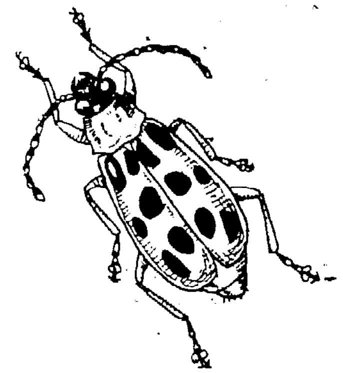


Sheep Tick

Sheep Scab Mite, *Psoroptes equi, var. ovis*. Sheep and occasionally equine.
Sheep Tick, *Melophagus ovinus*. Sheep.
Sinuate Peach Tree Borer, *Sanninoidea exitiosa*. Peach and pear trees.
Sinuate Pear Tree Borer, *Agrilus sinuatus*. Pear, hawthorn, and various trees.
Small Sugarcane Weevil, *Anacentrinus insularis*. Sugar cane stock.
Soft Brown Scale, *Coccus hesperidum*. Citrus, laurel, begonia, fern.
Soft Scale, *Coccus hesperidum*. Citrus, laurel, begonia, fern.



Sinuate Pear Tree Borer



Spotted Cucumber Beetle

SOUTH AMERICAN MIGRATORY LOCUST, *Schistocerca paranensis*. Various crops.

SOUTHERN ARMYWORM, *Prodenia eridania*. Potato, tomato, legumes.

SOUTHERN CORN ROOTWORM, *Diabrotica undecimpunctata howardii*. Corn, gramineous and cucurbitaceous plants, herbaceous as cucumber, etc.

SOUTHERN GREEN STINK BUG, *Nezara viridula*. Ornamental plants, legumes.

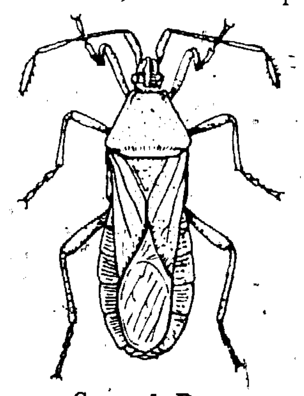
SOUTHERN RED-LEGGED GRASSHOPPER, *Melanoplus femur-rubrum propinquus*. Corn, oats, barley, peanuts, sugar cane.

SPOTTED ASPARAGUS BEETLE, *Crioceris duodecimpunctata*. Asparagus.

SPOTTED CUCUMBER BEETLE, *Diabrotica undecimpunctata howardii*. Corn, gramineous and cucurbitaceous plants, herbaceous as cucumber, etc.

SPRUCE BUD WORM, *Choristoneura fumiferana*. Fir tree, larch and spruce trees.

Spruce Budworm



Squash Bug

SQUASH BEETLE, *Epilachna borealis*. Cucurbitaceous plants.

SQUASH BUG, *Anasa tristis*. Squash, cucurbitaceous plants.

STABLE FLY, *Stomoxys calcitrans*. Bites both humans and animals, especially horses. Transmits carbuncle disease.

STALK BORER, *Papaipema nebris*. Corn, cotton plants, potato, tomato, tobacco, legumes, soft stalk plants.

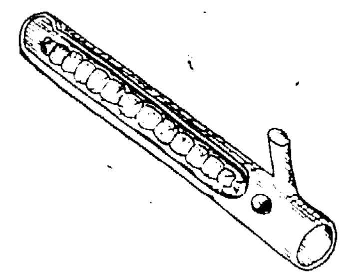
STEM NEMATODE, *Dytylenchus dipsaci*. Greenhouse plants (stems and bulbs); wheat.

STRAWBERRY APHID, *Capitophorus fragaefolii*. Strawberry roots.

STRAWBERRY FLEA BEETLE, *Altica ignita*. Strawberry, greenhouse plants.

STRAWBERRY LEAF ROLLER, *Ancylis comptana fragariae*. Strawberry, raspberry, brambleberry.

STRAWBERRY ROOT APHID, *Aphis forbesi*. Strawberry.



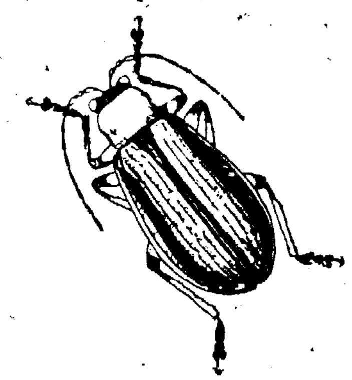
Stalk Borer

Strawberry Root Weevil

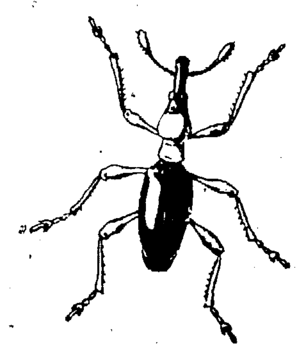
STRAWBERRY ROOT WEEVIL, *Brachyrhinus ovatus*. Strawberry and similar berries; nursery plants.

STRAWBERRY WEEVIL, *Anthonomus signatus*. Strawberry, raspberry, brambleberry, etc.

STRIPED CUCUMBER BEETLE, *Acalymma vittata*. Pepper, pumpkin, watermelon, beans, peas, corn.



Striped Cucumber Beetle



Sweet Potato Weevil

SUGAR CANE BORER, *Diatraea saccharalis*. Sugar cane, corn, rice.

SUGAR CANE GRASSHOPPER, *Perkinsiella saccharicida*. Sugar cane and other gramineous plants.

SUGAR CANE MEALY BUG, *Pseudococcus sacchari*. Sugar cane.

SUGAR CANE RHINOCEROS BEETLE, *Strategus anachoreta*. Sugar cane and other plants.

SUGAR CANE ROOT WORM, *Ancistrosoma klugi*. Sugar cane roots.

SUGAR CANE WEEVIL, *Anacentrinus subnudus*. Sugar cane.

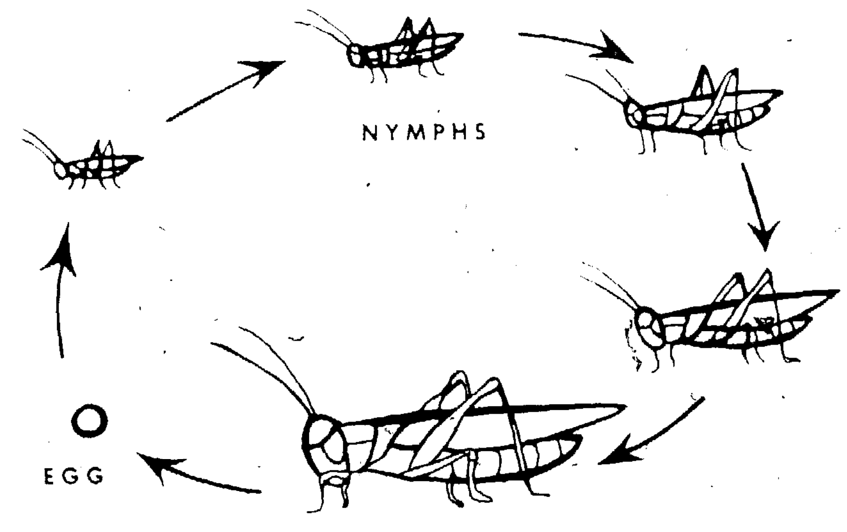
SUGAR CANE WEEVIL STALK BORER, *Metamasius hemipterus*. Cane fields, banana fields and old ratoons.

SWEET POTATO CATERPILLAR, *Prodenia ornithogallis*. Cotton and other plants.

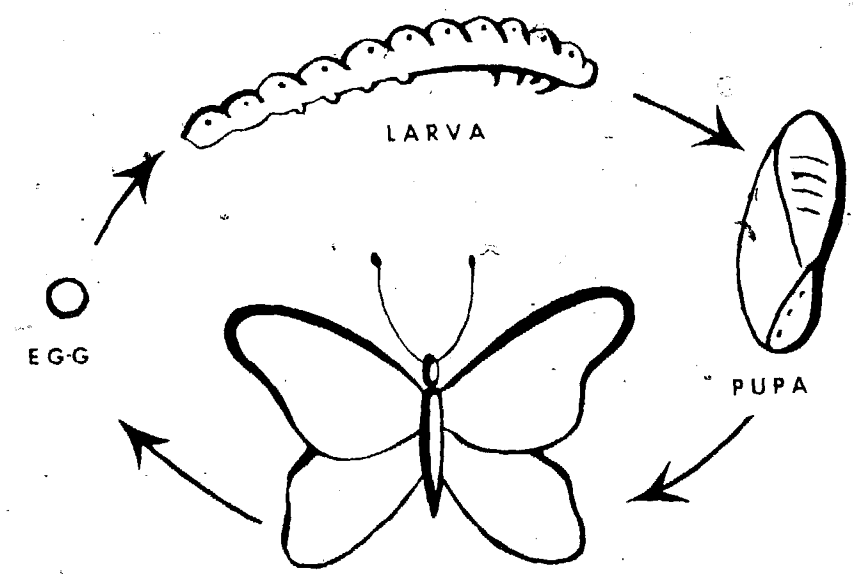
SWEET POTATO FLEA BEETLE *Chaetocnema confinis*. Sweet potato leaves.

SWEET POTATO LEAFHOPPER, *Empoasca batatae*. Sweet potato, cotton.

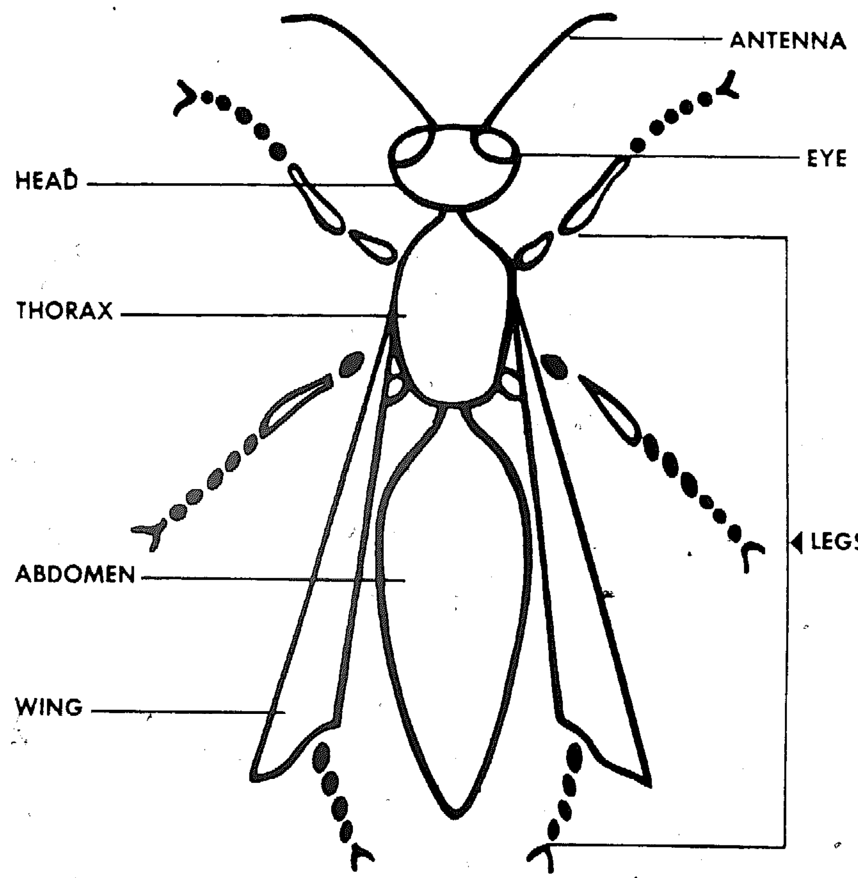
SWEET POTATO ROOT BORER, *Cylas formicarius elegantulus*. Sweet potato and other convolvulaceous plants.
SWEET POTATO WEEVIL, *Cylas formicarius elegantulus*. Sweet potato and other convolvulaceous plants.
TOBACCO BUD WORM, *Heliothis virescens*. Tobacco, tomato, cotton.
TOBACCO FALSE BUDWORM, *Heliothis armigera*. Corn (stem and tassel); cotton (bud or boll); sunflower (seed); flax, tomato, chickpea (pod).
TOBACCO FLEA BEETLE, *Epitrix hirtipennis*. Tobacco, potato, tomato, eggplant, pepper.
TOBACCO THRIPS, *Frankliniella fusca*. Ornamental plants, onions, garlic, tobacco.
TOBACCO THRIPS, *Thrips tabaci*. Onions, garlic, tobacco.
TOBACCO WEBWORM, *Crambus caliginosellus*. Tobacco, corn.
TOMATO BUG, *Phthia picta*. Tomato, pepper, potato.
TOMATO HORN WORM, *Protoparce quinquemaculata*. Solanaceous plants; tomato, tobacco, eggplant, pepper, potato.
TOMATO HORN WORM, *Protoparce sexta*. Tobacco, potato, tomato, pepper, etc.
TOMATO PIN WORM, *Keiferia lycopersicella*. Tomato, solanaceous plants.
TRINIDAD SUGARCANE BORER, *Diatraea impersonatella*. Sugar cane and other gramineous plants.
TWELVE-SPOTTED CUCUMBER BETTLE, *Diabrotica undecimpunctata howardii*. Corn, gramineous and cucurbitaceous plants, herbaceous as cucumber, etc.
VEGETABLE WEEVIL, *Listoderes costirostis obliquus*. Parasite of sugar cane borer.
VELVET BEAN CATERPILLAR, *Anticarsia gemmatilis*. Leguminous plants, soybeans, peanuts, velvet beans, legumes.
VETCH BRUCHID, *Bruchus brachiales*. Seeds of several pea varieties.
VETCHWORM, *Heliothis armigera*. Corn (stem and tassel); cotton (bud); sunflower (seeds); flax, tomato, chickpea (pod).
WALNUT CATERPILLAR, *Datana integerrima*. Oak leaves.
WASP, *Polistes cavapyta*. Ripe fruits.
WAX MOTH, *Galleria mellonella*. Apiary.
WEST INDIAN FRUIT FLY, *Anastrepha fraterculus*. Guava, cherimoya, peach, apricot, mango, medlar and apple trees.
WHEAT MIDGE, *Sitodiplosis mosellana*. Wheat spikes.
WHEAT STRAW WORM, *Harmolita grandis*. Wheat.
WHITE ANT, *Kalotermes brevis*. Construction wood.
WOOLLY APPLE APHIS, *Eriosoma lanigerum*. Apple, pear, elm and other trees.
YELLOW-STRIPED ARMY WORM, *Prodenia ornithogallis*. Cotton and other plants.



The grasshopper is an example of gradual growth.



The familiar butterfly is an example of complete change or metamorphosis.



Insect bodies are composed of three divisions: head, thorax and abdomen. There are three segments to the thorax, each having a pair of jointed legs which means that insects normally have six legs. Most of them have two pairs of wings attached to the thorax as well, but some have only one pair, and there are a few which have none at all. Insects usually have two sets of jaws, two kinds of eyes, simple and compound, and a pair of antennae.

APPENDIX D

Soil Survey of the Christiana Area Land Authority

by THE BRITISH WEST INDIES SOILS RESEARCH ORGANIZATION OF THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD (now The Faculty of Agriculture, University College of the West Indies)

Introduction

The Christiana area is the site of an experiment in agricultural planning. Amongst the aims, is the rehabilitation of agriculture and the control of erosion in the hill areas. The survey of the soils of the region was undertaken at the request of the Director of Agriculture, Jamaica. The Christiana Land Authority area is entirely in hill and mountain country and it is situated in a geological window in the White Limestone Formation with its bauxitic soils. The soils found within this window are typical of large areas elsewhere in Jamaica, and information and methods useful here should have widespread application.

Thanks are due to the Agricultural Chemist's Department for information and help, and to the Government Meteorologist for information used in this report.

General Description of the Area

(i) **Situation.** The Christiana Land Authority stretches east-west along the centre of Jamaica. On both sides, the dissected limestone plateau rises gently to an elevation of 3,000 feet on the boundaries of the region. The dissection of this great anticline has led to east-west drainage. The Hector's River runs westwards from the central watershed at Coleyville and the Yankee and Cave Rivers run eastwards. All three disappear into sinks in the bounding White Limestone Formation. Near White Shop the Minho River rises and flows eastwards out of the area surveyed. Frankfield on the river is on the edge of the region and at 800 feet is the lowest point within the Christiana Authority.

(ii) **Climate.** The climate is generally cool and moist by tropical standards. The average annual rainfall varies from 65 inches in the north-

TABLE 1

Air Temperature Data: Christiana District

(Average Maximum and Minimum degrees Fahrenheit)

	Jan.	*Feb.*	*Mar.*	*Apr.*	*May*	*Jun.*	*July*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*	*Mean*
Lorrimers: elevation—2,600 *ft.*; (*Period* 1946–1950)													
Maximum	74·8	75·6	77·9	79·3	79·4	80·2	81·6	82·0	81·0	79·9	77·5	75·0	78·7
Minimum	60·4	58·7	59·3	60·8	62·8	64·8	64·9	64·9	65·0	64·0	64·1	62·2	62·7
Extreme temps. Max. 89° F., Min. 50° F.													
Holmwood: elevation—3,000 *ft.*; (*Period* 1952 (one year only))													
Maximum	76·3	77·8	81·1	79·9	81·7	81·3	81·2	?	82·3	79·9	78·7	74·1	79·5
Minimum	59·4	60·0	61·4	64·0	65·1	66·1	65·6	?	64·6	65·4	62·8	60·8	63·2
Extreme temps. Max. 88° F., Min. 51° F.													

east to 98 inches in the west. The temperatures vary with altitude, but unfortunately only two stations exist, even in the neighbourhood of the region which keep temperature records. These are both at high levels near Christiana and the data is shown in Table No. 1.

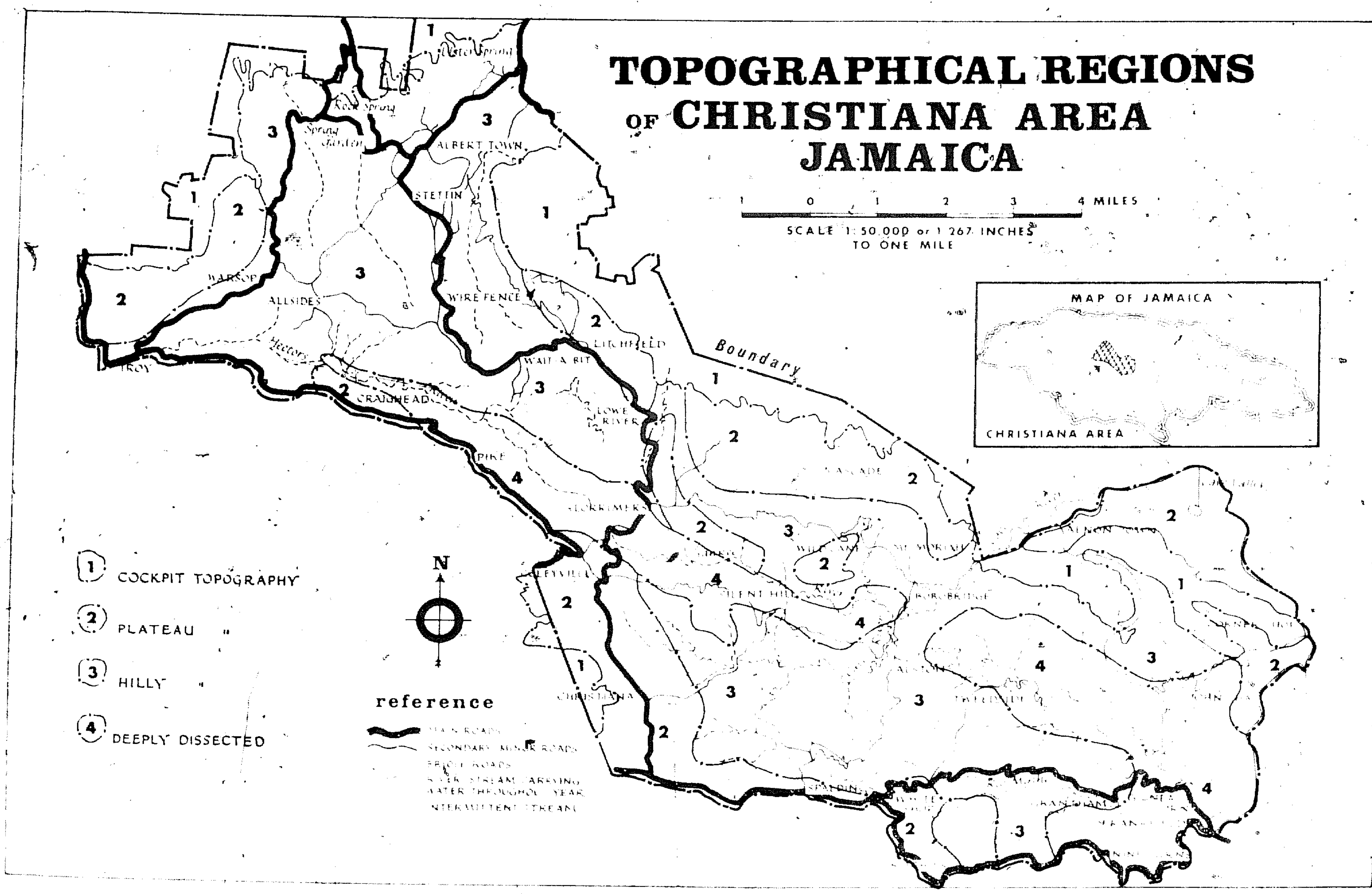
Winter nights are made colder on these ridge tops above 2,500 feet by exposure to the wind and in the deforested state of the land all the crops suffer from this exposure. The rainfall figures for stations within the Christiana Land Authority are given in Table No. 2 as monthly averages and as yearly averages.

From these figures a sketch map (Map 2) has been drawn showing the yearly rainfall distribution. This shows a noticeable increase from east to west. The winter dry season stretches from December to March inclusive. During the rest of the year there is normally sufficient rain for crop growth unless the early summer rains or 'May rains' fail. The rainfall is unreliable in this season which may seriously handicap crop growth. The October maximum, however, is reliable and there is generally a reasonable rainfall through the summer months. However, the rainfall variations have no control over the soils within the region and appear to have little control over crops or agricultural techniques. The control appears to be *altitude* with its attendant *temperature variations.*

(iii) Geology. The Geology is essentially simple as the area is a window in the younger White Limestone Formation. Map 3 is a sketch map of the solid geology of the area. The boundaries of the area surveyed are mostly drawn within the window, but here and there the White Limestone Formation appears on the edge of the map as on the northern boundary. Below this is the Yellow Limestone Formation which consists of limestones in the upper and lower divisions and of shales, sandstones and fine conglomerates in its middle division. This formation is associated with most of the plateau country in the area. Below this again are the Trappean Tuffs and conglomerates which run east to west along the centre of the region. To the south of Frankfield and forming Main Ridge are Cretaceous conglomerates giving rise to soils very similar to those of the Wagwater Series of Matley.

White Limestone Formation:	Upper Eocene—Lower Miocene
Yellow Limestone Formation:	Middle Eocene
Trappean Series	Cretaceous
Main Ridge Conglomerates	

Owing to the hilly nature of this area and the youth of its soils, almost every major geological boundary is a soil boundary also. With the exception of the Middle Yellow Limestone, each geological formation is of uniform lithology. The Middle Yellow Limestone lithology varies through


TOPOGRAPHICAL REGIONS
OF CHRISTIANA AREA
JAMAICA
1 0 1 2 3 4 MILES
SCALE 1:50,000 or 1.267 INCHES TO ONE MILE
MAP OF JAMAICA
CHRISTIANA AREA
Boundary
ALBERT TOWN
STETTIN
WIRE FENCE
LITCHFIELD
WAIT A BIT
WARSOP
ALLSIDES
TROY
CRAIGHEAD
PIKE
1 COCKPIT TOPOGRAPHY
2 PLATEAU "
3 HILLY "
4 DEEPLY DISSECTED
N
reference

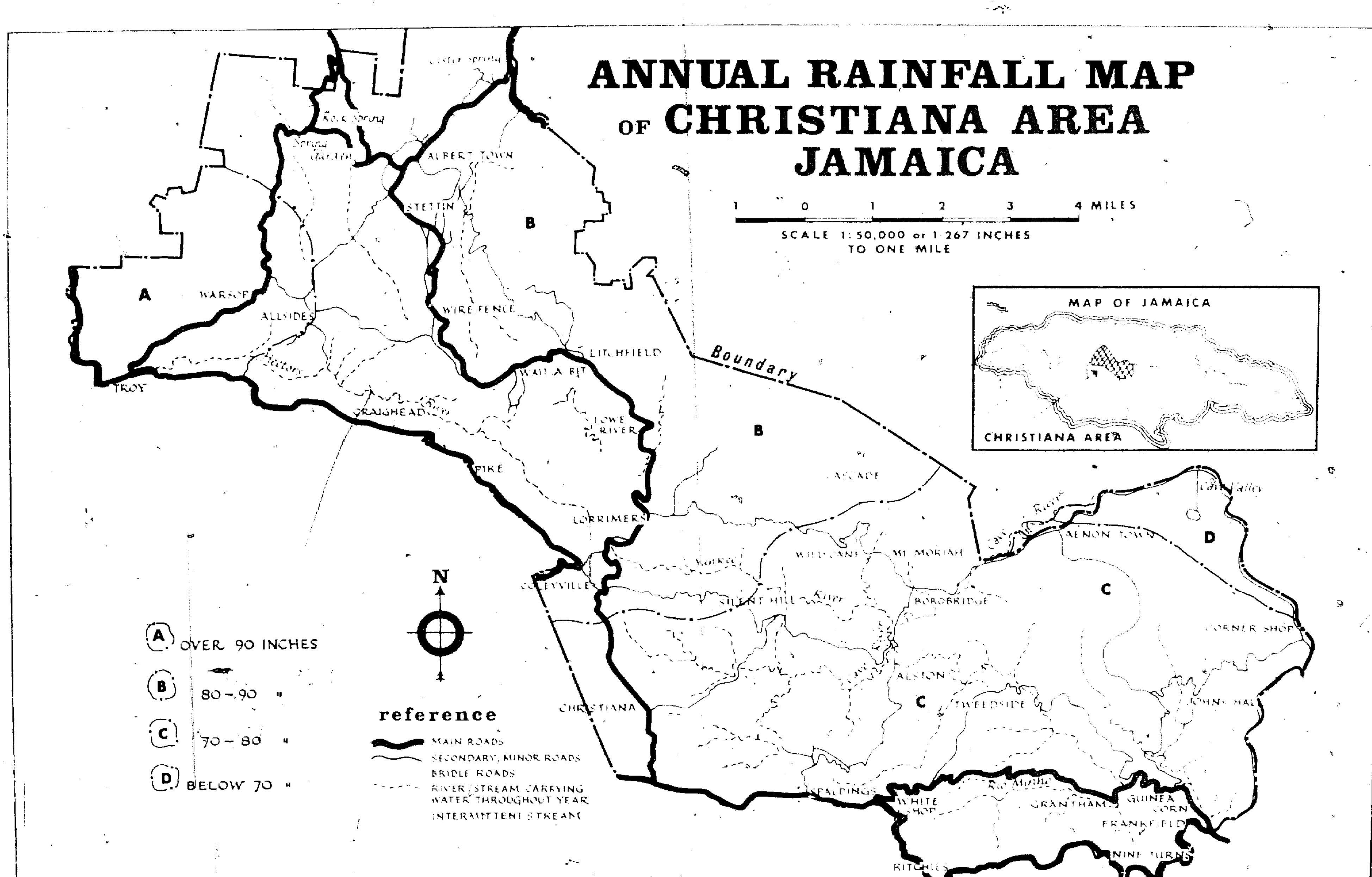

ANNUAL RAINFALL MAP
OF CHRISTIANA AREA
JAMAICA
1 0 1 2 3 4 MILES
SCALE 1:50,000 or 1.267 INCHES TO ONE MILE
MAP OF JAMAICA
CHRISTIANA AREA
Boundary
ALBERT TOWN
STETTIN
WIRE FENCE
LITCHFIELD
WAIT A BIT
WARSOP
ALLSIDES
TROY
CRAIGHEAD
LOWE RIVER
PIKE
LORRIMERS
COLEYVILLE
CHRISTIANA
ALSTON
TWEEDSIDE
BOROBRIDGE
SPALDINGS
WHITE SHOP
GRANTHAM
GUINEA CORN
FRANKFIELD
NINE TURNS
RITCHIES
CORNER SHOP
A OVER 90 INCHES
B 80–90 "
C 70–80 "
D BELOW 70 "
N
reference
MAIN ROADS
SECONDARY, MINOR ROADS
BRIDLE ROADS
RIVER, STREAM CARRYING WATER THROUGHOUT YEAR
INTERMITTENT STREAMS

TABLE 2

Monthly Rainfall Data: Christiana District

(70 years' averages, inches of rain)

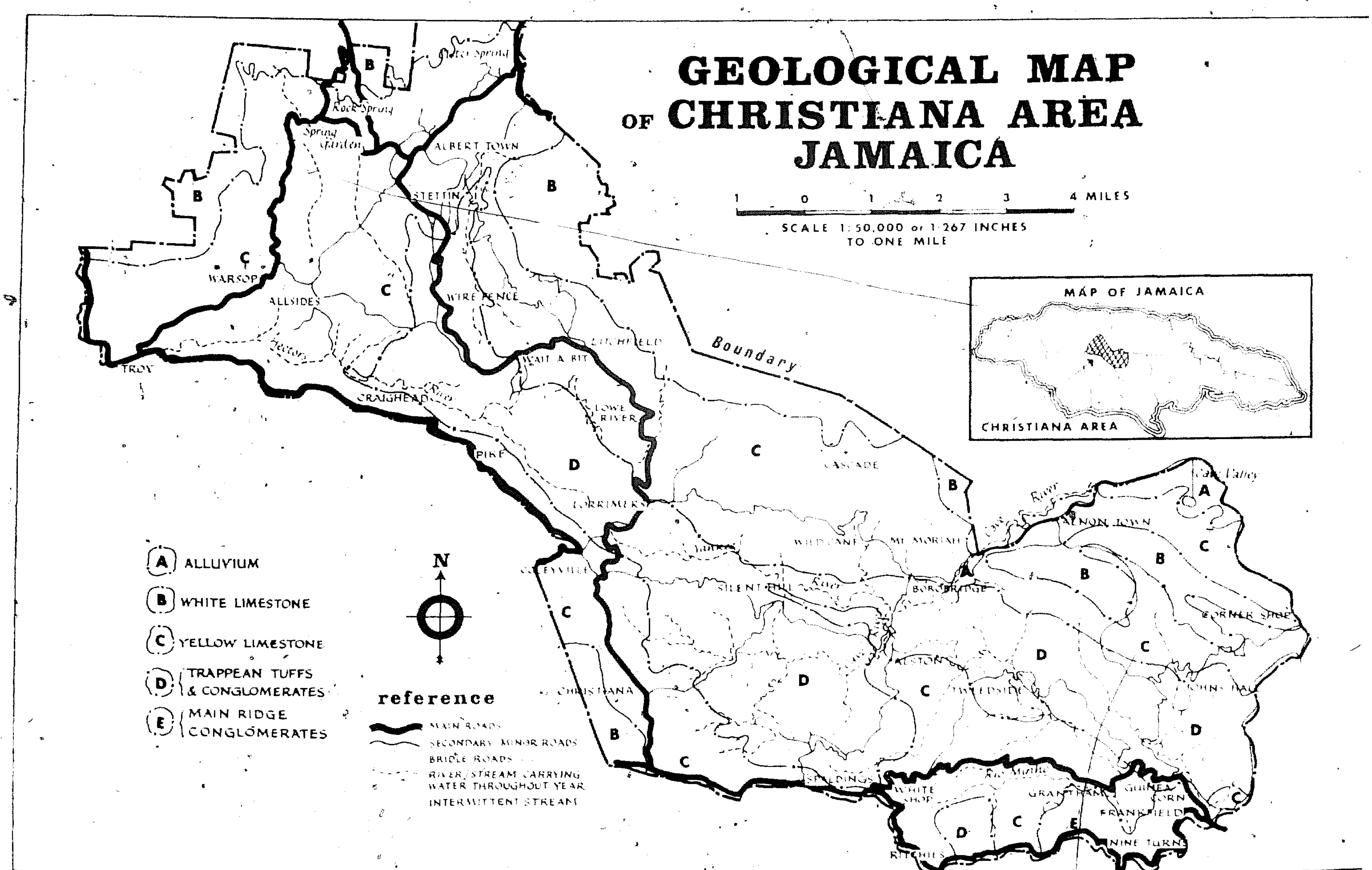
Station	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*Jun.*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Total*
Troy	2·00	3·22	5·47	8·57	15·03	8·13	6·90	9·90	13·10	15·89	7·41	2·86	98·51
Watsop	2·24	3·09	2·64	8·64	14·72	6·35	7·15	9·84	9·59	15·43	9·62	2·94	92·25
Albert Town	2·79	2·92	3·82	6·68	11·09	5·57	5·06	9·00	10·26	11·75	8·11	3·31	80·36
Ulster Spring	3·26	3·31	3·96	6·85	11·93	6·57	5·41	8·40	9·83	11·72	7·67	3·89	82·80
Lowe River	3·39	5·53	4·80	7·86	11·36	6·01	4·55	7·85	10·36	13·33	8·51	3·15	84·70
Christiana	2·31	2·80	4·00	6·59	10·56	6·23	4·35	7·05	8·70	11·13	6·77	2·71	73·20
Baillieston	2·18	2·49	4·41	5·08	9·95	8·16	4·38	6·84	8·98	10·43	6·08	2·58	71·56
Spaldings	2·17	3·39	2·68	5·03	8·71	6·08	5·10	7·57	7·82	13·27	7·75	2·12	72·23
Frankfield	1·92	2·56	2·30	4·58	9·27	6·78	6·61	8·58	8·09	11·83	6·00	1·89	70·41
Cave Valley	2·11	2·05	2·57	4·83	9·36	7·15	4·61	7·25	7·66	9·47	5·29	2·77	65·12

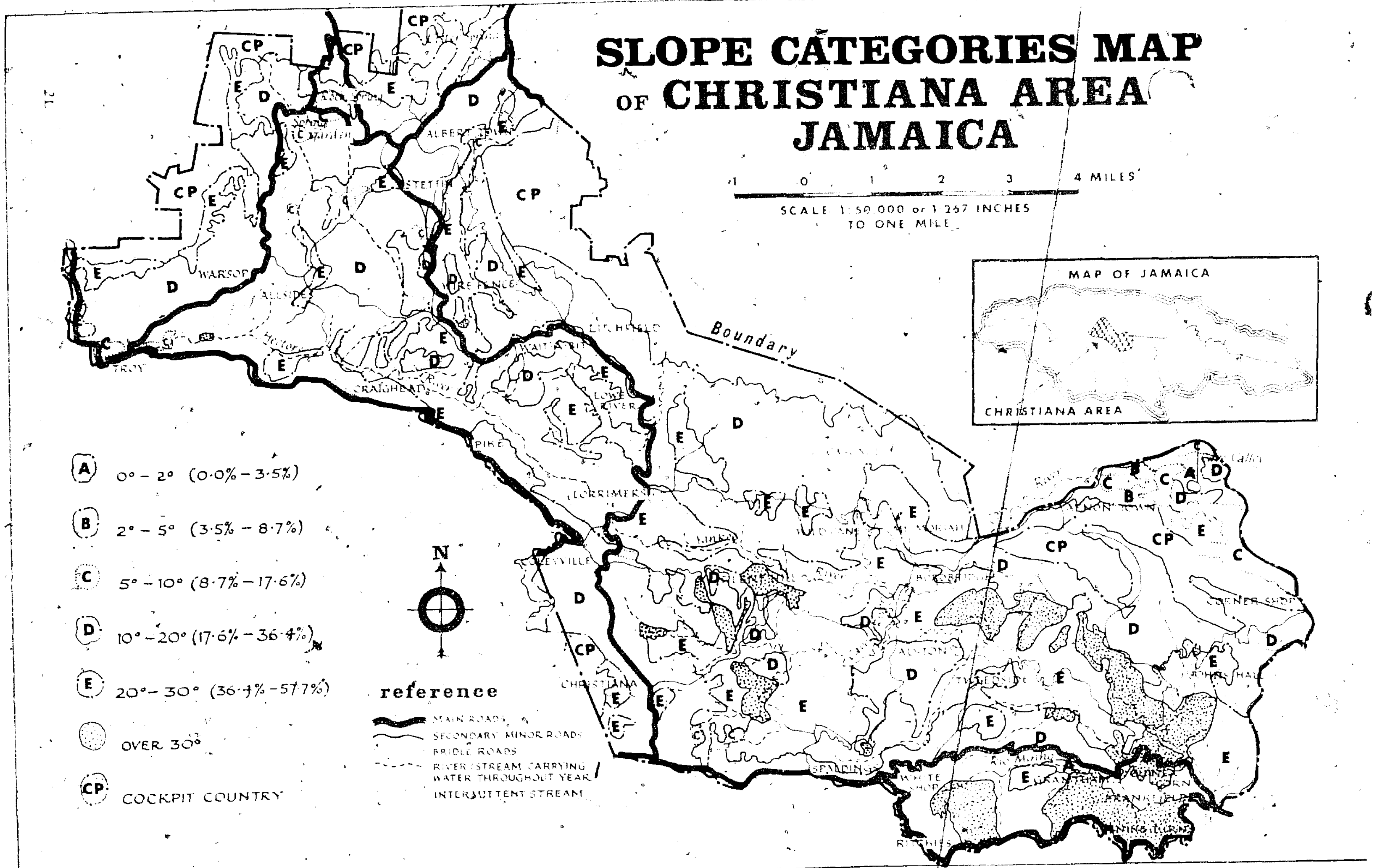
limestone; shales, sandstone, and fine conglomerates which has given rise to complex soil associations.

(iv) **Topography.** The topography of the region is almost completely controlled by the geology. The larger rivers run through much of their courses in the Trappean Tuffs and conglomerates which form the core of the region. This formation weathers rapidly and is easily eroded. The deep valleys of the Hector's and Yankee Rivers, are cut into this formation (Maps 4 and 5). The crests of the major Trappean ridges and watersheds are generally rounded with 'D' class slopes prevailing over most of this area. The smaller ridges, however, are frequently knife-edged with room for only a track along their crests. Although the major rivers have started to widen their valley bottoms, the tributary streams are still cutting downwards vigorously, which conditions have given rise to this steep topography with slopes falling into 'E' and 'F' class. The same conditions of rapid weathering and easy erosions hold good over the Main Ridge conglomerates, and the prevailing slopes over this formation are in 'F' class.

Over the limestones of the Yellow Limestone Formation, gentler topography prevails. Almost all drainage is under-ground, through the limestone, and the surface is pitted with shallow sinks. Between the sinks are numerous small knolls which are sometimes smooth-topped, and sometimes crowned with rock outcrops. The slopes are nearly all in 'D' class even though the overall slope may be negligible. This formation forms many small plateau areas such as the Cascade and Litchfield plateaux. The shales, sandstones and fine conglomerates of the Middle Yellow Limestone give rise to rolling ridge topography. This ridge topography is for the most part gentle, but may form steep slopes as below the Cascade plateau. Here 'E' class slopes prevail. However, these shales also form some of the gentlest topography in the region where they occur in the inland Basin between Aenon Town, Cave Valley and Corner Shop. Here they underlie wide areas of 'C' class slopes.

Over much of the White Limestone Formation of this region a peculiarly Jamaican type of Karst topography is found. This is locally known as Cockpit Country. This limestone is hard and relatively pure. It weathers slowly by solution into deep sink holes, with steep, craggy ridges and hills between them. Travel is extremely slow and difficult through this country and little or no agricultural use is made of it. The soil is almost all St. Ann's Clay Loam which is thick in the bottom of only some sinks and on occasional cols; otherwise it fills the crevices and solution hollows in the crags. These small areas of soil grow bananas and provisions near the edge of the cockpit country. However, few people actually live here, though overnight shelters may be built on cultivated ground. On the south of the area surveyed the cockpit country merges into a plateau of wider, shallower


GEOLOGICAL MAP
OF CHRISTIANA AREA
JAMAICA
1 0 1 2 3 4 MILES
SCALE 1:50,000 or 1·267 INCHES TO ONE MILE
MAP OF JAMAICA
CHRISTIANA AREA
Boundary
A ALLUVIUM
B WHITE LIMESTONE
C YELLOW LIMESTONE
D TRAPPEAN TUFFS & CONGLOMERATES
E MAIN RIDGE CONGLOMERATES
N
reference
MAIN ROADS
SECONDARY MINOR ROADS
BRIDLE ROADS
RIVER/STREAM CARRYING WATER THROUGHOUT YEAR
INTERMITTENT STREAM
ALBERT TOWN
STETTIN
WARSOP
ALLSIDES
WIRE FENCE
TROY
CRAIGHEAD
PIKE
LOWE RIVER
CASCADE
LORRIMERS
WILD CANE
MT. MORIAH
SILENT HILL
CHRISTIANA
SPALDING
WHITE SHOP
FRANKFIELD
NINE TURNS
CORNER SHOP
Rock Spring
Spring Garden


SLOPE CATEGORIES MAP
OF CHRISTIANA AREA
JAMAICA
1 0 1 2 3 4 MILES
SCALE 1:50,000 or 1·267 INCHES TO ONE MILE
MAP OF JAMAICA
CHRISTIANA AREA
Boundary
A 0° – 2° (0.0% – 3.5%)
B 2° – 5° (3.5% – 8.7%)
C 5° – 10° (8.7% – 17.6%)
D 10° – 20° (17.6% – 36.4%)
E 20° – 30° (36.4% – 57.7%)
OVER 30°
CP COCKPIT COUNTRY
N
reference
MAIN ROADS
SECONDARY MINOR ROADS
BRIDLE ROADS
RIVER/STREAM CARRYING WATER THROUGHOUT YEAR
INTERMITTENT STREAM
WARSOP
ALLSIDES
WIRE FENCE
TROY
CRAIGHEAD
PIKE
LORRIMERS
CHRISTIANA
SPALDING
CORNER SHOP

sinks and smaller, smoother hills. However, these plateau areas are outside the Christiana Land Authority and are not dealt with in this report.

(v) **Vegetation.** There is no original vegetation left within the Christiana Land Authority boundaries. Although original forest still appears to exist in the heart of the cockpit country, the margins which are included in the Christiana Land Authority have all been culled for timber and have frequently been cultivated for corn and bananas so that secondary growth now prevails. The Forestry Department has planted areas north of Troy and west of Christiana, with mahoe and cassia, while on the ridge, to the north of the Hector's River, mahoe broadleaf, and santa maria, have been planted. Elsewhere the land is cultivated, under pasture, fallowing or ruinate, the last three divisions are frequently synonymous. At higher altitudes as around the Christiana-Spaldings areas, acacias are the colonizers of fallowing or uncultivated lands. At lower altitudes, guava is the most rapid invader.

(vi) **Agricultural Development and Present-Day Land Use.** There are very few records of agriculture or land use in these hill regions. The most definite records are comparatively recent and are contained in the government list of properties of fifty acres or more which was first published in 1920. These give a broad classification of land use on the various properties. Of course, the number of these large properties has dropped since that date. Large cattle pasturing properties predominated in this area in the early days of this country. As roads and other communications improved, production of bananas became dominant. This remained the most important crop until Panama Disease spread through the regions and made it uneconomical. After bananas the various parts of this region divided as to which crop they should specialize in. In the lower areas to the east, coffee has been boosted by the building of a coffee factory at Aenon Town. Sugar-cane is also widely grown in this area as it can be taken in lorries to Frankfield and by rail from there to the factory. Large areas of this hillside cane are interplanted with sweet potatoes for the city markets.

In the higher areas centering on Christiana and Spaldings, ginger was grown at great profit until 1952 when the market collapsed. At present there is only a little being grown. Ginger is unfortunately a cleanly cultivated crop which gives no protective cover to the soil, so its cultivation has in many places completed the ruinous soil erosion which the former banana cultivation had started. In these high altitudes cabbages and Irish potatoes are also extensively grown for sale in Kingston and Mandeville. In general the cabbages are grown on the moister Carron Hall Clay while Irish potatoes grow on Donnington Gravelly Clay Loam and on St. Ann's Clay.

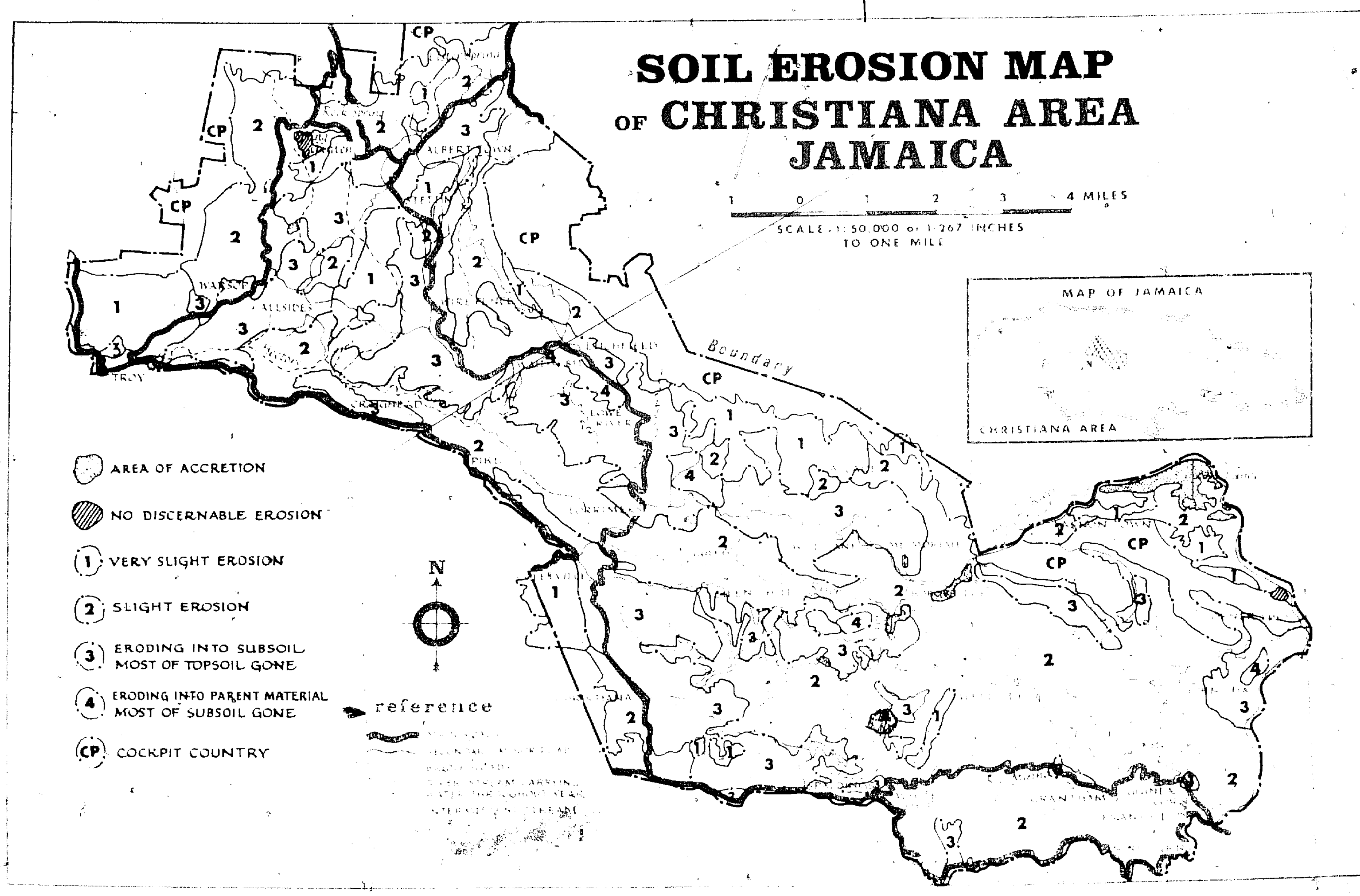
Wherever Wirefence Clay Loam and Wait-a-Bit Clay are found, they are devoted to the production of yams. The individual yam hills are

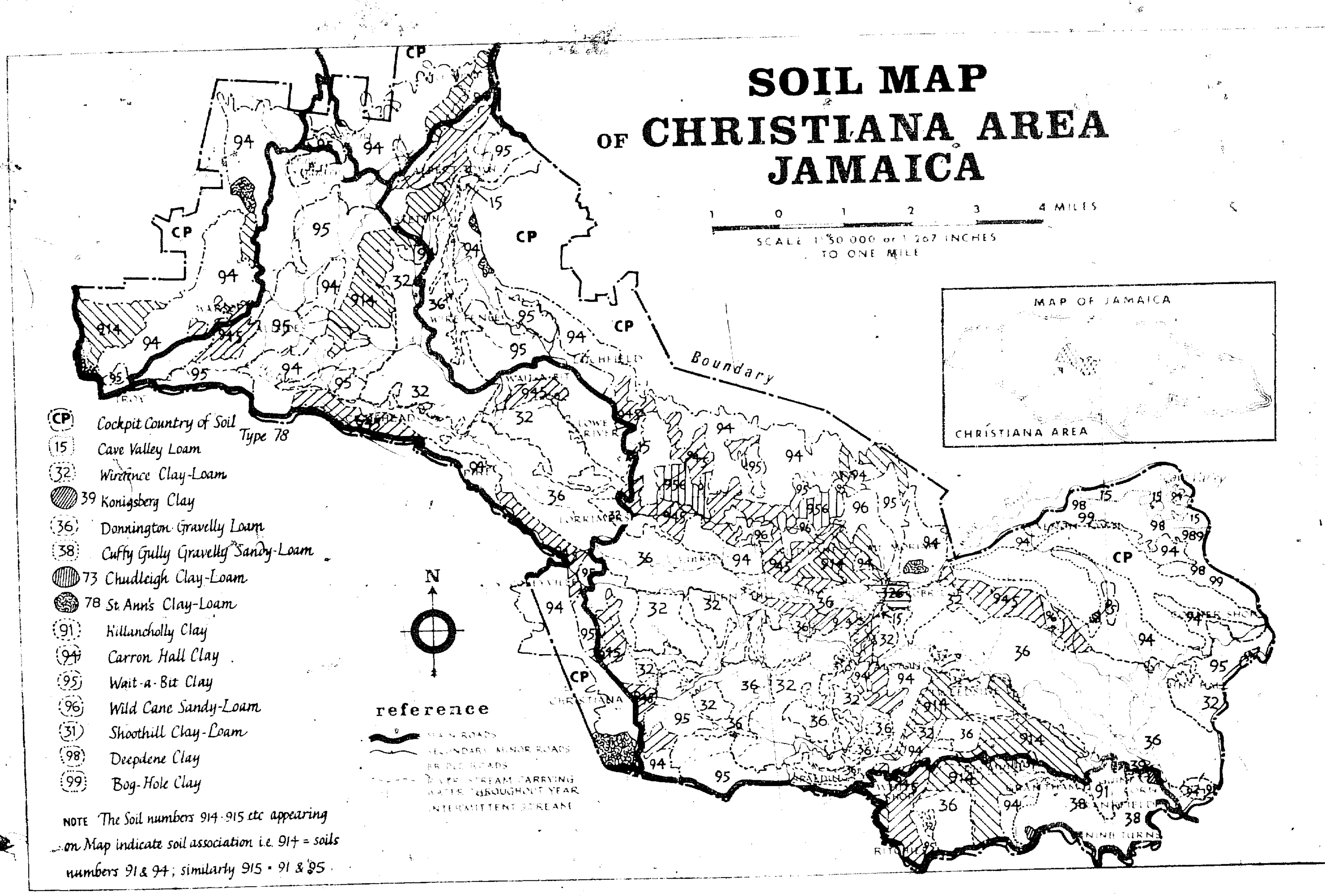
scattered haphazardly over the ground and channel run-off between them. After a heavy rain the hillside yam fields are always channelled by rivulets. As a result, these two soils have been very badly eroded; frequently erosion has reached patent material. The use of contour ridge cultivation appears to be a possible solution.

At present there is a widespread increase in the acreage under Panama Disease resistant bananas, which are now replacing ginger as the export crop over much of the area surveyed. Provision crops such as cassava, corn, sweet potatoes, yams and red peas are grown everywhere for local consumption. Coffee is widespread although it is more intensively cultivated in the eastern end of the region. Pimento is also widely grown and gathered for sale.

Very little of the land is now in properties larger than fifty acres and much of it is divided into plots of less than one acre. Several of the large properties are entirely rented to smallholders. This renting of land for periods of one year with absolutely no security of tenure for the tenant has had very bad results upon the soil and upon crop yields. Owing to the lack of security no fruit trees are planted on these lands, no measures are taken prevent soil erosion and no attention is paid to fertility maintenance. In view of the complete lack of fertilizer or manure, it is hardly surprising to learn that yields on these lands have dropped significantly and are still falling. In general land is fallowed for two or three years and then cultivated for one or two years. Much of the rented land, however, will not have even one year's fallow but is cultivated year after year. Only Irish potatoes and cabbages are grown regularly with fertilizers. On the few larger properties, bananas and citrus are also having intelligent manuring, and fertilizer used, applied to help their growth and yields.

Only in parts of the limestone country has there been much attempt to combat erosion and to evolve conservative practices. In these areas stones and small rocks, which abound in the soil, are piled in walls across the slope. These walls have halted surface wash and, where present, form the beginnings of future terrace cultivation. On other soils there have been small-scale attempts at contour ditching and banking, but as yet no long-term, large-scale, conservation practices have been applied. Little effort has been made to adapt crops and crop rotations to different soils or different slopes. The effort so far has been to adapt any soil to suit various special crops. In general, erosion is widespread and all soils have suffered to a greater or less degree. It is, however, especially marked on Wait-a-Bit Clay and Wirefence Clay Loam for three reasons. Both these soils are prone to erosion if deprived of cover; both soils are used to produce yams and due to their intrinsic poverty, large areas of these soils are found on rented lands. Lithosols such as Donnington Gravelly Clay Loam and Cuffy Gully Gravelly Clay Loam are not so badly effected by erosion since the


SOIL EROSION MAP
OF CHRISTIANA AREA
JAMAICA
1 0 1 2 3 4 MILES
SCALE 1:50,000 or 1.267 INCHES TO ONE MILE
MAP OF JAMAICA
CHRISTIANA AREA
Boundary
AREA OF ACCRETION
NO DISCERNABLE EROSION
1 VERY SLIGHT EROSION
2 SLIGHT EROSION
3 ERODING INTO SUBSOIL MOST OF TOPSOIL GONE
4 ERODING INTO PARENT MATERIAL MOST OF SUBSOIL GONE
CP COCKPIT COUNTRY
reference


SOIL MAP
OF CHRISTIANA AREA
JAMAICA
1 0 1 2 3 4 MILES
SCALE 1:50,000 or 1.267 INCHES TO ONE MILE
MAP OF JAMAICA
CHRISTIANA AREA
Boundary
CP Cockpit Country of Soil Type 78
15 Cave Valley Loam
32 Wirefence Clay-Loam
39 Konigsberg Clay
36 Donnington Gravelly Loam
38 Cuffy Gully Gravelly Sandy-Loam
73 Chudleigh Clay-Loam
78 St Ann's Clay-Loam
91 Killancholly Clay
94 Carron Hall Clay
95 Wait-a-Bit Clay
96 Wild Cane Sandy-Loam
31 Shoothill Clay-Loam
98 Deepdene Clay
99 Bog-Hole Clay
NOTE The Soil numbers 914 · 915 etc appearing on Map indicate soil association i.e. 914 = soils numbers 91 & 94; similarly 915 = 91 & 95
reference

formation of subsoil from parent material is extremely rapid and can keep pace with moderate surface wash. However, these soils as well as all the others in the region, could be made more fertile by some attempt to hold the topsoil on the land.

Soil Grouping

No attempt has yet been made to draw up a true classification of the following soil types. They have been divided for convenience into the following broad physiographic groups:

Alluvial Soils:	These two soils are found over recent water-laid deposits and within this region are still subjected to flood deposition.
Basin Soils:	These are soils associated with gentle relief in areas of interior drainage.
Ridge Top Soils:	These are mature soils with well-developed horizon differentiation. They occur on rounded ridge tops above steep valley systems on whose sides lithosols are developed.
Hillside Soils:	These are the normal soils of the region and are usually well drained and shallow.

Alluvial Soils

Cave Valley Clay Loam. This is the more widespread of the two alluvial soils found within the Christiana Land Authority. The alluvial 'flats' covered by this soil are still liable to flooding and deposition so that there is little profile development. The largest area is found near Cave Valley along the Cave River. Smaller areas are found along the river bottoms near Troy, Spring Garden and Grantham.

Profile. In pasture 200 yards south of Cave Valley House.

	(inches)
Very dark grey clay loam with very fine, stony subangular, blocky structure which is plastic when moist and firm as it dries out. Slightly acidic - - - - - - -	0–12
Dark brown clay loam of fine medium strength subangular, blocky structure which is slightly plastic when moist. Acidic - - - - - - - - - -	12–54
Dark brown clay loam of medium sized subangular blocky structure of the same consistence, strength and pH - -	54–72

Variation. There is little variation in this soil. The topsoil is often less deep and the texture may grade into loam.

Parent Material. This soil is found on alluvium derived from all the geological formations in the Christiana Area except the Main Ridge Con-

glomerate. These include White Limestone, Yellow Limestone and Trappean Formations in their various lithological variations.

Relief. Many acres of this soil are of 'A' class slopes, but these areas are chiefly in the Cave Valley area. Where the alluvium is of smaller extent, as in the other river valleys, 'B' class slopes prevail.

Drainage. Surface drainage is slow over this flat relief. Internal drainage is moderate to rapid. The soil has moderately good water retention.

Erosion. Little erosion takes place from this soil due to both its strong structure and to the gentle slopes. There is slight surface washing under cultivation.

Present Use. The most important crop at present on this soil is sugar cane. In Cave Valley area much of it is also under pasture and tobacco. Provision crops are also successfully grown on it.

Recommendations. This soil is an obvious site for mechanized cultivation with its gentle slopes. Cane and tobacco are both grown successfully and would both benefit from fertilizer experiments. This soil has often a high potash status while nitrogen and phosphates are normally of medium status.

Agualta Sandy Loam. A few acres of this alluvium occur within the Christiana area along the Minho River below Grantham. Like Cave Valley Clay Loam this alluvium is also liable to flood and deposition and has little profile development. Unfortunately under flood and rain the surface tends to pack, which may cause excessive run-off and erosion. Top soil is very dark grey, brown sandy loam to loam with fine, weak, subangular blocky structure which is of friable consistency. The subsoil is dark brown to dark reddish brown sandy loam with no structure.

The one pit sampled in this soil was slightly acid in the top soil and alkaline below, though this alkalinity may not be typical. Nitrogen and potash status were medium low, while phosphate status was high throughout the profile.

In the area surveyed this soil is devoted to the production of coffee, bananas and coconuts, while a little tobacco is planted once flood danger has passed.

Basin Soils

Deepdene Clay. This is a mature soil developed in areas of poor drainage over shales of the Yellow Limestone Formation. Almost all lies within the triangle formed by Aenon Town, Cave Valley and Corner Shop. Small areas of it exist in poorly drained situations in Waitabit Clay. It is associated with Boghole Clay and with Carron Hall Clay. Frequently Deepdene Clay and Boghole Clay are mapped as an association.

Profile. In banana field, 300 yards west of Deepdene House.

	(inches)
Very dark grey brown clay with very fine strong subangular blocky structure which is friable when moist. Highly acid -	0- 4
Reddish yellow clay with faint grey speckles with a similar structure and consistence to the topsoil. Highly acid - -	4- 8
Yellowish red clay with faint fine light grey mottles. The medium sized weak subangular blocky structure is plastic when moist. There are very few roots in this horizon or below it. Very highly acid - - - - - - -	8- 4
Clay with red and grey white mottles. The mottles are many, distinct and increase in size from fine at 21 inches to coarse at 72 inches. The structure is fine, weak, subangular blocky and it is plastic when moist. Very highly acid - -	21-72

Variations. The chief variation in this soil is the amount of topsoil left. Over many acres it is almost entirely absent.

Relief. Topography associated with this soil in the Christiana area is a basin of considerable extent with gentle rolling relief. On these soils the prevailing slope class is 'C' with occasional areas of 'D'.

Drainage. Surface drainage of this soil is moderate to slow over the gentle relief. The internal drainage is slow as the mottling shows. Below 2 feet drainage is very slow and this leads to the necessity of drains to cope with excess water.

Erosion. Sheet erosion is prevalent wherever the land is cultivated. Gullies may form where drains have been badly graded as the subsoil washes out easily.

Present Use. The most widespread crop on Deepdene Clay is sugar cane. Some bananas are grown and cattle are grazed over part of its extent. Ground provisions are also grown.

Recommendations. The topsoil where present is normally fertile with its strong structure and high nutrient status. Once this top is lost the nutrient status becomes low to very low as it is over large acreages. The use of proper drainage systems will do much to counter erosion and the use of fertilizers will help out the low nutrient status.

Boghole Clay. Boghole clay develops over shales of the Yellow Limestone Formation in badly drained hollows. Drainage frequently is underground through limestone which makes it prone to flooding by a rising water-table. It is closely associated with Deepdene Clay. This soil is almost completely confined, within the Christiana Land Authority, to the Cave Valley, Aenon Town, Corner Shop triangle, and is less than 300 acres in area.

The topsoil is 4 to 9 inches of dark brown clay with very fine, weak, subangular blocky structure which is plastic when moist and sticky when

wet. If it dries out it becomes firm. It is acid. The subsoil varies from highly acid to very highly acid. It has many coarse distinct mottles of very pale brown and reddish yellow. This changes to yellow or light grey with increasing depth. This subsoil is clay with a fine to medium, weak, subangular blocky structure which is very sticky when wet and very plastic when moist.

The whole soil cracks to at least four feet in drought which is long delayed in this water-retentive soil. The nitrogen status is high in this soil but other nutrients are low. Sweet potatoes and cane are grown here with some tobacco in the dry season.

Ridge Top Soils

Wirefence Clay Loam. This is a mature soil which is found associated with Donnington Gravelly Loam over tuffs and conglomerates of the Trappean Series. The greatest area of this soil lies between the Cave and Yankee rivers but it extends westwards along the northern watershed of the Hector's River and eastwards to John's Hall. It is a soil which has suffered much erosion in this area. While it was never an intrinsically fertile soil, it has been greatly impoverished until returns from cultivating it are sometimes non-existent.

Profile.

	(inches)
Dark reddish brown clay loam of very fine strong subangular blocky structure which is very firm when dry. Highly acid -	0-12
Dark reddish brown clay with very fine subangular blocky structure of medium strength and which is plastic when moist becoming very plastic with depth. Very highly acid -	12-72

Variations. This soil varies chiefly in its depth which may be as little as two feet and as much as over eight feet. The presence or absence of topsoil is also extremely variable but it is for the most part absent due to erosion. Quartz gravel may occur through the profile.

Relief. This soil is found on hilltops which are usually in 'D' slope class though it does occur on 'C' slopes and can occur on 'E' slopes. Rounded hilltops form the usual topography.

Drainage. Surface drainage is moderately rapid due to hilltop position and interior drainage is moderate to moderately slow. No waterlogging or its attendant mottling occurs above the parent rotten rock.

Erosion. This soil is extremely erodible when the topsoil has been lost. All tracks or roads rapidly become gullies as the red subsoil weathers into fine particles which are rapidly washed away in the rain. Under clean cultivation surface washing is also marked and much of the area has suffered badly under ginger and yams.

Present Use. This soil has a high potash status but otherwise it is very poorly supplied with plant nutrients. It is everywhere cultivated by small-holders and much of its area is rented land. The most widespread crop grown for sale is yams and these are planted in individual hills and are cleanly cultivated. This leads to channelling the surface run-off into rivulets and the rivulets into gullies. Aside from yams there is a little cane grown and the rest of the cultivation is of provision crops.

Recommendations. This soil is of low natural fertility and, if cultivated, needs manuring or fertilizer application. On 'C' and 'D' class slopes it can be cultivated with careful conservation practices, but on 'E' class slopes it should carry tree crops if this is possible. The growing of yams in banks on the contour would be a very great improvement upon the present methods and would certainly slow erosion.

Konisberg Clay. This is a mature residual soil that develops over the conglomerates found in Main Ridge. Within the area surveyed it is found on the ridge top at Leicesterfield and on a shelf above the Minho River just west of Frankfield. There is only a small area within the Christiana Area and it is all on gentle topography of 'B', 'C' and 'D' class slopes. It is associated with Cuffy Gully Gravelly Loam of the steep hillsides and the proximity of these ensure good surface drainage. The internal drainage is moderate to about 3 feet where mottling may occur as the internal drainage becomes moderately slow.

Topsoil is a very dark grey clay loam with a medium strength, very fine, subangular blocky structure and is friable when moist. It may be 10 inches in depth and is highly acidic. Below this is 8–10 inches of red clay to clay loam with a similar structure and a slightly plastic consistency. The subsoil may be four feet or more of mottled clay. The mottles increase with depth in both number and distinctness from red and reddish yellow to red and very pale brown. The structure is fine to medium subangular blocky of medium strength. It is very highly acid. Where the soil is shallow the mottles may be replaced by a zone of partially weathered parent material.

When uneroded the general nutrient status is low, but where topsoil has gone, potash status may be high. The soil is of small extent in the area surveyed and is devoted to citrus, coffee and ground provisions.

Hillside Soils

Carron Hall Clay. Carron Hall Clay is a widespread soil in the Christiana Land Authority and is probably the most promising for future use. It is a Rendzina that develops over limestones such as those of the Yellow Limestone Formation. Carron Hall Clay is associated with Waitabit Clay and with Killancholly Clay. To a lesser extent it is also associated with Wildcane Sandy Loam. These associations are often mapped as such since the soils are so closely mixed.

Profile. Beside Beulah Church near Ritchies, in land-fallowing before and after cabbage crops.

	(inches)
Dark grey brown clay with a fine strong subangular blocky structure. This topsoil is plastic when moist and slightly sticky when wet; it becomes firm as it dries out. It is alkaline - - - - - - - - - - -	0– 4
Dark yellowish brown clay loam which is otherwise similar to the topsoil - - - - - - - - - -	4–10
Yellowish brown clay loam with fine strong subangular blocky structure which is plastic when moist - - - - -	10–17
Brownish yellow to reddish yellow clay loam which contains an increasing proportion of limestone mottle with depth. The structure also grades down until there is no structure at 48 inches. It is highly alkaline - - - - - - -	17–48

Variations. The principal variation in this soil is the proportion of stones and gravel which depends upon the variations in parent material. The pH also varies from a slightly acid topsoil to a very highly alkaline subsoil.

Parent material. Carron Hall Clay is formed from the weathering of limestones with considerable percentage of impurity and which are relatively soft. So it is principally associated with the Yellow Limestone Formation.

Relief. This soil is normally found over mature topography of small rounded hills and shallow sinks. The prevailing slopes are in 'D' class. Some of the sinks contain ponds which may or may not dry up by the end of the dry season.

Drainage. Surface drainage is normally moderate to moderately fast and the surface water ultimately disappears underground in one of the many sink holes. Thereafter its course is underground. Internal drainage in this soil is moderate and occasionally moderately slow.

Erosion. Because of its strong structure this soil is more resistant to erosion than are most of the soils of this area. Because of the moderate internal drainage, drains are necessary to care for the excess rainfall. All too frequently these lead at a steep gradient into an ungrassed main drain running straight down-hill. Fortunately even under these conditions this soil gullies very slowly. The surface sheet erosion can frequently be countered by stone contour terracing, as there are frequently stones in the profile and occasional limestone outcrop will also provide the materials for walls. The necessary drains should be better graded and even if main drains are graded they could be grassed over to prevent gullying.

Present Use. With the exception of those which are not tolerant to an alkaline soil, all crops are grown on this soil. The chief crops now are bananas, cabbage, Irish potatoes and cane. It is, however, a soil which is heavy to work and so is neglected in favour of soils which are infertile but easily worked.

Recommendations. This soil which in the Christiana Land Authority lies mostly above 2,000 feet, is suitable for vegetable crops for the markets of Kingston, Spanish Town, etc. It is already utilized for cabbage production and these lines should be followed up. More information as regards fertilizer needs should be made available. Especial effort should be made to prevent erosion as this is the only hillside soil in the area which has not yet been worked to near ruin.

Waitabit Clay. This is another widespread soil and is everywhere cultivated. It is found over shales, sandstones and fine conglomerates of the Yellow Limestone Formation. It is frequently so closely associated with Carron Hall Clay and Wildcane Sandy Loam that they are mapped as an association. In poorly drained hollows, there may be small areas of Deepdene Clay.

Profile. One quarter mile south of Stettin House in banana field.

	(inches)
Strong brown clay with a very fine medium strength subangular blocky structure which is slightly plastic when moist and is friable when dry. Highly acid - - -	0– 4
Yellowish red clay with a fine subangular blocky structure which is slightly plastic when moist. Very highly acid -	4–12
Reddish Yellow clay with very fine weak subangular blocky structure which is plastic when moist and is very highly acid - - - - - - - - - - - -	12–36
Reddish Yellow clay with no structure and which is slightly sticky when moist. Very highly acid. Near the base of the profile there is an increasing proportion of rotten shale until this is reached at 58 inches - - - - - -	36–58

Variations. Normally the topsoil is absent on this soil due to erosion. In deep profiles there may be a little greyish mottling near the base.

Parent Material. This soil is formed from shale, tuffaceous shales, sandstone and fine conglomerates found in the Yellow Limestone Formation.

Relief. Over much of soil the relief is mature with 'D' and 'C' class slopes as is found to the north and west of Albert Town. In other places, as below the Cascade plateau, 'E' class slopes prevail within youthful ridge topography. So this soil is associated with many types of relief each with their own problems.

Drainage. Surface drainage is rapid off this soil, which is normally found in mature or youthful ridge and valley topography. Internal drainage is

also rapid through the top horizons but becomes slow as parent material is reached. This leads to slumping along this line of impedence.

Erosion. Sheet erosion is very rapid off this soil when it is cleanly cultivated as it is under yams. Once the topsoil has gone it will gully readily and especially easily at a sudden increase in the slope. Over most of the soil it has suffered badly from erosion and much needs to be done to counteract it.

Present Use. This soil, like Wirefence Clay Loam, is everywhere used to grow yams with the same bad results to itself. Some areas are also cultivated in sugar cane and others, of course, devoted to ground provisions. Bananas and ginger have, of course, had their day and left their wake of soil erosion.

Recommendations. Nutrient status of the topsoil may be fairly high but as soon as it is eroded the subsoil is very poorly supplied with plant nutrients. Much needs to be done with fertilizer trials to boost yields. The chief need, however, is to stop the sheet and gully erosion. The sheet and rivulet erosion is to be plainly seen after rain in any yam field where the yams are planted in individual hills.

Donnington Gravelly Loam. Donnington Gravelly Loam is a shallow lithosol which develops on steep topography over Trappean tuffs and conglomerates. It is associated with Wirefence Clay Loam on the hilltops. The soil forms an almost continuous east to west belt along the axis of the Christiana area. This axis consists of the Hector's and Yankee rivers and the northern tributaries of the Minho.

Profile. Grass and acacia a quarter of a mile west of Borobridge.

	(inches)
Dark brown gravelly loam with a very fine strong subangular blocky structure and which is slightly friable. Acid - -	0– 4
Dark reddish brown gravelly loam with a very fine weak subangular blocky structure. Slightly friable and slightly acidic. Grades into weathered conglomerates at this level -	4–20

Variations. There is little variation in this soil save that over tuffs; the gravel may be absent but this is rare. The colour may also be grey, brown or reddish grey.

Relief. Donnington Gravelly Loam occurs on steep slopes of 'E' and 'F' classes. It may also occur on small areas of 'D' but this is rarer. Such rivers as the Yankee, the Cave and the Hector's have selected this rock and dug their beds deep into it, so that their valley sides and those of their tributaries are steep. On these slopes this soil develops.

Drainage. Both surface and internal drainage are rapid to excessively rapid. The surface of base soil is liable to pack under heavy rainfall.

Erosion. Erosion is widespread and active in the form of sheet erosion, but it is hardly noticed as parent material weathers into raw soil just as rapidly.

Present Use. At present almost all crops are grown or attempted on those soils. Near Christiana it is used to produce Irish potatoes and near Frankfield it grows sugar cane and sweet potatoes.

Recommendations. This soil has normally a medium nutrient status with a high phosphate status in particular. It is quite fertile but is severely limited in its uses by the shallowness and the rapidity with which it dries out.

Cuffy Gully Gravelly Sandy Loam. This Cuffy Gully Gravelly Sandy Loam is the lithosol developed on steep topography over Main Ridge conglomerates. It is mostly found on slopes of over 30° but slopes of 'D' class also occur under this soil. Surface drainage is rather excessive because of these slopes. The associated soil developed on the ridge top is Konisberg Clay. Within the Christiana area this soil is confined to the south bank of the Minho River and to the south-east of the area surveyed. It is very similar to Donnington Gravelly Loam but is deeper, more retentive of moisture and hence carries more trees.

Topsoil is 4 to 8 inches deep, very dark brown gravelly sandy loam with a fine subangular blocky structure of medium strength and which is ~~slightly~~ plastic when moist. Below this is dark reddish brown gravelly loam from 1 to 3 feet deep, with a similar weaker structure and a slightly friable consistency. The gravel in the profile increases with depth until it becomes the parent material.

The whole profile varies from acid to markedly acid, and the nutrient status is low to medium low. The soil is permeable but is retentive of a certain amount of water. Due to the steep slopes erosion is prevalent, but replacement from parent material is rapid so that erosion has little effect upon yields. At present all crops and many fruit trees grow on this soil but in this region rail connection at Frankfield with a factory has placed the emphasis upon cane production.

Killancholly Clay. Killancholly clay is shallow Rendzina developed over rubble limestones such as found in the Yellow Limestone Formation. It is associated with Carron Hall Clay and at times so closely that an association has been mapped. It frequently covers the same type of shallow sink topography but may also occur on steep slopes. Due to this prevalence of 'D' and 'E' class slopes the surface drainage is rapid though it rapidly disappears underground into the cavernous limestone. Within the Christiana Land Authority this soil is confined mostly to the valley of the Minho River and some of its tributaries.

The topsoil is a very dark grey brown clay of very fine strong subangular blocky structure from 4 to 8 inches deep. It varies from being very firm when dry to plastic and slightly sticky when moist. It is alkaline. The subsoil is either brownish yellow or yellowish brown gravelly clay to clay

loam with a similar structure but which is generally more plastic when moist and more sticky when wet. The gravel is pieces of rubble limestone and increases in proportion till at 2 feet or less the parent material is reached. This subsoil is very highly alkaline.

The presence of lime in this soil frequently induces chlorosis in plants, though the nitrogen status is high. Phosphate and potash are normally low to medium low in status. The strong structure of the topsoil has enabled it in many places to resist erosion even under peasant provision cropping. Its resistance is partly helped by the growth of sugar cane in the Minho Valley. If helped by improved cultivation this soil should continue to retain its topsoil and some of its fertility.

Wild Cane Sandy Loam. This is a shallow lithosol developed over sandstones and sandy tuffs in the Yellow Limestone Formation. It is intimately associated with Waitabit Clay on the ground and is frequently mapped as such an association. The relief upon which it occurs is normally steep with 'E' class slopes even though the surrounding Waitabit Clay topography may be mature. In the Christiana area this soil lies in a strip of country running from east to west between Litchfield and Mount Moriah. The surface drainage of this soil is always rapid and usually excessive.

Where topsoil remains it is generally a dark sandy loam of very fine weak granular structure and is friable to very friable. On drying out the colour changes to light grey. This topsoil is acid. The subsoil is a brown to yellowish brown sandy loam with little or no structure and is friable and highly acid. Topsoil is rarely more than 6 inches deep and the subsoil is usually 2 to 3 feet deep though it may be 6 feet. The nutrient status throughout is low except for potash which may be high to very high.

This soil is not of great extent but is everywhere cultivated because of its ease of handling. It is, however, a poor, shallow, droughty soil, very liable at erosion and has, almost everywhere, lost its topsoil. At present it produces peasants' provision crops and none of them very well.

St. Ann's Clay Loam. St. Ann's Clay Loam, locally known as Terra Rossa or Bauxite, is one of the most widespread soils in Jamaica and is typically developed over hard crystalline limestone of the White Limestone Formation. Since the Christiana Land Authority area is a geological window into this formation, St. Ann's Clay Loam occurs around the borders of it, except for a few hundred acres south-east of Aenon Town. Much of the topography is the karst topography known as cockpit country. In the deep precipitous sinks of this country there are large areas of bare limestone and the soil is mostly confined to sink bottoms and to shoulders between hills where the slopes permit soil to accumulate. These areas of cockpit country are of little agricultural importance; only on its fringes are there areas of smoother topography which are cultivated. Surface drainage is rapid to the sink bottoms where all water disappears underground.

The topsoil is from 4 to 8 inches of red brown clay loam which is frequently neutral to slightly acid. Below this is a dark red clay loam varying from a few inches to sixty feet in depth; otherwise it is uniform. This subsoil is slightly acid to acidic in reaction. The soil has a very fine subangular blocky structure which is strong in the topsoil and becomes weak with depth. This soil is plastic when moist and plastic when it is slightly drier. It is exceedingly permeable and is very seldom wet.

This soil is used in the Christiana area to produce coffee, pimento and yams besides provision crops and is mostly worked by small-holders. It is very liable to both wind and sheet erosion when it is lying bare. The sheet erosion can easily be stopped if the water is given the least chance to settle. Contour cultivation should easily stop this erosion. Besides the erosion induced poverty of the soil, the greatest difficulty lies in the extremely rapid fixation of water soluble phosphates by iron and aluminium sesquioxides in the soil. This makes fertilizer use unbalanced even though potash fertilizers have boosted yields enormously on this soil. Only through the humic layer can plants obtain phosphates, which makes the building up and retention of topsoil vitally important.

Chudleigh Clay Loam. This soil develops over hard crystalline limestone of the White Limestone Formation and has a similar land use to St. Ann's Clay Loam with which it is generally associated. The topography in which it has been seen is smoother and within the Christiana area it occurs as a few acres in a complex sink bottom with 'C' slopes prevailing. Some sixty acres of this soil lie north of Troy.

The topsoil in the one pit sampled was 11 inches deep and was a strong brown clay loam with a strong very fine subangular blocky structure which was moist and friable. Below this is a yellowish red clay with a similar but weak structure to 36 inches. Below 3 feet the structure becomes fine to medium angular blocky and of medium strength. It is slightly plastic when moist. The topsoil is markedly acid and the subsoil is highly acid. In the profile examined the nitrogen status was high but other nutrients were low. The important difference between this soil and St. Ann's Clay Loam is that phosphates are not fixed to any appreciable extent. This makes fertilizer application balanced and profitable.

Shoot Hill Clay Loam. This soil covers up approximately fifty acres to the west of Grantham and is found over volcanic material of uncertain geological formation. In this locality it is associated with Killancholly Clay and Carron Hall Clay and with steep topography. It has been badly eroded in this locality.

Topsoil may be 6 inches deep or entirely absent and is a dusky red clay loam with fine subangular blocky structure of medium strength. When

moist it is slightly plastic and when dry is friable. The subsoil is 1 to 3 feet of dark reddish brown gravelly clay loam with a similar structure and greater plasticity. The entire profile is acid. Nutrient status is low except for high phosphates.

At present most of this soil is under citrus.

Glossary

Alluvial. The name given to soil deposited by running water or flood usually on the flats along river courses or on plains from which the water has receded.

Annual. A plant which completes its life, flowering and fruiting, within a year.

Aril. An extended growth from the substance enveloping the seed, e.g. mace of nutmeg.

Barbecue. A construction of stone with a flat surface finished in mortar used for drying gathered crops such as coffee, cocoa, pimento, etc.

Beta-indole-butyric acid. A growth promoting substance, used to encourage the rooting of stem cuttings.

Biotic. Relating to life or living organisms.

Bud. A miniature shoot bearing a number of young leaves closely packed.

Budding. A method of propagating plants by taking the bud of the desired plant (scion) and inserting it under the bark of a related plant (stock).

Cambium. A thin layer of tissue between the wood and the outer bark (bast). A growth mechanism.

Chlorophyll. The green colouring matter in leaves.

Coir. The fibre from the husk of ripe coconuts used for mats, rope, brushes, etc.

Compost. This is a mechanical mixture of leaf, trash, animal manure, plant cuttings, vegetable garbage and other animal or vegetable matter, all well rotted for use on the land as an organic fertilizer. It nearly approaches *humus* in character and use.

Conservation. Lit. preserving. The planned management of the soil so as to increase its productivity and to reduce the waste of its most valuable components.

Contour-Farming is the cultivation of sloping land in strips on the contour, i.e. crossways, instead of straight uphill or downhill. This method produces a series of small terraces and helps to check eroding downflow of rain water.

Corm. A bulb-like fleshy stem. A bulb free of 'scales'.

Cover Crops, usually legumes, are green crops planted between main crop seasons to protect the soil. They are usually ploughed under to assist the fertility of the soil with their nitrogen content. Cover crops are also grown between rows of orchard trees (e.g. Citrus) until the plants have attained sufficient size that the cover crops may be dispensed with.

Crop Rotation. This is the successive planting of different crops on the same land so as to vary the consumption of the different plant foods in the soil and to regulate the restoration of organic matter to the soil. The various crops so planted are usually in recurrent cycles.

Culm. The hollow stem or straw of grasses and grain crops.

Deciduous. Leaf losing. The periodic falling off of leaves, more particularly at the approach of cold weather in temperate climates.

Dioecious. The male (staminate) flowers on one plant and the female (pistillate) flowers on another, as is usual in Pawpaw.

Erosion. (*a*) Geological erosion—the slow wearing down of surface soil by the action of wind and water;

(*b*) Multiple erosion—the accelerated process of the same wearing down, caused by man's use of the earth. Wherever water runs, winds blow, and the surface of the earth is bared of its natural protecting cover, the process is hastened and the results rendered more visible to the eye.

Farinaceous. Starchy. Containing farina, mealy, floury.

Fertilization. The action of pollen upon the pistil, through the stigma.

Fertilizer (Commercial). Manufactured compounds whose components when introduced into the earth and subjected to the action of water contribute plant food to the field. These usually contain nitrogen, potash, lime and phosphorus in varying proportions.

Forage. Vegetable food consumed by animals for their sustenance.

Germination. The development of the seedling from the embryo contained in the seed.

Guano. The dried excrement of sea birds, consisting chiefly of calcium and tri-calcium phosphate mixed with ammonium oxalate and ammonium hippurate.

Habitat. The kind of locality in which a plant naturally grows, (as forest, mountain etc.); the geographical distribution or native home of a plant.

Hermaphrodite flowers. Both pistil and stamen in one flower.

Humus. This is the natural layer of earthy matter composed of decayed leaves, roots, plants and other vegetables or animal matter occurring usually in tree-covered areas of the earth.

It is extremely fertile and is of sponge-like character, absorbing water readily and retaining it for a long period.

Hybridization. The crossing of two distinct species by the action of the pollen of one upon the pistil of the other, the resulting plant being a hybrid.

In Situ. On the spot. Sowing where the plant is intended to remain after germinating.

Irrigation. The distribution of water for agricultural purposes in dry areas, either by canals and runnels or by overhead spraying.

Laterite Soil. A clayey acid soil with iron oxides present imparting a reddish colour to the earth.

Layering. Inducing a branch to send out roots by covering it with earth while still attached to the parent plant.

Leaching. The absorbing of soluble minerals or organic matter in the soil and its subsequent washing away by the action of water.

Legume. Members of the pea family, capable of fixing by bacteriological action nitrogen in the soil by means of nodules on and among the roots.

Monoecious. Male and female organs in separate flowers on the same plant, as in many gourds.

Monopodial. Having a branch system in which each or any branch continues to increase in length by apical extension.

Mulch. This is a top dressing of grass, leaves, bush, etc. of various depths to conserve the moisture of the underlying earth from evaporation by the direct rays of the sun. The mulch also serves to improve the soil by the addition of organic matter when it rots.

Nematodes. Minute threadlike grubs that usually infest the roots of plants and vegetables.

Node. A joint. The part of a stem from which a leaf usually grows.

Node or Joint. The part (often swollen) of a stem from which normally arises a leaf or whorl of leaves.

Nodule. A tubercle on the root of a legume formed by bacteria which fix and store nitrogen in the nodule.

Oval. Flat, rounded at each end, with curved sides, and about twice as long as broad, widest in the middle.

Ovate. Flat and thin, shaped like the longitudinal section of an egg, widest below the middle.

Perennial. A plant that lives for more than two years, as distinct from biennials and annuals.

Pericarp. The wall of a fruit, the fleshy covering.

Petiole. The stalk of a leaf, sometimes absent, when the leaf is sessile.

pH: A convenient method of expressing small differences in the acidity or alkalinity of substances.

Pinnate. Leaves with feather-like divisions reaching to the mid-rib.

Pistil. The female organ of a flower, consisting of ovary, style and stigma.

Pollen. The fertilizing dust produced by the anthers (male organ) of flowering plants.

Protein. A complex organism formed in leaves or grain with flesh-forming properties.

Pulp. The juicy or flesh tissue of fruit.

Ratoon. A second or subsequent crop formed by the axillary offshoots arising from the buds found at the base of the original plant.

Retting. Separating the fibres in vegetable stalks from the bark and other woody growth by prolonged submersion in water.

Rhizome. A creeping stem above or underground with buds or eyes, and scales, e.g. ginger.

Root Absorption. The phenomenon of water in the soil containing dissolved inorganic substances passing into the root-hairs by diffusion through a permeable membrane (*osmosis*).

Scion. The part of a plant used in grafting or budding representing the variety desired to be propagated.

Sessile. Without stalk.

Shale. A sedimentary rock that is thinly stratified and is composed of fine grained hardened muds.

Slips—Pineapple. The axillary offshoots which arise from the buds found nearest to the base of the fruits in the fruiting stalk of the plants.

Soil. A composition of organic and inorganic substances. The former is termed *humus*; the latter comprises clay, sand, calcium, etc. in varying proportions.

Stamen. The pollen bearing parts of a flower.

Stigma. The receptive part of the pistil or style which receives the pollen.

Stipule. One of the two appendages, usually leaf-like, often present at the base of the stalk of a leaf.

Stool. A plant from which off-sets or layers are taken growing in clusters, e.g. Bananas.

Strip Cropping. This is the successive planting of different crops of thick grasses or similar compact growing plants alternately between other strips of cultivated plants all on a contour to act as a check on the downflow of rain water.

Suckers. The axillary offshoots which arise from the buds found at the base of the stem of the plant and which give rise to the ratoon or second crop.

Sympodial. Having a branch system in which the main axis ceases to elongate after a time, and one or more lateral branches grow on.

Tendril. A slender, string-like spiral growth arising from the stem of climbing or creeping plants by means of which they gain support when climbing.

Tillering. The formation of tillers or lateral shoots that spring from the basal nodes of grasses.

Tuber. The swollen underground stem or part of a stem of certain plants, e.g. Potato.

Tubercled Roots. The roots of leguminous plants (peas, beans, clover, etc.) possessing little galls or nodules containing nitrogenous particles.

Unisexual Flower. A flower containing either stamens or pistil but not both, the other sex being in a separate flower.

Vitamins. Substances of unknown composition present in minute quantities in foodstuffs, the absence of which leads to maladies and disorders.

Watershed. An area of drainage feeding water by run-off and seepage to surface and underground streams.

Windbreaks. These consist of rows of quickly growing trees of fairly good height and low branching habit in compact masses at the outer edges of cultivated fields to break the force of incoming high winds which would otherwise adversely affect the crops.

Suggested References for Further Reading

Items marked * are recommended for beginning

Banana Growing

FAWCETT, WILLIAM. The banana: its cultivation, distribution and commercial uses. 2nd and enl. ed. London, Duckworth, 1921.

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*SIMMONDS, N. W. Bananas. London, Longmans Green, 1959.

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