

# **AT** MICROFICHE REFERENCE LIBRARY

A project of Volunteers in Asia

Land Clearance: Alternative Techniques for  
Removing Trees and Bushes

Published by:

Intermediate Technology Publications, Ltd.  
9 King Street  
London WC2E 8HN  
United Kingdom

Paper copies are \$ 4.25.

Available from:

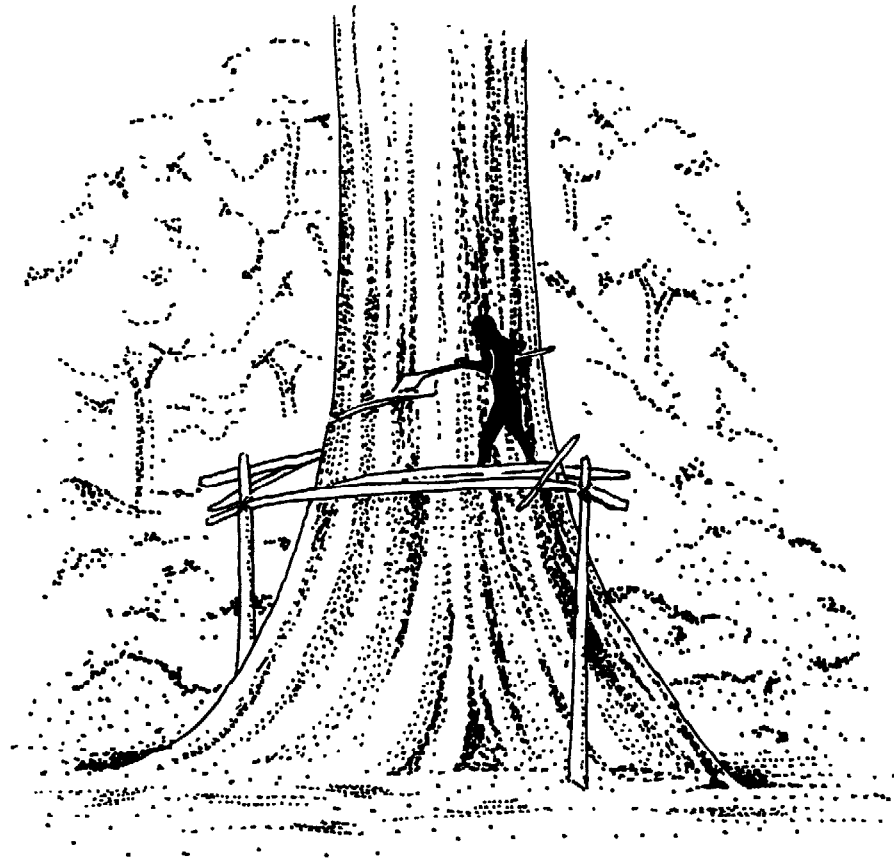
Intermediate Technology Publications, Ltd.  
9 King Street  
London WC2E 8HN  
United Kingdom

Reproduced by permission of Intermediate  
Technology Publications, Ltd.

Reproduction of this microfiche document in any  
form is subject to the same restrictions as those  
of the original document.

# **Land Clearance**

## **Alternative techniques for removing trees & bushes**



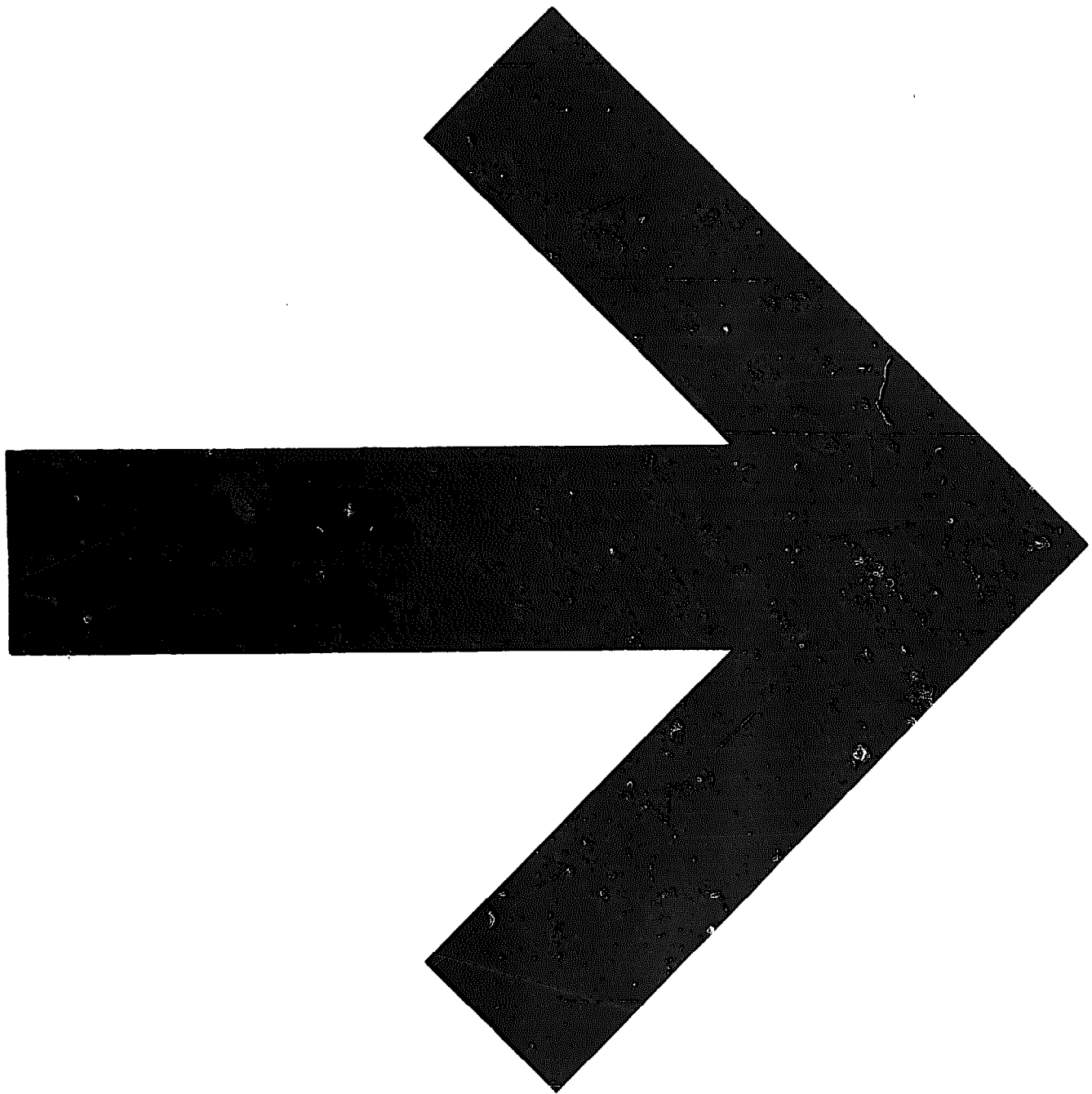
**Intermediate Technology Publications Ltd.**

If land has to be cleared of trees, how do you go about it? What ecological and environmental factors have to be considered before undertaking any programme of land clearance, how do you plan your programme, how do you decide between the various techniques and equipment, how many men will be needed, how much will you spend? This booklet has been compiled in response to such questions and is based on the experience of experts in answering technical enquiries on land clearance from many countries. It provides a much-needed guide to choosing the most suitable method for the type of land to be cleared, type of tree growth and the resources available.

The authors are members of the Agriculture Panel of the Intermediate Technology Development Group.

**ISBN 0 903031 77 9**

**Intermediate Technology Publications Ltd.**



# CONTENTS

	Page
ACKNOWLEDGEMENTS	ii
PREFACE	1
INTRODUCTION	2
PLANNING LAND CLEARANCE	6
APPROACHES TO LAND CLEARANCE	10
TECHNIQUES AND EQUIPMENT	12
KILLING STANDING TREES AND BUSHES	14
Fire	15
Biological control	17
Ring barking	18
Chemical treatment of individual trees & bushes with arboricides	20
Mistblowers	23
Aerial spraying	25
UPROOTING WHOLE TREES AND BUSHES	26
Hand uprooting tools	27
Hand winch	29
Draught animals	31
Tractor (direct pull)	34
Tractor winch	36
Tractor-mounted tree extractor	38
Bulldozing	40
Two tracklayers with chain	43
CUTTING THROUGH THE TRUNK AT GROUND LEVEL	44
Hand cutting tools	45
Hand-held clearing saw	47
Chainsaw	49
Tractor-mounted slasher	51
Tracklayer with roller-crusher	53
Tracklayer with shearing blade	55

	Page
REMOVING STUMPS	57
Hand digging tools	58
Root hook	60
Explosives & burning	62
Tractor-mounted stump extractor	63
Tractor-mounted stump chipper	64
Bulldozers, rakes and root ploughs	66
LAND CLEARANCE AT THREE LEVELS OF INVESTMENT	68
FURTHER READING	71

**LAND CLEARANCE**

**Alternative Techniques for Removing Trees and Bushes**

Compiled by the Agriculture Panel  
of the Intermediate Technology Development Group

**An Intermediate Technology Publication**

Published by Intermediate Technology Publications Ltd,  
9 King Street, London WC2E 8HN, U.K.

© 1981 Intermediate Technology Publications Ltd

ISBN 0 903031 77 9

Printed by House of Arts, Luton, Beds.

#### ACKNOWLEDGEMENTS

Many thanks are due to the members of the Intermediate Technology Development Group Agriculture Panel and their colleagues who assisted in the compilation of this publication.



## PREFACE

This publication aims to give those not familiar with the subject of land clearance a general idea of the range of techniques and equipment available. It does not cover any aspect in detail but aims to advise those who may occasionally have to administer land clearance of the different methods that could be used for removing trees and bushes. This choice is always influenced by the type of land, type of vegetation cover, the resources available and the objectives of both the decision makers and the community. Only limited technical details are included and expert advice should be sought at an early stage.

Before clearing a forested area of trees it is worth considering the global situation. Sixteen million hectares of forest are being lost annually. That is equivalent to an area that would supply, in perpetuity, the wood raw material requirements of 480 million people.

Policy makers will want to consider not only the adverse, direct consequences of this resource depletion but also the indirect prospects of soil erosion, climatic changes and broader environmental damage. Further attention may also be directed towards developing alternatives to wood and for a more efficient use of wood where no alternatives exist.

## INTRODUCTION

Land clearance can be required for many different reasons. It may be considered as a means of clearing land for cultivation of other crops, for providing fuel, for replacing certain trees with others, or to meet the need for timber locally or abroad. Any programme of land clearance, however, should focus on both the specific means and manner of performing the clearance and the broader implication stemming from the programme; the two aspects are intertwined when one considers the public good.

The bulk of this publication concerns itself with choices reflected in the issue of the most appropriate technology to perform the job at hand, but the broader considerations are vitally important too. The appropriateness of the technology issue arises because too often in the past development programmes have failed to consider the impact of technology choices on the use of local labour, physical and financial resources or indeed on the needs and aspirations of local populations, especially those in the (largely) rural areas. It is increasingly accepted that technology choices should reflect shortage of foreign exchange, unemployment, dependence on outside sources of fuel, equipment, maintenance, supervision. Moreover, for socio-economic reasons policy-makers may need to reflect on the consequences of technology choices on the issues of agro-forestry, diversity within agricultural production, rural employment patterns, as well as the basic needs and aspirations of the people of the country.

It is important to consider the consequences of removing trees before proceeding to techniques for doing so. The wood may be vital to the community for fuel, it may provide a living for local charcoal burners and to remove trees would affect the rate of soil erosion, soil fertility, the micro-climate and the ecology of the area. Many potentially adverse effects can be mitigated by minimising clearance or

doing it more rationally. For tree crops it may only be necessary to thin the indigenous forest and for field cultivation the preservation of strips or blocks of trees will limit erosion and will continue to provide wind breaks, shelter for stock, fuel and an essential habitat for wildlife. Alternatively trees, crops and animals could be raised in a land-use system known as agro-forestry. Agro-forestry is an age-old practice for which modern concepts are only now being developed. It is a socially, culturally and ecologically acceptable integrated form of land use involving trees, that improves or does not degrade the soil and permits increased and sustained production of animal and plant produce including wood. The advantage of growing food crops and trees together and of raising livestock on the same piece of land is that greater productivity from the land can be achieved than if the same things were done independently. In addition this system can conserve the environment and provide farmers with a much wider range of products than they would otherwise obtain from their land. If existing species of trees were unsuitable then consideration should be given to selective felling and replanting with other species before embarking on a new land-use programme.

Careless clearance of trees could cause permanent economic damage through irreversible degradation of the soil. Before clearance, the soil and forest have a remarkably closed nutrient cycle in which most nutrients are stored in the biomass and topsoil, and transferred from one to the other via rainwash, litter fall, timber fall, root decomposition and plant uptake. Losses from this system are usually negligible. Lush tropical vegetation can grow without nutrient deficiency symptoms in soils of very low native fertility. When this nutrient cycle is broken by clearing the vegetation, significant changes in soil physical properties take place. Soil and air temperatures increase because more solar radiation reaches the soil surface. Soil moisture regimes are also altered, with less moisture removal from

the subsoil than when forest roots are active. Soil structure deterioration which leads to runoffs and erosion losses occurs in poorly aggregated topsoils subjected to inappropriate management practices. Land-clearing methods are crucial because certain mechanical operations, particularly those using heavy equipment, may result in serious damage to soil physical properties, leading to compaction, topsoil removal and erosion.

When it has been decided that clearance of the existing vegetation is necessary careful planning will minimise the negative effects. A detailed land-use plan is required which shows the existing trees, topography, soils and rainfall pattern; the order, time-scale and extent of clearance; and the planned tree and crop cover throughout the year. The future production plans will show the range of products to be extracted and the production method to be used which will determine the kind of clearance that is required, whether, for example, tree stumps need to be removed or large areas need clearance of debris for mechanical cultivation. Knowledge of the soils, topography and rainfall will allow adequate soil conservation measures to be taken. The plan will indicate which trees need felling and which scrub and brushwood areas need clearing by a certain date, thus showing the size of the task to be undertaken. Detailed local knowledge of existing tree clearing practices is essential. It may be that these are adequate for the task, but if not information on the availability of local manpower, equipment and servicing is required. In the event that these too are inadequate further investigation of sources of equipment and spares within the country and from overseas is necessary.

In the following pages the initial planning steps and approaches to tree clearing are summarised. Various techniques and types of equipment are then listed and illustrated. Finally three possible sets of tree clearing equipment are selected: a labour-intensive set using 20 times as many man days to clear

an area than the most capital-intensive set: a moderately capital-intensive set; and a capital-intensive set costing about 300 times as much as the most labour-intensive set.

## PLANNING LAND CLEARANCE

### PREPARE PRODUCTION PLANS FOR THE AREA

The plans will indicate the cropping pattern and the use of trees and animals in the production system. Production methods will be detailed and full consideration will be given to the transport of goods to and from the area.

### SURVEY THE AREA

At the same time as production plans are being prepared a comprehensive survey of the area should be made. This will assist in planning future production as well as planning the method of developing the area. The survey will include:

#### Types of trees present

An inventory of the existing trees should be made taking into account species and their economic potential, size of tree and distance between trees. The trees for felling and the areas to be cleared can then be mapped out. Detailed knowledge of the size of trees for felling the range of their sizes and of whether they are hard or soft woods, will aid equipment selection.

#### A soil map of the area

Knowledge of the soils will assist in production plans and in the planning of adequate soil conservation measures.

#### A relief map

If there is no adequate map of the area steps should be taken to make a sketch map. The information gathered in the survey should be plotted on the map.

## Rainfall distribution

The frequency and quantity of rainfall should be ascertained. Soil conservation measures can be planned more effectively if the likely intensity of the rainfall is also known. Where there is a long dry season the soil may become so hard that it is impossible to uproot trees or remove stumps until some rain has fallen. Removing the tree cover and disturbing the soil will tend to increase soil erosion, so it may be better not to uproot trees just before the rainy season. However, at the end of the rainy season the soil may be too wet for tractors to work effectively. Killing trees by burning is only possible in areas where there is a pronounced dry season and the burning should be left until the end of that season. It may be necessary to use heavy machinery if the work must be finished quickly and the climate permits only a short working season in each year.

### DETERMINE THE EXTENT OF CLEARANCE NECESSARY

The plans will indicate how much land needs clearing and the thoroughness of the clearance required. For example: if a tractor will subsequently be used for cultivation then large fields should be cleared of most of the trees, stumps and roots to below cultivation depth. A deeper cleared layer will be necessary for root crops, or land which will be ridged, than for non-root crops grown on level ground. If the land is to be ploughed by oxen instead of a tractor some of the larger stumps may be left in place, and the cleared fields can be smaller because an ox plough is more manoeuvrable. If the cleared land will be used for pasture or tree crops there may be no need to remove the stumps. Belts of trees can also be left to give shade to the young trees or to the grazing animals.

For sloping land, clearance should be restricted to narrow belts, on or close to the contours. The cleared timber can

be placed in windrows along the upper edge of the tree shelter belts to assist in controlling erosion. As few trees and stumps as possible should be cleared from the land: sufficient should be left so as to minimise erosion.

#### CONSIDER ACCESS ONTO THE LAND

The ease of access onto the land and the topography of the land will affect the types of equipment that can enter the area and be used safely and the saleability of the timber. An access road may need to be constructed for bringing in heavy equipment to extract large trees and to cultivate the land mechanically. Land intended for ox cultivation, re-forestation or pasture may not need an access road.

The choices for subsequent crop production may be limited if access to the area is difficult.

#### PLAN THE DISPOSAL OF THE TIMBER

The disposal of timber needs careful planning otherwise the costs of this operation could exceed the initial cost of cutting down the trees. If use cannot be made of the timber on the farm, the cheapest method may be to sell the timber to local merchants, charcoal burners and firewood cutters. However, they may not clear the land in time for planting and they are unlikely to have removed the stumps. The extra difficulty and cost of digging out the stumps, if this is necessary, may outweigh the initial advantage. An alternative is to sell the plank timber (i.e. that above the flared bowl), which can be cut from the roots and bowl after felling whole trees. When it is not possible to remove the timber and if it will not rot down, burning may be necessary. But stringent precautions must be taken to prevent the fire from getting out of hand and damaging the nearby fields and trees.



## FIND OUT THE AVAILABILITY OF MANPOWER

Land clearance can be carried out using labour and simple equipment alone if there is sufficient manpower available. Most mechanical tree clearing equipment needs highly skilled operators if it is to be used efficiently. Much of the equipment is very dangerous in unskilled hands. Specialised training for various lengths of time may be required, including the training of service engineers.

## FIND OUT THE AVAILABILITY OF EXISTING MACHINERY AND MAINTENANCE FACILITIES

Sometimes the land clearance can be done by agricultural tractors during slack periods. If a tractor is available it may be worth buying a winch or tree extractor to fit on to it. It may only be economic to use heavy tracklayers for land clearance if they can be hired from those who normally use them for building dams, roads etc.

The maintenance of hand tools can be carried out in a nearby village. But if engine-powered equipment is used it is essential to have maintenance workshops and spare parts available. The lack of the latter may paralyse equipment for months, whilst spares are on order. The slow running diesel engines of tractors are generally more reliable than the small high speed petrol engines of chainsaws. Wheeled tractors usually need more maintenance when used for land clearance than when used for normal agricultural operations. Pneumatic tyres have a very short life if tractors are driven over stumps.

Small engine tools, such as chainsaws, can usually be taken to the nearest town for repair, but broken-down tractors often cannot be moved and have to be repaired in the field. Although repair facilities for ordinary wheeled tractors may be available nearby it is unlikely that such convenient facilities would be available for tracklaying vehicles.

## APPROACHES TO LAND CLEARANCE

There are four basic approaches to the task of removing trees and bushes during land clearance operations.

### KILLING STANDING TREES AND BUSHES

Fire can be used to destroy small bushes and to kill larger trees by scorching. Cutting through the bark of a tree all the way round its trunk (ring barking) will eventually kill it. Trees and bushes can be treated with chemical arboricides by spraying or by application through cuts in the bark. Animals, insects or diseases can be introduced to kill the trees.

### UPROOTING WHOLE TREES AND BUSHES

This is generally done by pulling or pushing sideways on the trunk at some height above ground level. For small trees there are machines which grip the trunk and lift the whole tree vertically out of the ground.

### CUTTING THROUGH THE TRUNK AT GROUND LEVEL

This can be done with an axe, by hand or power saw, or by a shearing blade mounted on a heavy tracklayer. Small trees and bushes can be knocked down and cut through by a heavy-bladed roller towed behind a tractor. Small bushes can also be cut with a tractor-mounted slasher. The stumps left in the ground have to be removed in a second operation.

### REMOVING STUMPS

Stumps can be pulled or lifted out of the ground. They can be shattered with explosives into small pieces which can then be removed by hand. Stumps can also be destroyed where they are by burning them or by chipping them mechanically into

very small pieces, or they can simply be left to decay. In general, it is easier to remove the root with the rest of the tree than to pull it out afterwards.

## TECHNIQUES AND EQUIPMENT

This section describes the techniques and equipment available for tree clearing. It is divided into four parts dealing with methods of killing standing trees and bushes, uprooting whole trees and bushes, cutting through the trunk at ground level and removing stumps.

Notes on each piece of equipment are provided, where appropriate, as follows:

### THE EQUIPMENT REQUIRED IS LISTED

A list of equipment is given and a guide to its price is quoted in price ranges A to G, which were equivalent during 1980 to the following UK prices:

- A less than £25
- B less than £50
- C less than £500
- D less than £5,000
- E less than £10,000
- F less than £100,000
- G less than £200,000

(It is worth emphasising that hand-operated equipment is many hundreds of times cheaper than high-powered engine driven equipment and although local manufacture of equipment may reduce its price, generally, the relative prices of different pieces of equipment will be fairly constant).

Other items that are required to perform the operation, such as chemicals, are also listed. Items such as fuel and lubricants will be required by all petrol and diesel driven machines and these are not specially listed.

## THE OPERATION TO BE PERFORMED IS DESCRIBED

The technique is explained and the operation of the equipment is described. No indication is given of the labour cost of the operation but if skilled personnel are required this is mentioned and as there will be large differentials between the skilled and unskilled this needs to be taken into account.

## SPECIAL POINTS ABOUT THE EQUIPMENT ARE MADE

Comments are made, if appropriate, on the equipment's durability, maintenance, transport and manufacture.

Mechanical equipment may only have a life of five years. If a particular piece of equipment has a much longer or shorter life expectancy this is noted. The type of maintenance facilities required are suggested. Repair costs often amount to about 150% of the original purchase price over the life of a machine. If the costs are likely to be higher, this is noted. If the equipment has special transport requirements these are noted. The possibility of production in areas with limited manufacturing capability is indicated. Otherwise the equipment may have to be brought in from other areas or countries with specialised manufacturing capability.

## SAFETY POINTS ARE NOTED

Most land clearance operations are potentially dangerous if care is not taken. This section emphasises any special safety points, and the necessity for using skilled operators. For every operation some training is essential, during which operators should be instructed in the safe use of the tools and equipment and be shown the protective clothing that is necessary for the operation.

## **Killing Standing Trees & Bushes**

## FIRE

Fire, if it is hot enough, can completely kill bushes and trees.

### EQUIPMENT REQUIRED

Price range

Machetes	} for fire control	A
Fire beaters		A

Small bushes can be completely destroyed by burning, particularly if there is a lot of dry grass underneath them. It is simplest to burn bushes at the end of the dry season, although the danger of the fire getting out of control is very high in these conditions. Tall trees are more difficult to burn, but the heat from burning the grass and bushes may kill the trees by scorching them. Firebreaks, cleared areas to separate areas to be burnt from surrounding trees, crops, or dwellings, should always be used. There is some benefit to the subsequent crop from the fertiliser value of the ash.

A common procedure for burning, in areas with an extended dry season, is as follows:

- a) Make firebreaks of sufficient width, all around the area.
- b) At the end of the dry season and at a windless time, e.g. early morning, set the tinder alight.
- c) Have a team of fire fighters prepared to stop the spread of the fire.

## SAFETY

The risk of fire getting out of control is very great. Firefighters should always be on hand and firebreaks must be used. Operators need training in fire control.

This operation only requires the simplest equipment to cut down scrub in order to make firebreaks.

## BIOLOGICAL CONTROL

Goats and sheep can kill most types of small bushes by gnawing the bark or by eating the leaves. The process takes years to complete as they are selective in what they eat. Fencing or shepherding is required to limit the area to be cleared. Alternatively, it is possible to bring an insect or disease which will kill trees or bushes but usually the parasite will attack only a single species or tree and it is difficult to restrict this to a limited area.

Biological control can only be used in a few specialised circumstances and is not a generally applicable tree-clearing method.



## RING BARKING

The removal of a complete ring of bark from around the tree will kill it.

### EQUIPMENT REQUIRED

### Price range

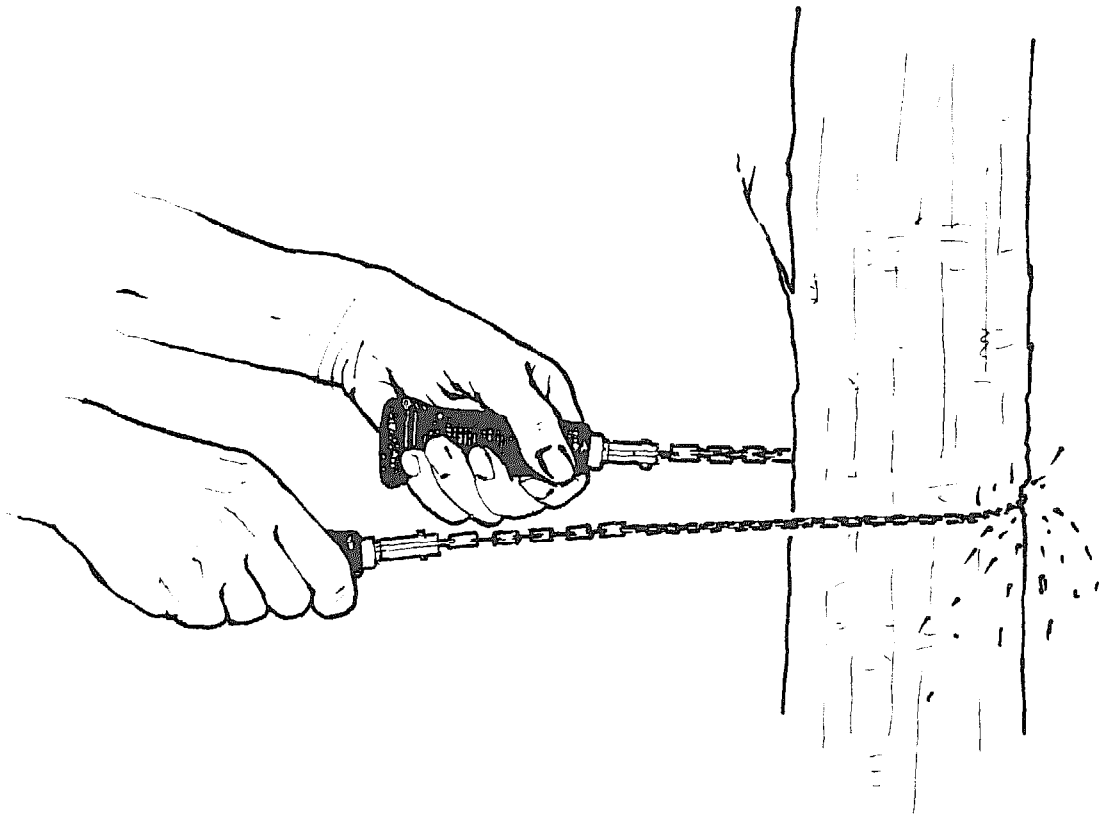
Axe	A
Machete	A
Chainsaw blade	A

Trees can be killed if a complete ring of bark of sufficient depth and width is removed from the trunk, but it may take from one to five years before the tree finally dies. The ring must be cut as close to the ground level as possible, to minimise sprouting from below the ring. The usual method of cutting away the ring of bark is with an axe or machete. Another method, suitable for trees up to about half a metre in diameter, is to use a chainsaw blade fitted with two handles, though in some species the wound thus formed is narrow enough to heal. This method is slow and once the trees are dead they have to be removed.

A chainsaw blade if used continuously will only last from one to three months, otherwise the equipment is durable. It can be maintained locally, and with the exception of the chainsaw blade, can be manufactured by a village blacksmith.

### SAFETY

There is a low risk of injury except, once the trees die, from falling branches.



*Ring barking using a chainsaw blade*

## CHEMICAL TREATMENT OF INDIVIDUAL TREES WITH ARBORICIDES

Arboricides, chemical tree killers, are effective when applied onto leaves, the bark or injected into the trunk.

EQUIPMENT REQUIRED	Price range
Painting equipment	A
Knapsack sprayer	B
Injector (hand operated)	B
Protective clothing	A
Hand auger	A
Chemicals	

The simplest way of applying chemicals to individual trees is by painting them onto the bark around the base of each tree. Alternatively, the chemical could be sprayed onto the tree with a hand operated knapsack sprayer. Sometimes the chemical is painted or sprayed onto a 'frill girdle' cut in the bark with a machete. Other methods include placing the chemical in downward inclined auger holes made in the trunk, or injecting the chemical from a knapsack container. A wide variety of chemicals is available and the manufacturers will usually be able to suggest the best for the species of trees to be killed. Training in the use of chemicals is required.

The equipment can be maintained using a small set of hand tools. It could be manufactured in a small factory.

### SAFETY

Arboricides are very dangerous and must be handled correctly with extreme care. Protective clothing must be used and chemicals and containers must be handled according to safety instructions.



*Applying chemical to a frill girdle using a knapsack sprayer*



*Arboricide injector*

## MISTBLOWERS

Mistblowers can distribute arboricides, chemical tree killers, over the leaves of trees up to 5 metres high.

### EQUIPMENT REQUIRED

### Price range

Knapsack mistblower	C
Protective clothing	C
Chemicals	

A hand-operated or small petrol-driven mistblower can be used to spray the leaves of trees up to about five metres high with arboricides. Tractor-mounted mistblowers have a longer reach, but a tractor can seldom be driven over land where the trees are close enough together to justify overall spraying. Operators need considerable training in order to make operation safe. Operators should also have some skill in the use of small engines.

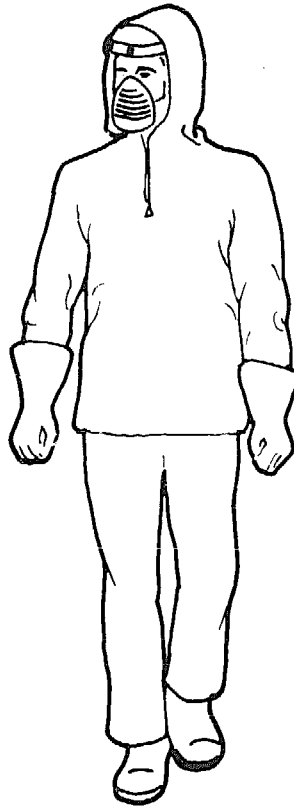
Most small engines will have a relatively short life. The petrol driven mistblowers will need regular maintenance. The spraying equipment can be maintained using a small set of hand tools.

### SAFETY

The wearing of protective clothing is essential, especially face masks, and chemicals and containers must be handled according to safety instructions. There is a danger of chemical drift into other areas.

## AERIAL SPRAYING

Leaf-contact arboricides, chemical tree killers, can be applied indiscriminately to large areas by aeroplane. The equipment is usually hired and is expensive. Insurance premiums increase the cost. Security staff should be employed to keep people away from the area to be sprayed. The chemicals are dangerous and protective clothing is essential. Residual chemicals may cause problems later.



*Safety clothing for mistblower operator*

## Uprooting Whole Trees & Bushes



## HAND UPROOTING TOOLS

Small bushes can be uprooted with hand tools.

### EQUIPMENT REQUIRED

### Price range

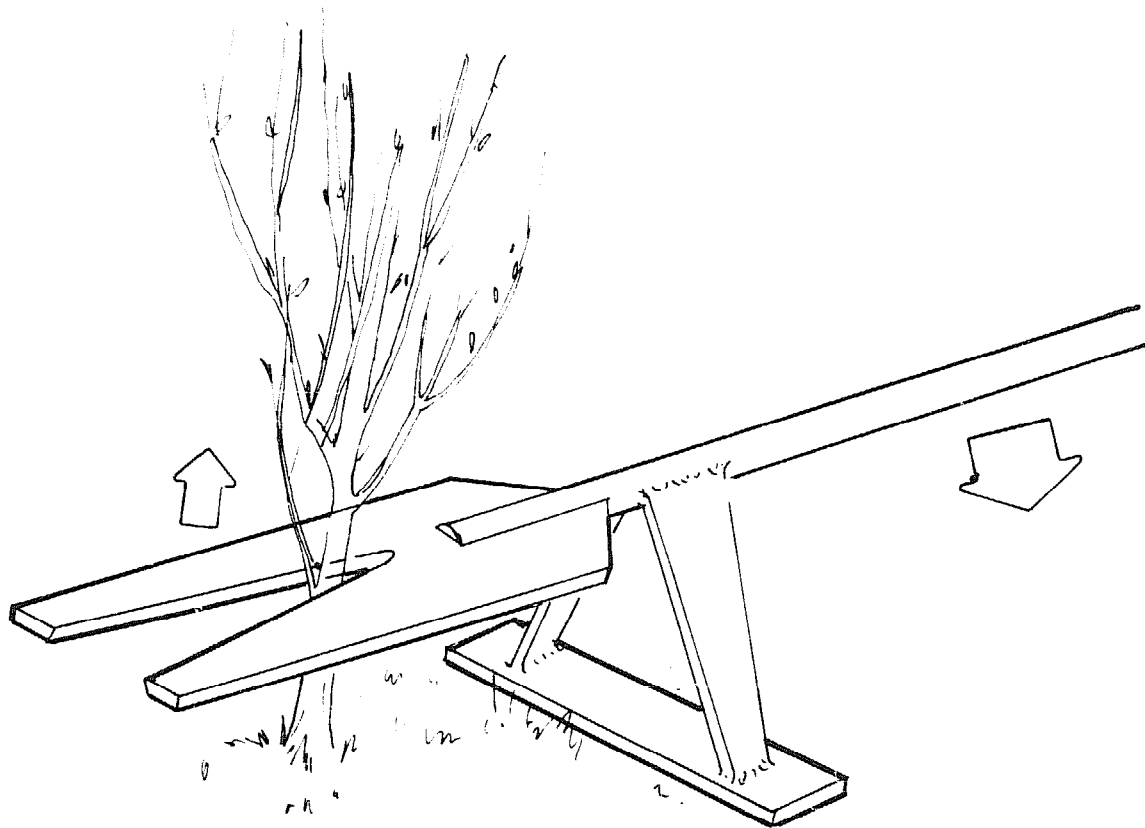
Mandypick	A
Hand cotton-stalk puller	A

The mandypick and the hand cotton stalk puller can be used to uproot small bushes with stems less than about 2cm in diameter provided that the ground is not very hard. Both tools consist of a jaw, to grip the base of the bush, on the end of a long-handled lever. They are more efficient for uprooting bushes than spades or mattocks and little training in their use is necessary.

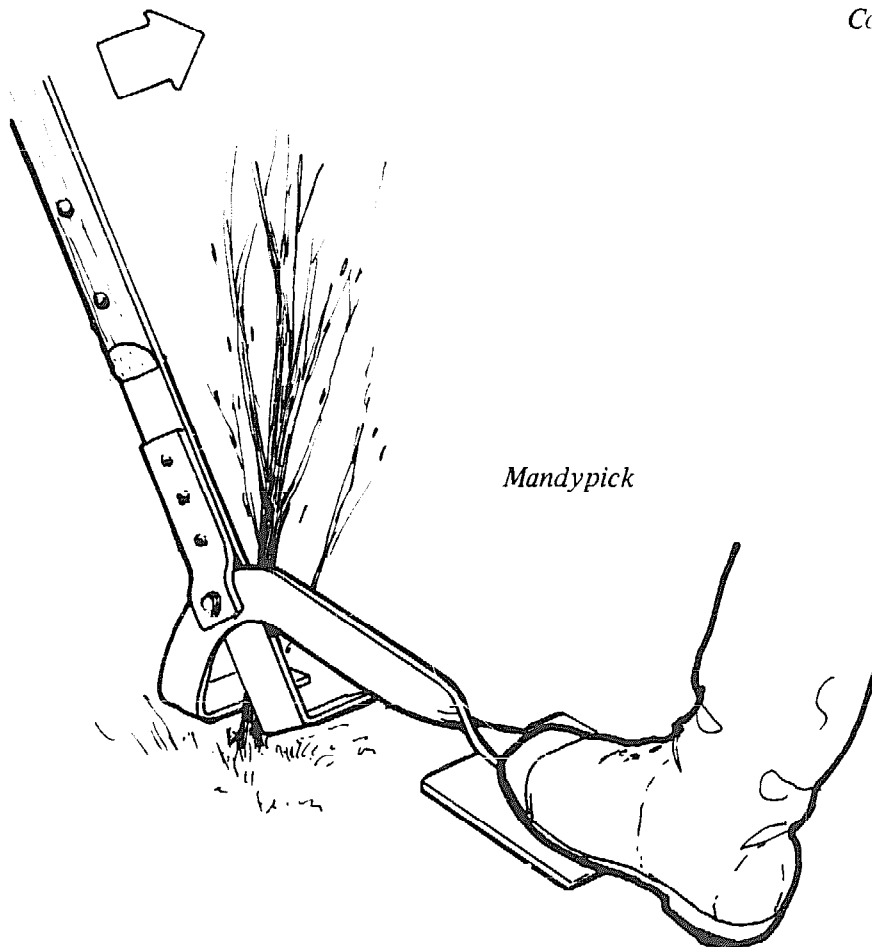
These are cheap, easily manufactured tools, that can be very effective in the right circumstances.

### SAFETY

No special points need noting.



*Cotton stalk puller*



*Mandypick*

## HAND WINCH

Trees can be pulled over by a hand winch.

### EQUIPMENT REQUIRED

Price range

Hand winch

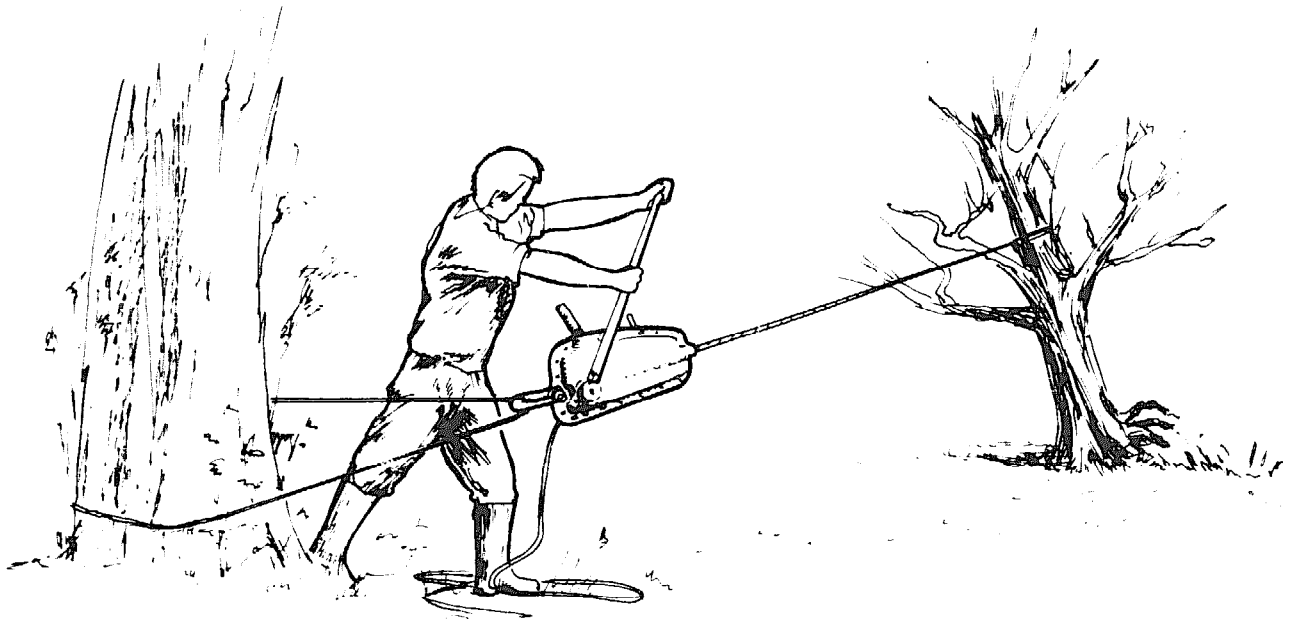
C

A hand winch or pulling tool can exert a very large pull (up to about 5 tonnes) if a firm anchorage is available. It can be used to pull out trees in the same manner as draught animals are used (see next section). The usual method of anchoring the winch is to tie it to the base of a large tree.

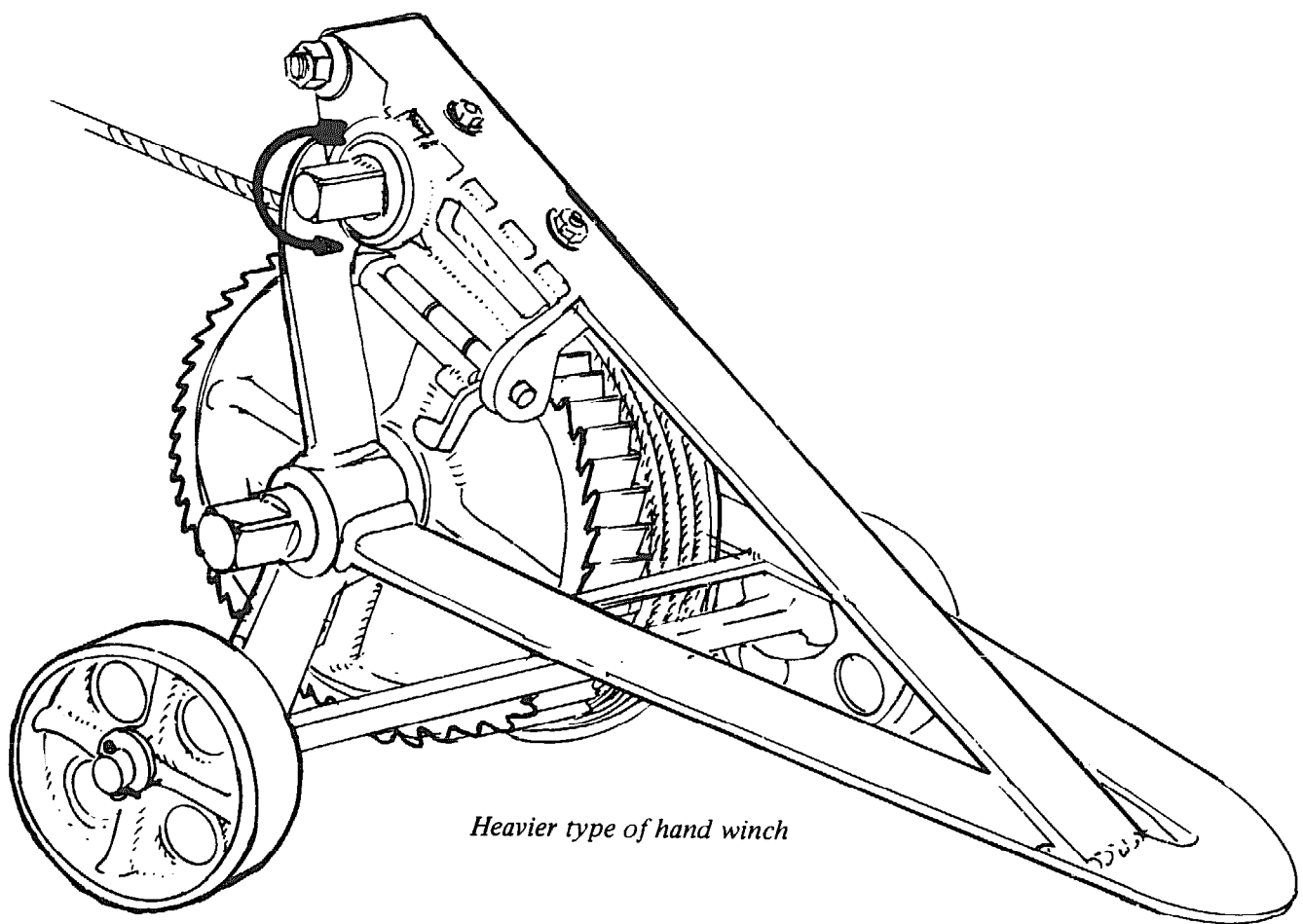
Apart from routine oiling the equipment needs little maintenance and will last a long time. The large winches will require an ox-cart, or similar, for transport. Hand winches could be made in a small factory.

### SAFETY

Handled carefully this equipment provides an effective safe method for uprooting small trees. The distance from the winch to the tree trunk should be at least twice the height of the tree to be felled. Some operator training is necessary for safe operation.



*Lightweight pulling tool*



*Heavier type of hand winch*

## DRAUGHT ANIMALS

Draught animals can pull down small trees.

### EQUIPMENT REQUIRED

### Price range

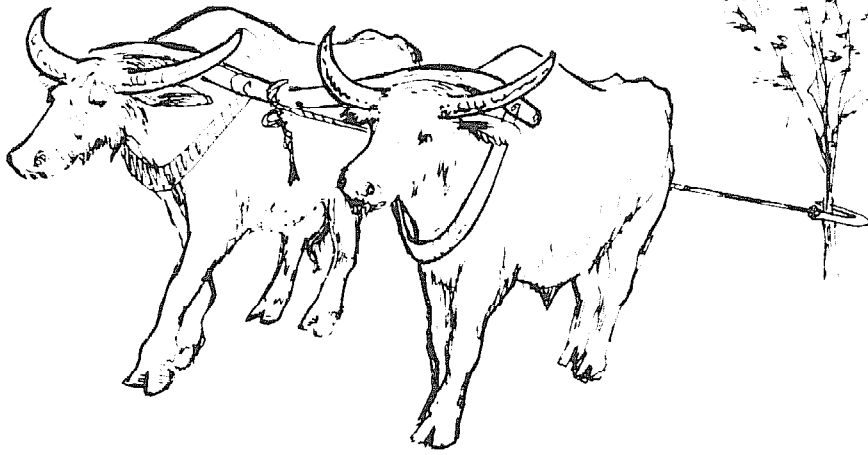
Pair of oxen	C
Rope	A
V-hook	A
Pulley	A
Axe	A

Draught animals can pull a small bush out of the ground by means of a rope attached to the base of the stem. A sharpened V-shaped hook can be used to attach the rope quickly to the bush. For larger trees, the rope must be attached higher up so that the tree can be pulled over. The rope must be as long as possible so that the direction of pull is nearly horizontal. This is because animals have difficulty in pulling downwards, particularly where a neck yoke harness is used. If the tree will not move when the animals pull, it maybe helpful to cut the roots with an axe on the side opposite the animals. The animals can be moved round until all the accessible roots have been cut, after which the tree can be pulled over much more easily. In general, animals can pull as much as one-third of their own body weight for very short periods, such as when pulling out a tree, although they can only pull about one-tenth of their own weight in continuous work. Their pull can be increased by threading the rope through a pulley attached to the tree being uprooted. The animals pull on one end of the rope while the other end is tied to the base of another tree. Animal handling skills are required by the operators.

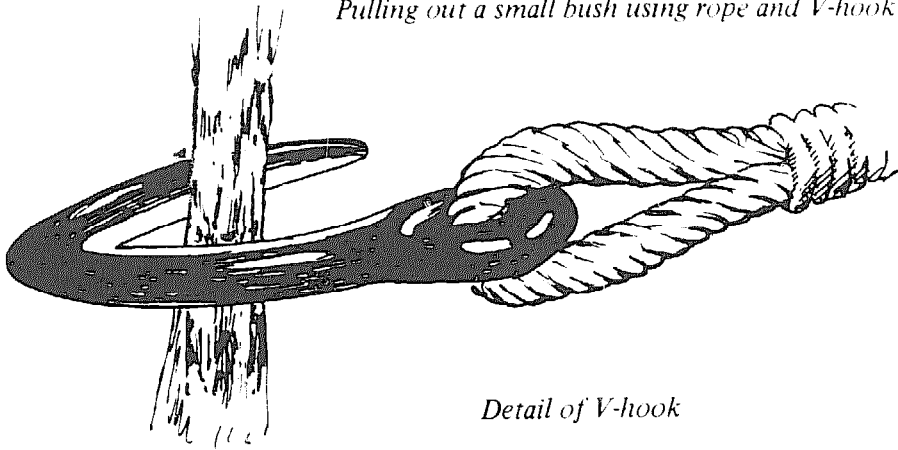
The life of the rope is very short but the other equipment should last for many years. The equipment, which can be made by a village blacksmith, can be carried on the backs of the animals.

### SAFETY

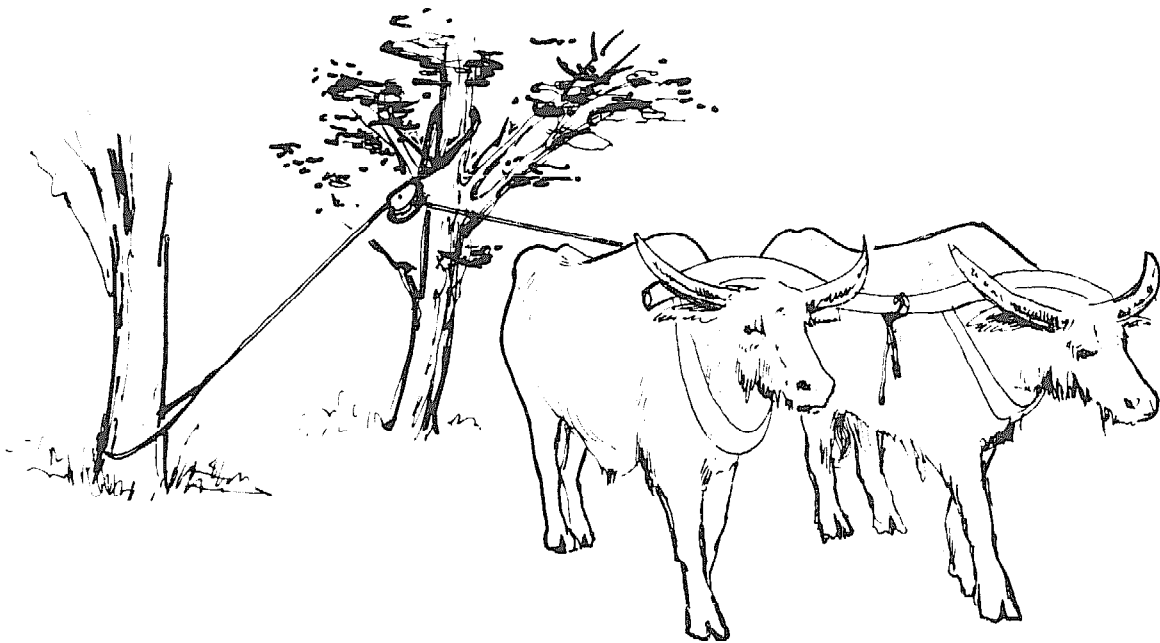
For their own safety, people and oxen should keep a minimum distance between them and the tree of twice the height of the tree.



*Pulling out a small bush using rope and V-hook*



*Detail of V-hook*



*Pulling down a tree using rope and pulley*

## TRACTOR (DIRECT PULL)

Tractors can pull down medium-sized trees.

### EQUIPMENT REQUIRED

### Price range

60 h.p. wheeled tractor

E

Chain

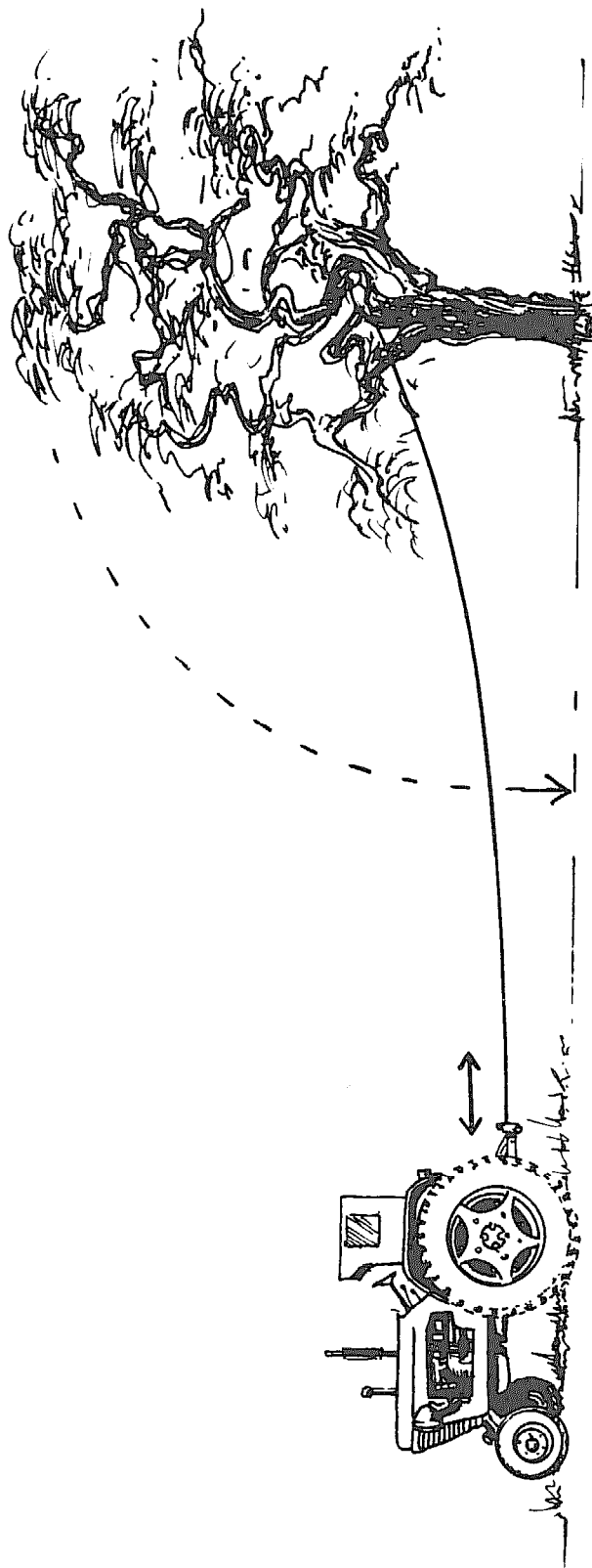
C

Tractors can be used to pull out trees in the same way as draught animals, but can exert a much greater pull (in the region of half the tractor's own weight). Because of the larger force, a chain or steel rope is normally used instead of a fibre rope. Tractors, like draught animals, have difficulty in gripping the soil if a downward pull is needed. The chain should be long enough to make the pull almost horizontal. Normal tractor driving skills are required.

Normal tractor servicing and repair facilities are required.

### SAFETY

There should be a safety frame fitted to the tractor with a low attachment for the chain. The distance between the tractor and the tree trunk should be at least twice the height of the tree.



*Tractor pulling out a small tree*



## TRACTOR WINCH

A tractor winch can exert a greater pull than a tractor pulling directly.

### EQUIPMENT REQUIRED

### Price range

60 h.p. tractor  
Winch

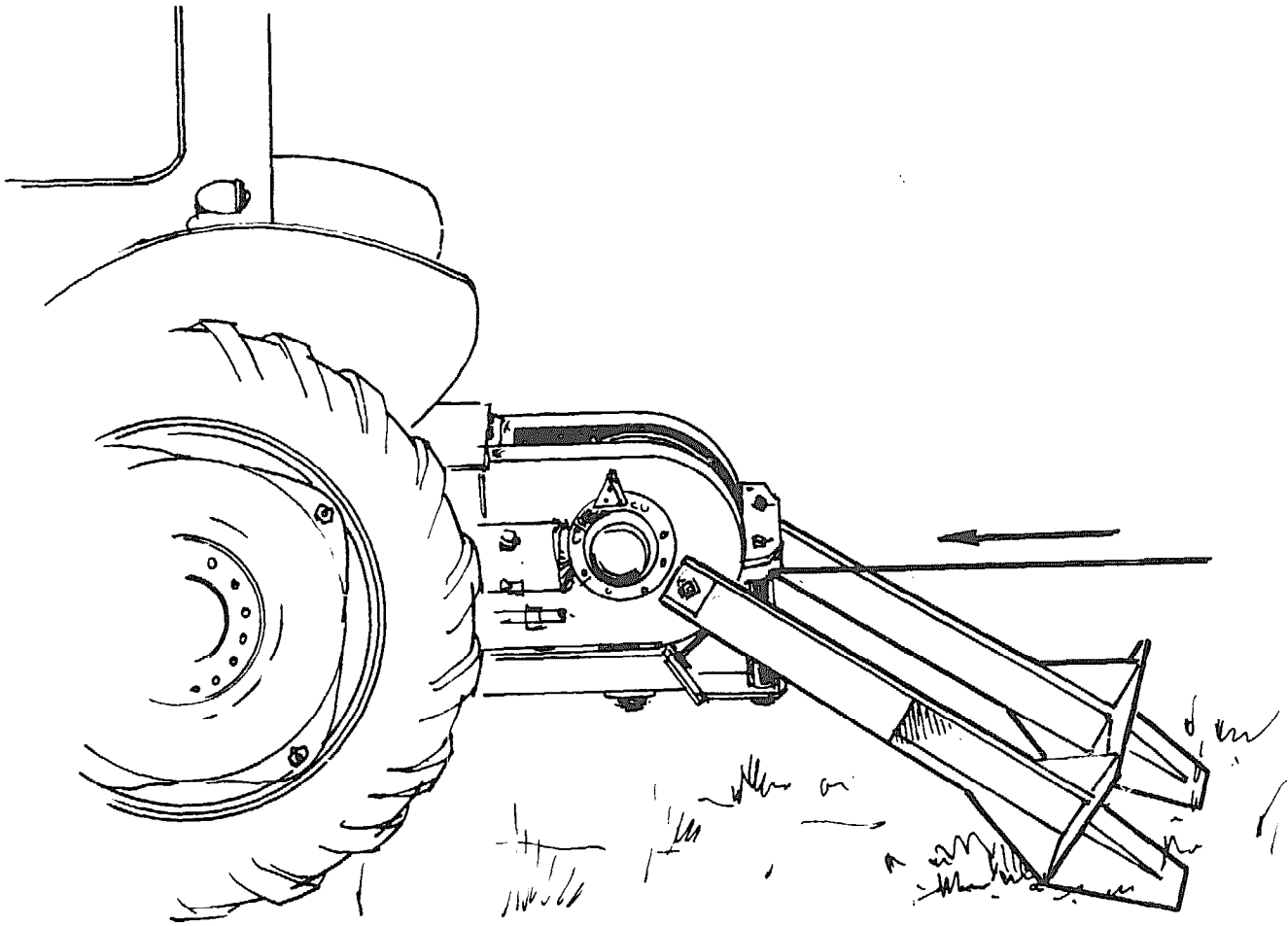
E  
D

The winch is attached to the rear of the tractor and driven mechanically or hydraulically by the tractor engine. A winch on a wheeled tractor can exert a pull of around 10 tonnes, which is resisted by a soil anchor fixed to the tractor. The winch and anchor can be fitted on to the tractor in a few hours. The tractor can be very easily overturned if it is not placed exactly in the line of pull of the winch and the clutch released at the least sign of the front wheels rising. The driver should be trained carefully.

Normal servicing and maintenance should be carried out regularly. Particular attention should be paid to the winch cable.

### SAFETY

The tractor should be fitted with a safety frame and should be placed at least at a distance of at least twice the height of the tree. Additionally there is the danger of the winch cable snapping and injuring an operator if it flies back. As a precaution straddle the cable with a trailer or similar object around which the cable would wrap itself in the event of it snapping.



*Tractor-mounted winch*

## TRACTOR MOUNTED TREE EXTRACTOR

Tree extractors can lift small trees vertically out of the ground.

### EQUIPMENT REQUIRED

### Price range

60 h.p. tractor

E

Tree extractor

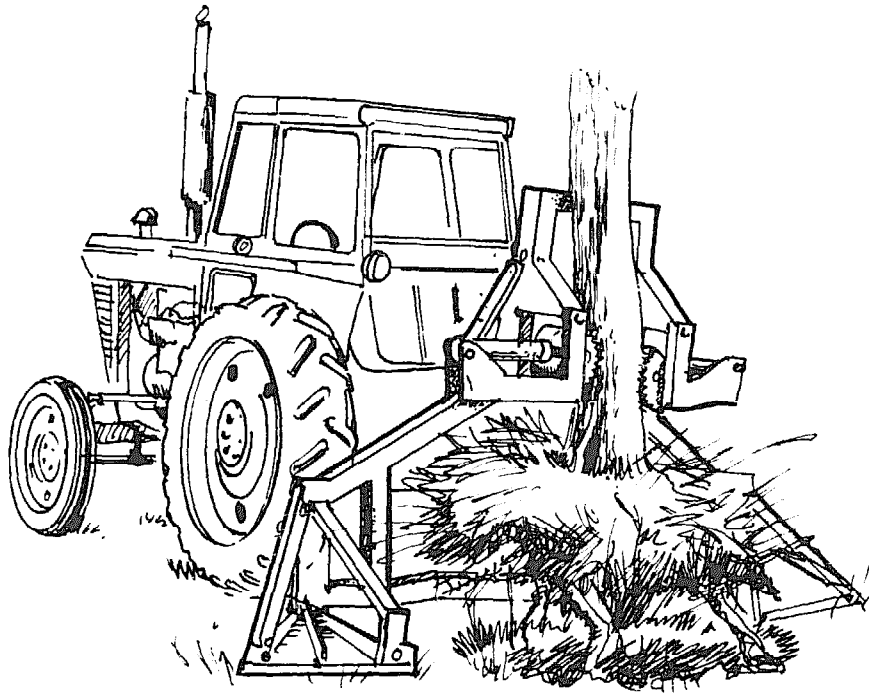
D

The tree extractor is an attachment fitted to the rear of an ordinary wheeled tractor. It has jaws which can grip the tree trunk and then lift it vertically out of the ground. The maximum size of tree which can be extracted is limited by the opening of the jaws and is generally about 40cm in diameter. After extraction, a tree can be carried in the jaws and deposited where required. Some training is necessary.

Normal tractor servicing and repair facilities are required. The extractor could be manufactured in a small factory using brought-in hydraulic components.

### SAFETY

The tree extractor is rather more expensive than a tractor winch, but it is much easier and safer to use.



*Tractor-mounted tree extractor*

## BULLDOZING

Bulldozers mounted on tracklayers can push trees over.

### EQUIPMENT REQUIRED

### Price range

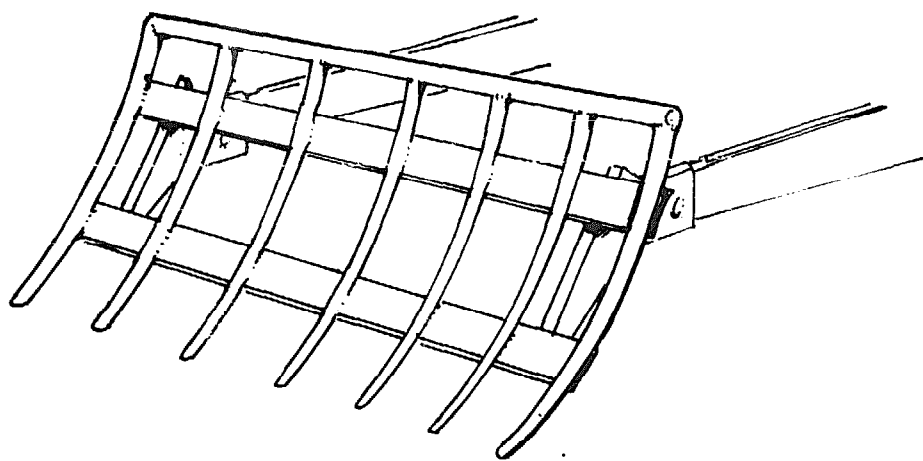
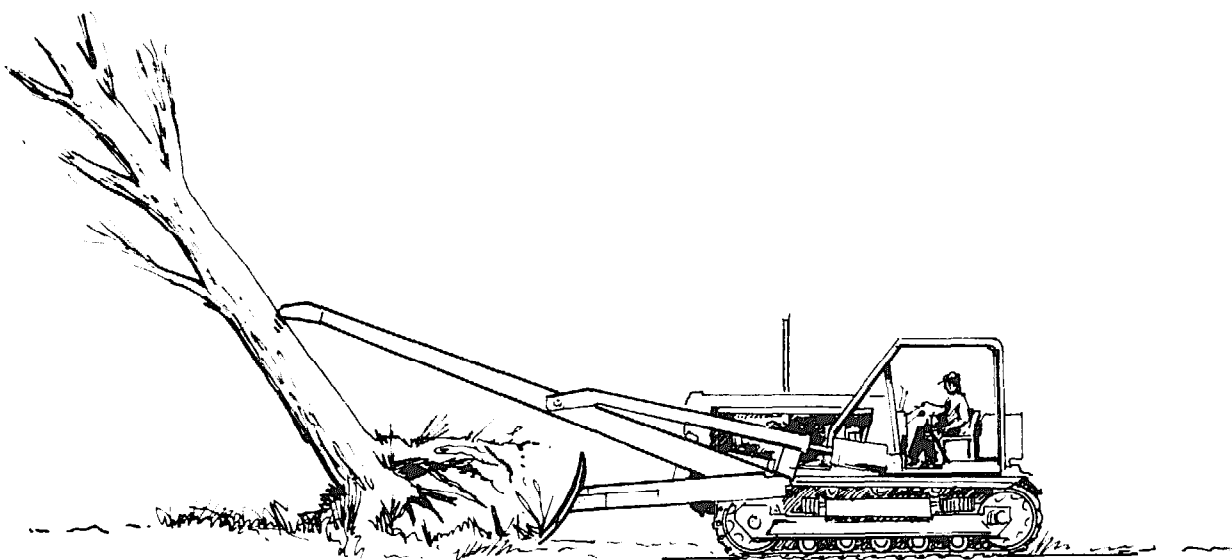
150/180 h.p. tracklayer	F
Bulldozer blade	D
Rake	D
Push-over bar	D

Light blades are available for wheeled tractors but are only suitable for rooting out scrub. Tracklayers with earth-dozing blades can be used on small trees by direct pushing from the side with the least bowl. The root can also be reduced by excavating soil and roots on the side to be pushed. The dozer's capacity to fell large trees can be increased by fitting a push-over bar as an extension to the blade. For a small number of exceptionally large trees a ramp can be built up on the side to enable the tracklayer to obtain more leverage, but this is not recommended as it moves the soil around too much. Although commonly used for tree-clearing, bulldozers are designed for earth-moving and they usually disturb the topsoil excessively. An open-toothed rake is more appropriate as it allows the soil to fall through when the tree is moved. There is a danger of soil compaction. Special skill in tree clearing is required in addition to normal tracklayer driving skills.

Normal tracklayer servicing and repair facilities are required. The push-over bar and the rake could be manufactured in a workshop. Transport of the tracklayer would be by low-loading lorry.

### SAFETY

Safety mainly depends upon the driver's skill. A safety frame should be fitted to the tracklayer.



*Above: Bulldozer with push-over bar for tall trees*  
*Below: Rake for tree-clearing work fitted in place of a bulldozer blade.*

## TWO TRACKLAYERS WITH CHAIN

Trees can be knocked over by a heavy chain pulled behind two tracklayers.

### EQUIPMENT REQUIRED

2 large tracklayers and chain (usually hired)  
150/180 h.p. tracklayer with bulldozer blade (usually hired)

Rapid clearing of small and medium-sized trees can be achieved by knocking them down with a heavy chain pulled behind two large tracklayers. This method is suitable for clearing large, flat areas. It is sometimes necessary to make two passes; the first to bend the trees over and the second in the opposite direction, to uproot them. Large iron balls are often placed in the chain to raise the level of contact with the trees. Swivels should be fitted to prevent twisting or knotting of the chain. Additional equipment, such as a bulldozer, is necessary to assist in the felling of larger trees and to remove the uprooted trees. Skilled operators are required to perform the task effectively and to avoid soil compaction or topsoil removal.

The contractor from whom the equipment is hired is normally responsible for maintenance, transport to the site and the provision of drivers.

### SAFETY

This is a relatively safe, but capital intensive, method for clearing large areas.

## Cutting Through the Trunk at Ground Level



## HAND CUTTING TOOLS

Trees of any size can be cut down using hand tools.

### EQUIPMENT REQUIRED

### Price range

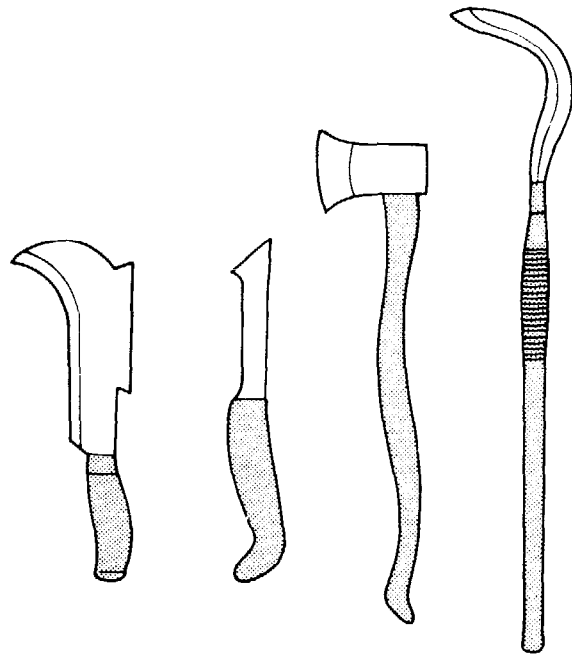
Machete	A
Slasher	A
Billhook	A
Axe	A
Two-man saw	B
Forestry wedges	A

Machetes, slashers and billhooks are useful, for cutting down small bushes with stems up to about 8cm diameter. Larger trees can be cut with a felling axe. A two-man saw is generally faster than an axe for cutting down trees of more than about 50cm diameter. The maximum size which can be sawn depends on the length of the saw. Wedges are often used to prevent the saw jamming.

The equipment will have a long life. It can be maintained by the user or a village blacksmith. Saw sharpening is a skilled job but can be carried out by the user after some training. The equipment could be manufactured by a blacksmith, except the saw which would be made in a small factory.

### SAFETY

Operator skill is required to prevent damage from falling trees.

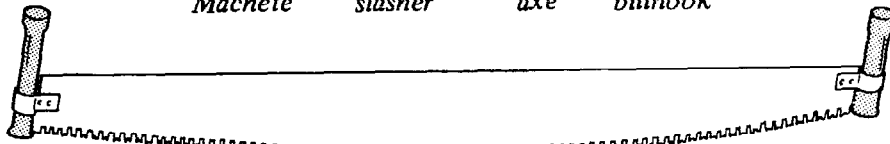


*Machete*

*slasher*

*axe*

*billhook*



*Two-man saw*

## HAND-HELD CLEARING SAW

Clearing saws can cut down small trees.

### EQUIPMENT REQUIRED

### Price range

Hand-held clearing saw

C

Safety helmet

B

These machines have a rotary saw blade driven by a small petrol engine. They can cut small trees with stems up to about 20cm in diameter. Operators require training in the use and maintenance of clearing saws and in the use of small engines.

Small engine servicing and repair facilities are required, but even with these the engine will have a relatively short life.

### SAFETY

Onlookers should be kept away for their own safety. The operator can be protected from flying debris by a safety helmet.



*Clearing saw*

## CHAINSAW

Chainsaws can cut down trees of any size.

### EQUIPMENT REQUIRED

### Price range

Chainsaw

C

Protective clothing

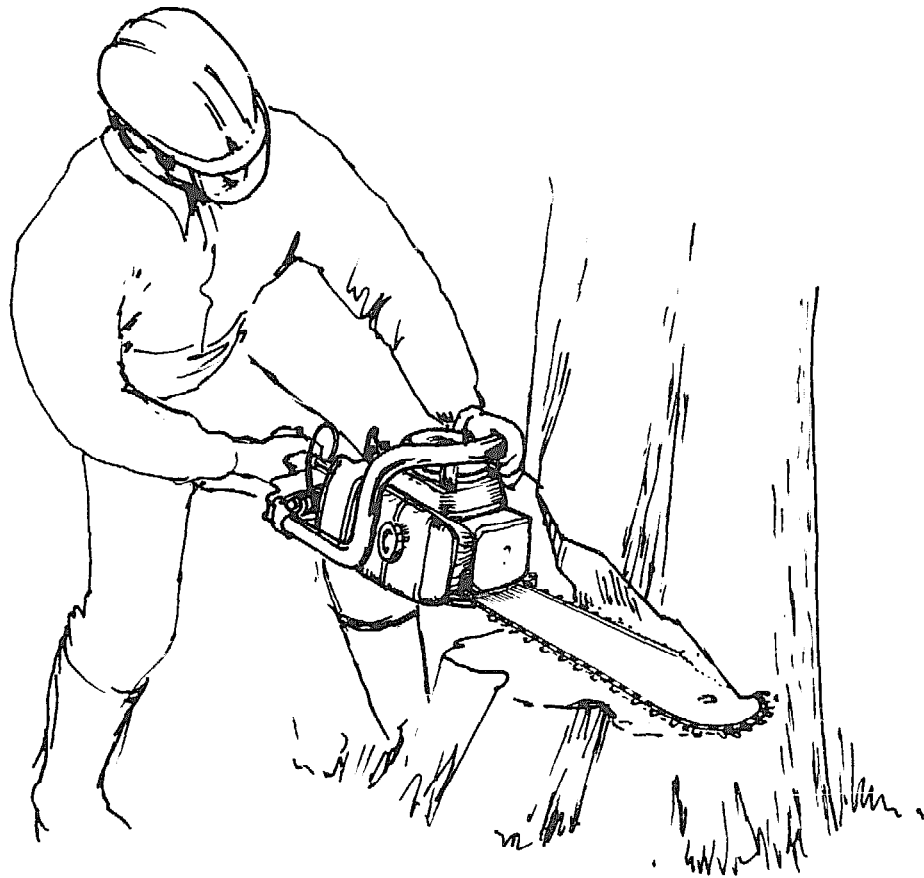
B

A chainsaw can cut down trees up to a size which is limited by the blade length. Chainsaws longer than about 50cm need skilled operators. They can be very dangerous. Most chainsaws are driven by small petrol engines, but it is possible to buy a chainsaw driven by a hydraulic motor which runs off the hydraulic circuit of a tractor. Special training in the use of chainsaws is essential.

Chainsaws will last for about five years but the chains may need replacing after about a month. Normal small engine servicing and repair facilities and also special equipment for adjusting and sharpening the blade are required.

### SAFETY

Operator skill is vital: chainsaws can be very dangerous in unskilled hands. It is advisable to wear a safety helmet with a visor.



*Using a chainsaw*

## TRACTOR-MOUNTED SLASHERS

Tractor-mounted slashers can be used to clear scrub.

### EQUIPMENT REQUIRED

### Price range

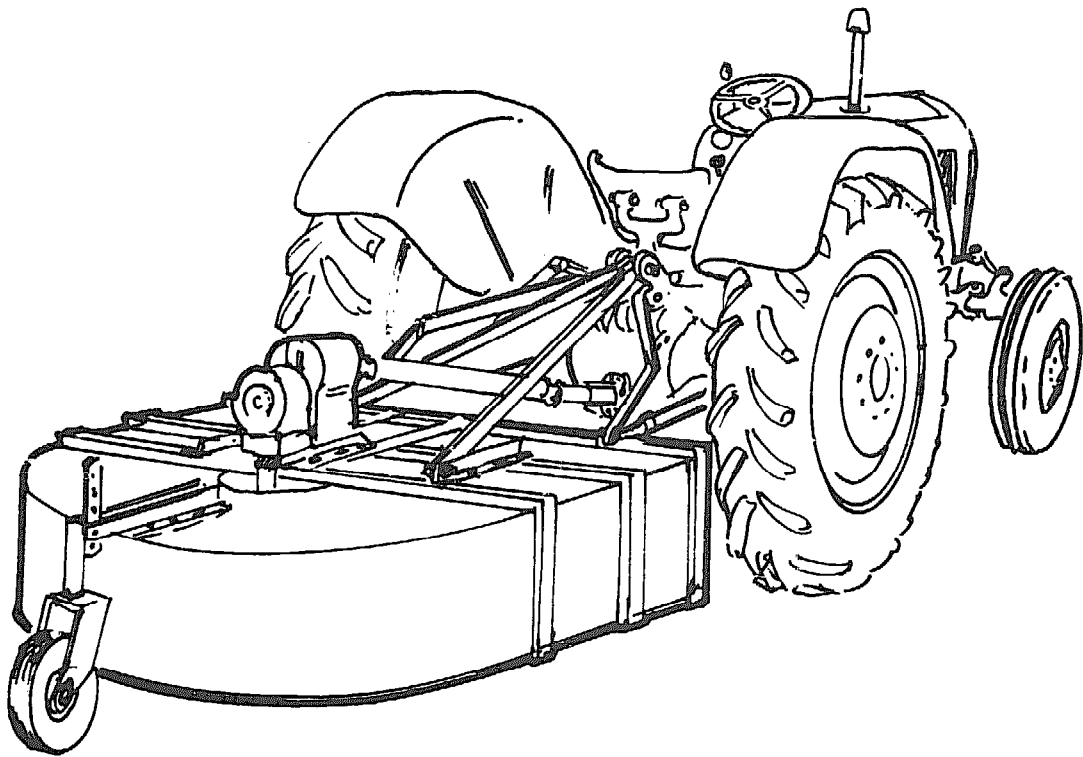
60 h.p. wheeled tractor	E
Vertical axis slasher	D
Horizontal axis slasher	D

These are heavy duty versions of the machines normally used for grass cutting and can be used for stems up to about 5cm. There are two types - one with two large blades or chains rotating about a vertical axis and the other with large numbers of flails rotating about a horizontal axis. The advantage of the former is that it is cheaper, while the latter is more robust and leaves the cut material as a fine mulch which could decompose quickly. They are of particular value in clearing regrowth. Normal tractor driving skills are required by the operator.

Normal tractor servicing and repair facilities are required. The chains, blades or flails may need replacing after a long period of heavy use.

### SAFETY

Keep manufacturer's guards in place and in good condition for safe operation.



*Tractor-mounted vertical axis slasher*



## TRACKLAYER WITH ROLLER-CRUSHER

The roller-crusher will break down small trees.

### EQUIPMENT REQUIRED

### Price range

150/180 h.p. tracklayer

F

Roller-crusher

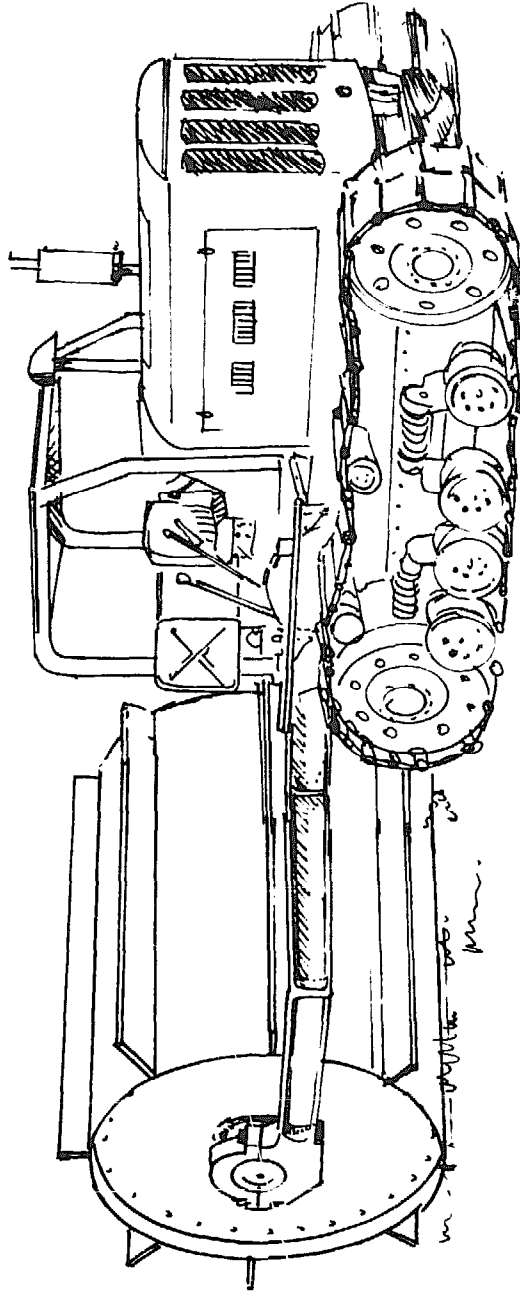
F

The roller-crusher consists of a large diameter heavy roller with sharp blades set around its circumference and it is towed behind a tracklayer. It knocks down trees with trunks up to about 10cm diameter and the blades can cut through the trunks in several places. It is useful for clearing undesirable regrowth. Tracklayer driving skills are needed.

Tracklayer servicing and repair facilities must be available. The roller-crusher could be made in a small factory. The tracklayer and equipment needs transporting to the site on a low loading lorry.

### SAFETY

Normal safety precautions are required when using heavy equipment.



*Tracklayer with roller-crusher*

## TRACKLAYER WITH SHEARING BLADE

A sharpened blade in front of a tracklayer will cut through small trees.

### EQUIPMENT REQUIRED

### Price range

150/180 h.p. tracklayer

F

Shearing blade

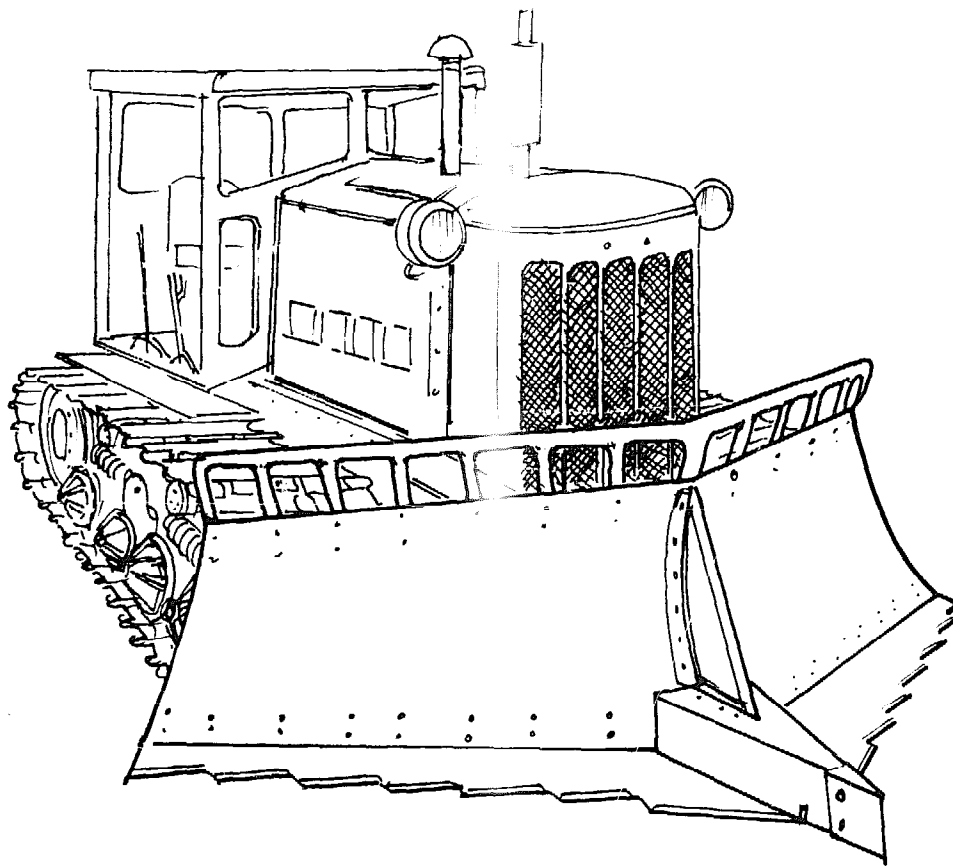
E

The shearing blade is mounted on the front of a large tracklayer. Its sharp edge cuts trees and bushes at ground level as the machine is driven forward. It is most effective on trees with stems up to about 10cm diameter. There are two types of shearing blade - the single angle blade and the V-blade. The capital cost is high in relation to the size of trees that can be felled. Special driving skills are needed. In certain soil conditions there is a danger of compaction.

Normal tracklayer servicing and repair facilities are needed. The blade needs to be sharpened daily and will need replacing from time to time. A low loading lorry is required for transporting the equipment to the site.

### SAFETY

A safety cab is required on the tracklayer.



*Tracklayer with shearing blade*

## Removing Stumps

## HAND DIGGING TOOLS

Stumps can be dug out by hand.

### EQUIPMENT REQUIRED

### Price range

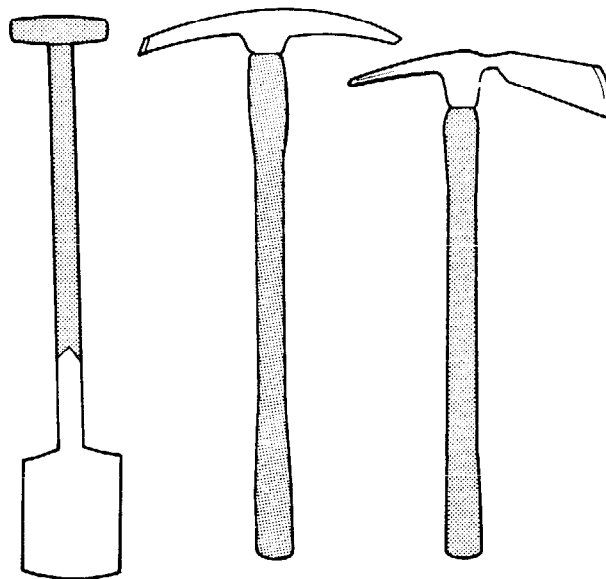
Pickaxe	A
Mattock	A
Spade	A

The soil needs excavating around the stump and roots. Some roots may have to be cut until it is possible to lift the stump out of the ground. This is an arduous task.

The equipment can be maintained by a village blacksmith and can be made in a small factory.

### △ SAFETY

The hand tools should be used correctly with care, especially when more than one person is working on a particular stump.



*Spade*

*Pickaxe*

*Mattock*

## ROOT HOOK

A large hook can be used to pull out stumps.

### EQUIPMENT REQUIRED

Price range

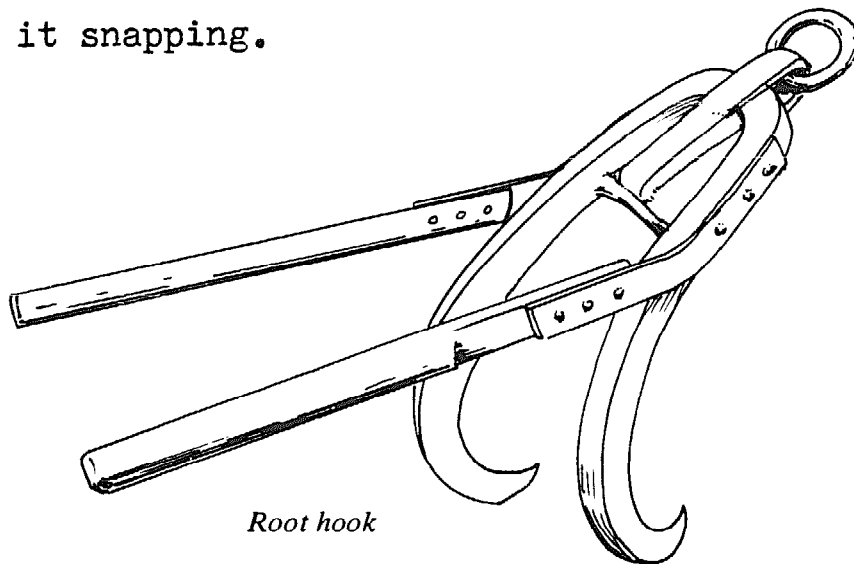
Root hook	B
Rope	A
Cable/chain	C
Power source (hand winch/draught animals/ tractor/power winch)	
Pickaxe	A
Mattock	A
Spade	A

This is a large hook which is used to grip the stump or roots while they are pulled out. The pull can be provided by draught animals, a tractor, hand winch, engine-powered winch or tractor mounted winch. Some hand tool work is also required for partially digging out the stumps and cutting the roots.

A root hook would last for many years and could be made by a blacksmith or in a small factory. Mechanical power sources would need normal maintenance and servicing.

### △ SAFETY

Precautions should be taken to minimise damage, should the rope or cable snap. If a tractor mounted winch is used it is recommended that the cable be straddled with a trailer or similar object around which the cable would wrap itself in the event of it snapping.



*Root hook*

## EXPLOSIVES AND BURNING

Stumps can be shattered by explosives or be burnt away.

### EQUIPMENT REQUIRED

### Price range

Hand Auger

A

Explosives

Chemicals

Explosives can be used for breaking up large stumps into small pieces which can be lifted out of the ground by hand. The explosive material is usually packed into holes in the stump, which can be made using a hand auger. Considerable skill and experience is required to judge the amount of explosive needed and the best place to bore the holes. In most countries licences are necessary for the purchase and storage of explosive materials. Only skilled operators should attempt this method. Burning can be accelerated by using oxidising agents such as sodium chlorate either packed in auger holes or introduced over a period of time, in a concentrated solution.

### SAFETY

This is a very dangerous method and even with a highly skilled operator injury is not infrequent. Sodium chlorate needs handling with great care: in certain circumstances it can also be explosive. Specialists should be engaged to do this work.



## TRACTOR-MOUNTED STUMP EXTRACTOR

Stumps can be lifted vertically out of the ground.

### EQUIPMENT REQUIRED

### Price range

60 h.p. tractor

E

Stump extractor

D

The stump extractor is a modification of a tractor-mounted tree extractor. The trunk-gripping jaws are replaced by a pair of hooks which grip the stump and lift it out of the ground. Some training is necessary.

Tractor servicing and repair facilities are required. The extractor could be manufactured in a small factory using bought-in hydraulic components.

### SAFETY

Normal precautions need to be taken.

## TRACTOR-MOUNTED STUMP CHIPPER

The stump chipper reduces a tree stump to small pieces.

### EQUIPMENT REQUIRED

### Price range

60 h.p. tractor

E

Stump chipper

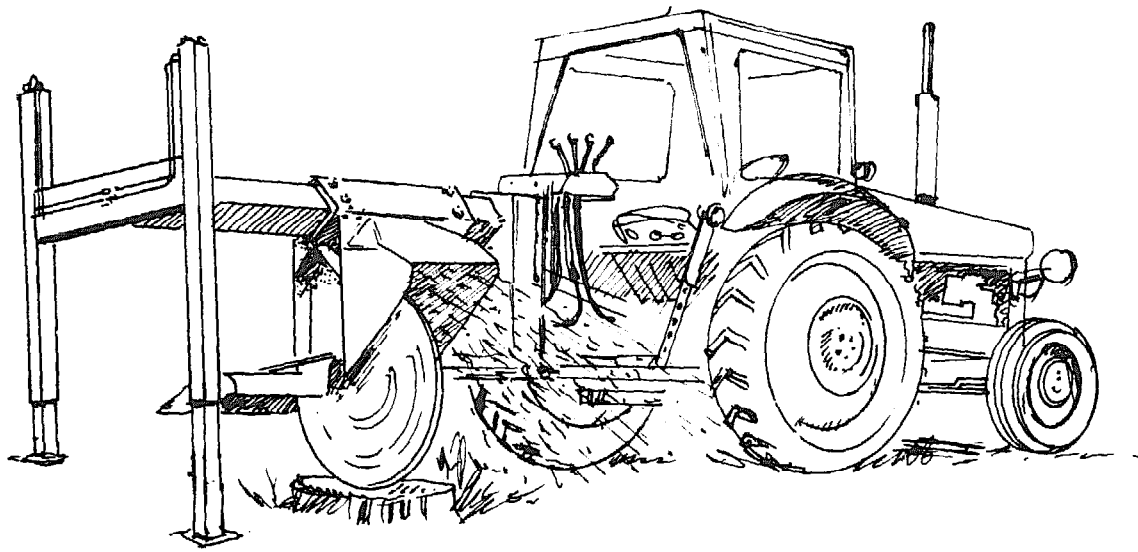
E

This is a machine with a circular saw type blade which is used to cut away stumps to below ground level. The depth of chipping can be down to 40cm below ground level, so that any remaining part of the stump will not interfere with cultivation implements. It is an expensive tool. Some training in its use is required.

Normal tractor servicing and repair facilities are required.

### SAFETY

Guards must be kept in place whenever the chipper is rotating.



*Tractor-mounted stump chipper*

Tree stumps can be pushed or pulled out of the ground by implements attached to tracklayers.

#### EQUIPMENT REQUIRED

#### Price range

150/180 h.p. tracklayer	F
Bulldozer blade	D
Rake	D
Root plough	E

Bulldozers can be used to push out stumps, but rakes are better as they disturb the soil less. Some rakes are mounted on the front of a tractor (like a bulldozer blade); others are mounted at the back and resemble very strong tined cultivators.

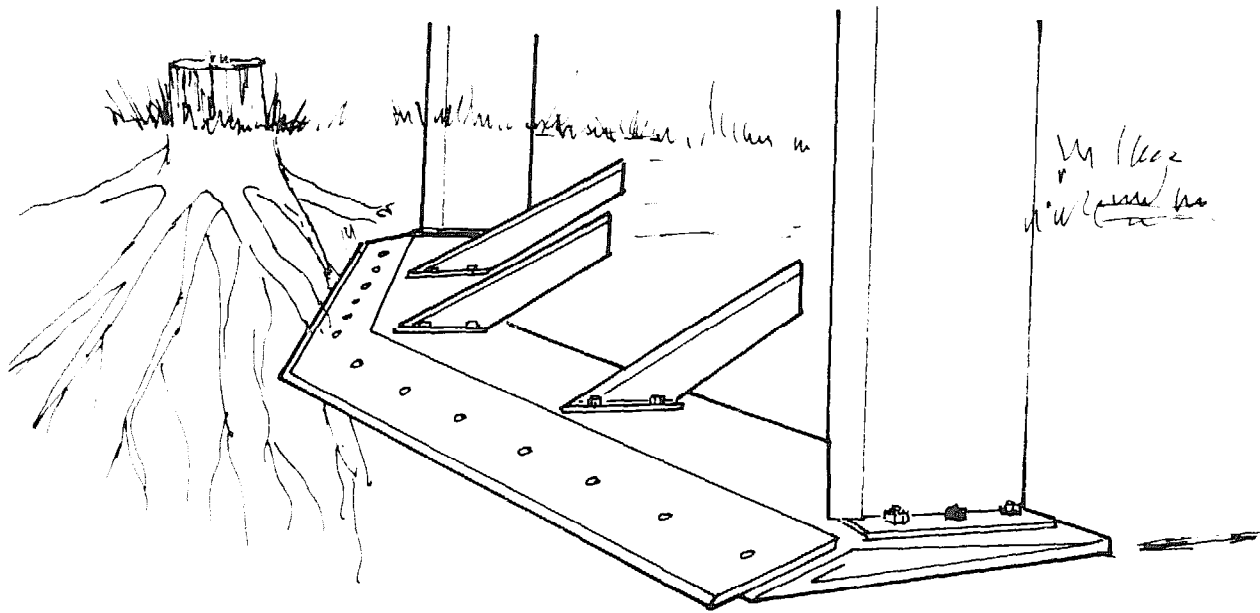
A root plough is a blade attached to the back of a tractor which cuts through roots below ground level. The roots can then be pulled out or raked out more easily.

The implements can be fitted to wheeled tractors, but they can only deal with small stumps and the pneumatic tyres are easily damaged by the stumps. The implements are normally fitted to heavy tracklayers. Care should be taken to protect the soil. The driver requires special skill.

Normal tracklayer servicing and repair facilities are required. The rake could be manufactured in a small factory. A low loading lorry would be required for transport.

#### SAFETY

Mainly depends on the driver's skill.



*Root plough*

## LAND CLEARANCE AT THREE LEVELS OF INVESTMENT

### EQUIPMENT WHOSE TOTAL COST IS WITHIN PRICE RANGE C

For use by a team of 6 people

Approximately 120 man-days to clear one hectare

The team could clear one hectare in about 20 days

### EQUIPMENT REQUIRED

4 machetes

4 axes

4 digging hoes

Two-man-saw

Hand operated winch

Small root hook

With the exception of the winch and the saw all of this equipment can be made or repaired in a small workshop or blacksmith. Skill is needed to use a two-man-saw, but the rest of the equipment can be used by relatively unskilled labourers. All of the equipment can be transported by hand. A team of 6 people with this equipment could clear land of any type of tree growth. Such a team would be very suitable for clearing isolated small areas of trees, at a rate of about one twentieth of a hectare per day.

ANCILLARY EQUIPMENT WHOSE COST IS WITHIN PRICE RANGE E  
(Plus the cost of a tractor, price range E)

For use by a team of 3 people

Approximately 30 man-days to clear one hectare

The team could clear one hectare in about 10 days

#### EQUIPMENT REQUIRED

60 h.p. wheel tractor fitted with safety cab

Tree extractor with stump extractor attachment

Chain and V hook

Rear mounted winch

Chainsaw

2 axes

2 machetes

2 digging hoes

This set of equipment could be used to clear any type of tree growth from any land accessible to a tractor. Skilled operators and proper maintenance facilities would be essential. This set of equipment would be suitable for use by a tractor hire unit or a farmer's cooperative, which already owns tractors and has the necessary operators and servicing facilities. The rate of work would be approximately one tenth of a hectare per day.

## EQUIPMENT WHOSE TOTAL COST IS IN PRICE RANGE G

To be used by a team of 12 people

Approximately 6 man-days to clear one hectare

The team could clear one hectare in about half a day

### EQUIPMENT REQUIRED

2 150 h.p. tracklayers

Front mounted rake

Front mounted shearing blade

Rear mounted root plough

Rear mounted winch

Knockdown chain fitted with swivels

60 h.p. wheeled tractor

Horizontal axis slasher for wheeled tractor

Low loading trailer to be pulled by wheeled tractor

3 chainsaws

6 axes

6 machetes

6 digging hoes

This set of equipment would be justified only where large areas of trees had to be cleared. Specially trained operators and special servicing facilities would be needed. The rate of work could be two hectares per day.



## FURTHER READING

The clearing of land for development Caterpillar Tractor Company, 118 rue du Rhone, 1211 Geneva, Switzerland (1974), 111 pages

Forest Farming J.S. Douglas and R.A. de J. Hart, Watkins, London (1976), 197 pages

Forestry Safety Council leaflets, Forestry Commission, 231 Corstophine Road, Edinburgh EH12 7AT, U.K.