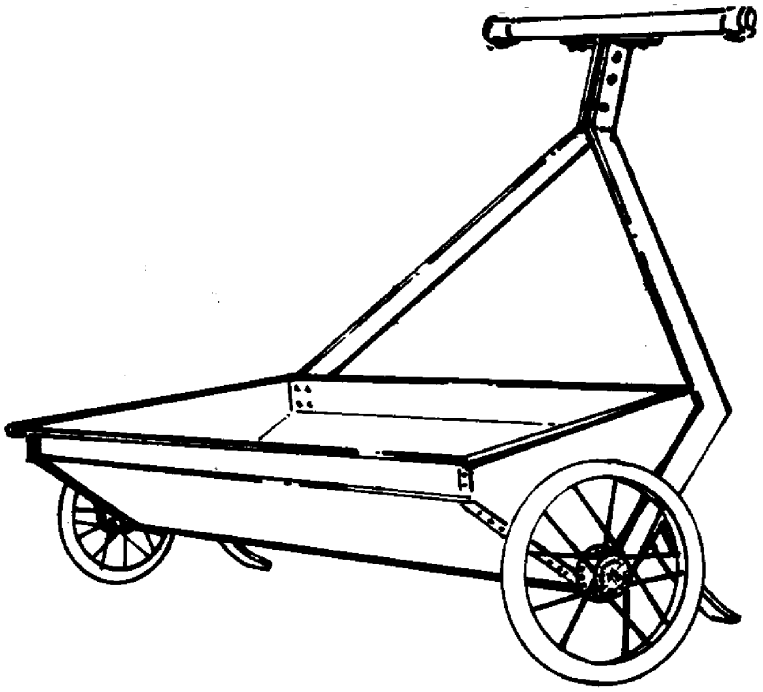


Agricultural Tools

There are a number of appropriate technology principles that specifically concern agricultural tools. Such tools should be produced within the country, in part simply because of the large numbers involved. They must be repairable at the local level. With much of agriculture characterized by short intense periods of activity, farmers cannot afford delays caused by equipment failures.

The FAO book **Farm Implements for Arid and Tropical Regions** *includes a list of important general principles for appropriate agricultural tools, some of which go beyond the general criteria for appropriate technology.*

"Such tools should be:

a) adapted to allow efficient and speedy work with the minimum of fatigue;

b) not injurious to man or animal;

c) of simple design, so that they can be made locally;

d) light in weight, for easy transportation (there are also considerable advantages when threshers, winnowers, and machines such as coffee hullers can be easily moved to where they are needed;

e) ready for immediate use without loss of time for preparatory adjustments;

f) made of easily available materials."

Appropriate agricultural tools and equipment should contribute to the broad objective of increasing the viability of the small farm. Where small farmers are currently employing traditional technologies that are inefficient, they often cannot improve this technology because of the leap in scale and capital cost to commercially available equipment. It is therefore the goal of intermediate technology proponents to help fill this gap with good quality tools and equipment that are affordable and

suited to the scale of operations of the small farmers.

There is a tendency for equipment development and commercial firms to concentrate their energies on tools that are affordable only to the wealthier farmers. This happens in part because of a focus on what technically could be done, without attention to financial constraints faced by the typical small farmer. Contributing factors include the inappropriate application of industrialized, extensive farming strategies to small intensive farming communities, and the failure to include the small farmer in the process of identifying helpful new technologies that can truly fit into the existing farming system. The result is usually either outright failure of innovations to attract interest or the consolidation of landholdings by wealthier farmers taking advantage of the technology newly available. The position of tenant farmer may become worse, and that of small farmer in general is not improved. Appropriate technology advocates must be careful to avoid repeating these mistakes.

The degree of concentration of land ownership is a key factor in determining if there are opportunities available for appropriate technology strategies in a community. Agricultural technologies developed with and for the smallest farmer can certainly strengthen the viability of their farms. But if most families have no land at all, land reform and the establishment of rural industries may be far more important steps in a positive community development program than the improvement of agricultural tools and equipment.

In most of Asia and much of Latin America, farms are quite small. Under these conditions, most mechanized equipment will not increase the amount of food produced, but will only decrease the amount of labor required. Productivity per acre or hectare may in fact decline if these large tools require extra space to maneuver and wide lanes to drive or roll over. The appropriate tools under such circumstances, even if supported by unlimited resources, would be very different than those used in the United States, where the amount of cultivated land per capita is relatively large.

From the national perspective, support for communities of small farms should bring significant benefits. Whereas it has been widely assumed that only the large farm could efficiently increase national food production in the struggle against hunger, mounting evidence from many countries indicates that the small farm has higher yields per acre and plays a crucial role in the distribution of food. Small farms also make the best use of national capital resources:

"To maintain ... a rational growth of capital in a low-income economy, small farms are better suited than large ones, for the small farmers do not experience the same pressure to substitute capital for labor; no one wants to mechanize himself out of a job." (Folke Dovring, in **Agricultural Technology for Developing Nations**).

People interested in improving local agricultural equipment should be looking for technologies that accomplish one or more of the following:

1) Remove labor bottlenecks in the agricultural calendar that are limiting production (e.g., short periods of time when all available labor is fully employed, such as during planting or harvesting).

2) Replace or speed up activities that are extremely inefficient in the use of time (e.g., traditional hand-milling). This can free time for more productive activities.

3) Increase the productivity of land (e.g., with irrigation weeding, natural fertilizers)

The effectiveness of efforts to create relevant new tools can be increased by

concentrating on some key agricultural activities. Irrigation is the biggest single factor in increasing crop yields. The successful widespread use of hand pumps for small-plot irrigation in Bangladesh is a very interesting development. Water-conserving irrigation methods in arid lands have similar potential benefits. Animal-drawn plows, cultivators and carts tend to satisfy the equipment needs of small farmers using both intensive and extensive techniques. Good quality hand tools should not be overlooked. Equipment that helps to conserve expensive fertilizers and pesticides will reduce cash costs and have beneficial environmental effects. Greenhouses can conserve water, and in temperate climates, they offer an early start on the growing season. Crop processing equipment, including threshers and mills, can reduce losses caused by traditional techniques and save much low-productivity labor time. Very small-scale equipment of this kind could allow the small farmer to retain full crop production instead of paying 10% or more to the mill owner. Crop storage is a prime area for improvement as a significant percentage of food produced on small farms may be lost due to poor drying and storage. Low-cost, small-scale storage bins are particularly promising (see CROP DRYING AND STORAGE chapter). In many areas it is difficult to move agricultural inputs to the farm, harvested crops from the fields to storage, and surpluses from the farms to markets. Appropriate transportation technologies are thus of great importance to the farmer (see TRANSPORTATION chapter).

Many of the books in this chapter make recommendations as to the kinds of agricultural tools and equipment most needed by small farmers in developing countries. Encyclopedic listings of commercially available equipment are contained in **Tools for Agriculture** *and two other books. These and the books documenting older small-scale equipment contain a wealth of ideas that may stimulate the imagination of readers.* **Rural Africa Development Project** *describes a method of identifying labor bottlenecks in the agricultural calendar.*

A group of excellent books on the use of draft animals are reviewed. Animal-drawn equipment, carts, harnesses, and draft animal training techniques are well-covered in these comprehensive volumes.

Solar photovoltaic irrigation pumps are discussed in several entries, including information on cost and output. (Hand and foot-operated pumps for irrigation have made an impact in some countries such as Bangladesh; these pumps are covered in the WATER SUPPLY chapter. Wind-powered irrigation pumps are to be found in the ENERGY: WIND chapter.)

On North American family farms, the partner is often expected to act as a mechanic and handy-person during daily farming activities. The well-equipped farm workshop and multiple skills have continued to play a powerful role in generating farm equipment innovations. **Mechanics in Agriculture** *is a text for vocational courses teaching the skills commonly required on these farms.*

A large number of small engines are used in the South for power tillers, irrigation pumps, crop processing and other applications. The two books on small engines should be helpful references for maintenance and repair of many of these power units.

Most of the remaining entries are plans for threshers, winnowers, corn shellers and so forth, all of them hand or foot-operated, that can be produced in small workshops by local craftspeople. (Three publications reviewed in the ENERGY: GENERAL chapter also discuss pedal-powered agricultural equipment.)

Tools for Agriculture: A Buyer's Guide to Appropriate Equipment, MF 06-256, book, ITDG, 1985, 1992 edition £30.00 from ITDG; also from VITA and TOOL.

The 1985 edition of **Tools for Agriculture** is an impressive compilation of small-scale equipment and tools from all over the world. Compared with past editions and with the now out-of-print **Tools for Homesteaders** (see next review), there is much more information here from manufacturers based in developing countries.

Each category of tool is introduced with a discussion of key considerations for its use and production. Advantages, costs and benefits, and alternatives are explored. Line drawings of individual items are accompanied by information on capacity and manufacturers' addresses. Many hundreds of items are covered. The careful reader will find that this book alone can provide a considerable education on the topic.

This is the best book available on agricultural tools for developing countries. Highly recommended.

Tools for Homesteaders, Gardeners, and Small-Scale Farmers (A Catalogue of Hard-to-Find Implements and Equipment), MF 06-257 book, 512 pages, edited by Diana S. Branch, 1978, Rodale Press, out of print in 1985.

"Finding the right tools can be the most critical need for a small-scale farmer or a large-scale gardeners. It can mean the difference between staying on or leaving the land, between a sense of drudgery or a sense of fulfillment, between a successful harvest or a meager crop, between profit or loss."

"This catalogue will help you to find and use the tools you need to produce food. The tools and equipment described in its pages were selected primarily for their value to the homesteader, truck farmer, and the small-scale organic farmer, but backyard gardeners should also find things of interest."

This very welcome book is the result of a cooperative effort between the London-based Intermediate Technology Development Group and Rodale Press, an American group which researches and publishes many other titles in the fields of alternative energy sources, organic gardening, and waste recycling. "The idea for this book grew out of the ITDG book, **Tools for Agriculture: A Buyer's Guide to Low Cost Agriculture Implements**" (see review).

Thoroughly illustrated and referenced, this catalog of over 700 implements from around the world is an impressive accomplishment. Included are tools for cultivation and plowing; implements for draft animals; tractors and accessories; seeders; planters; harvesting implements; threshing and cleaning tools; processing equipment; tools for composting, mulching and handling sludge; woodlot and orchard equipment; livestock and fish-farming equipment.

The sources for these tools are primarily in industrial countries, although this reflects current manufacturing realities more than any bias on the part of the authors. Most of the best hand tools and animal-drawn equipment for developing countries are included: the Grelinette/U-bar digger, IRRI's push-type paddy weeder, Jean Nolle's various tropical cultivators, the Mochudi toolbar, hand corn shellers, CeCoCo pedal threshers and winnowers, etc. Also featured are interesting articles on topics such as renovating old equipment and experimental stationary winch systems for pulling farm implements.

A minor shortcoming of this book is the lack of price information. Even though inflation would make such prices quickly out-of-date, this would be valuable for comparative purposes.

"There is a strong heritage, especially in the United States but elsewhere too, of the farmer as inventor. A large percentage of our inventors came from rural communities, and virtually all the industries which grew up in the United States in the 1800s started on a very small scale, often as one-man operations. Cyrus McCormick, Oliver Evans, Eli Whitney, even Henry Ford—each grew up on a farm. The inventors of tools we still need will most likely come from the ranks of today's small farmers—and their children."

A valuable book.

Dibble Sticks, Donkeys, and Diesels: Machines in Crop Production, MF 06-289, book, 329 pages, by Joseph Campbell, available from IRRI Publications, P.O. Box 933, Manila, Philippines.

There has long been a need for a book that takes a broad view of agricultural equipment options, from human-powered to engine-driven, and from traditional to modern, for each of the common tasks in agriculture. The practical reader is particularly interested in the relative costs and productivity of these different options. Until **Dibble Sticks, Donkeys and Diesels** appeared, the reader had to make do with either 1) historical pieces that didn't cover more recently developed small-scale equipment; 2) books that focused on narrower slices of the equipment universe, such as animal-drawn equipment; or 3) the excellent **Tools for Agriculture**, which is limited to commercially available equipment.

This book deserves a place on the shelf alongside **Tools for Agriculture** for its ability to give the reader a quick understanding of many of the basic elements of technology choice in agriculture. While there is the strong coverage of Southeast Asian farm requirements that one would expect from the publisher, the author tries to offer a more universal perspective that will be useful worldwide.

The author begins with a look at the basics of human, animal and mechanical power and important considerations that come with different agricultural production systems. He then takes each agricultural task (tillage, planting, fertilization, weed control, insect and predator control, harvesting, grain drying and storage, and transport) and examines the many possible means to accomplish it. The one vitally important topic that is not included is irrigation pumping. There is a bonus in the discussion of machinery economics, which helps the reader think about the long-term costs of equipment. A brief examination of social consequences provides some useful thoughts on when mechanization is and is not appropriate.

Small Farm Equipment for Developing Countries, MF 06-290, book, 629 pages, Proceedings of an International Conference on Small Farm Equipment for Developing Countries, International Rice Research Institute, 1985, available from IRRI, P.O. Box 933, Manila, Philippines.

A compilation of conference proceedings on various topics, from the history of rice agricultural mechanization in Korea and Japan, to specific discussions of specialized pieces of equipment, to the effective marketing of small farm equipment. The scope is broad but not comprehensive, and focuses almost entirely on Asian experiences.

Specific papers cover issues and consequences of agricultural mechanization, the impact of tractors in South Asia, power-tillers in the Philippines, four-wheel tractors and implements in Thailand, the twin-treadle pump in Bangladesh, the

axial low-lift pump in Thailand, rice transplanters, seed/fertilizer drills in India, fertilizer injectors, wheat and rice reapers, power threshers, mechanical dryers, R&D for farm equipment, and the encouragement of entrepreneurship in equipment development and production.

Guide Book for Rural Cottage and Small and Medium Industries: Paddy Rice Cultivation, MF 06-245, illustrated catalog, 158 pages, by CeCoCo (Central Commercial Company), 1965 (revised 1975), US $40.00 airmail from CeCoCo, Chuo Boeki Goshi Kaisha, P.O. Box 8, Ibaraki City, Osaka, Japan.

CeCoCo is a unique business enterprise. The main interest of this Japanese firm is promoting food production and employment opportunities in developing countries. This "Guide Book" is a catalogue of the hand and machine implements marketed by CeCoCo for the cottage and small industry sector.

A sample of the contents: rice plant cutter, hand seeder and planter, bird and animal scarer & bang (!), noodle making machine, tapioca & fish processing machinery, peanut digger, coconut husk processing machinery, rattan and bamboo weavers, and hydraulic ram pump.

The catalogue includes a wealth of ideas and implements. CeCoCo has drawn heavily from the Japanese historical experience, in which a feudal agricultural economy was gradually converted into a mixed modernizing one. The Japanese were able to control their own pace of development and filter Western technologies to suit their own needs. There is much of interest in these examples of ingenious labor-intensive, locally-manufactured agricultural equipment marketed by CeCoCo, many of which contributed significantly to Japan's economic development in the first half of this century.

American Farm Tools, MF 06-262, book, 121 pages, by R.D. Hurt, 1982, $12.95 from Sunflower University Press, Box 1009, Manhattan, Kansas 66502, USA.

This readable book has many photos and drawings of equipment related to plowing, harvesting, threshing, winnowing, and seeding operations in the United States.

The details on plow and harrow design should be valuable to designers of improved small-farm implements for better seedbed preparation (for higher production per unit of land area).

Appropriate Industrial Technology for Agricultural Machinery and Implements, MF 06-237, book, 159 pages, UNIDO, 1979, Document No. ID/232/ 4, available free of charge from Documents Unit, UNIDO F-355, P.O. Box 300, A-1400 Vienna, Austria.

This publication is for policymakers and planners, offering a systematic look at the kinds of farm equipment needed for different sizes of farms and the levels at which the different ranges of farm equipment can be produced. Some examples are given of production facilities for both simple and complex agricultural tools and equipment, including lists of necessary workshop equipment and anticipated operating costs.

There is no mention of the tradeoffs between employment and mechanization, no effort to examine agricultural equipment that would especially support organic agriculture (e.g., manure spreaders and bug light traps), and no

concern with participation of the rural people in the design of equipment.

The authors recognize the importance of good quality tools and implements for the very small farms that predominate in much of the South. They suggest that "in farms below 2 ha, where farming is carried out in a traditional way, using hand tools and animal-drawn equipment with little or no purchase of inputs ... the mechanization policy should be based on: improved supplies of high-yield seeds and fertilizers and single or double cropping; high-quality hand tools such as spades, spading forks, digging hooks and hoes, shovels, ploughs, and single-wheel hoes; animal-drawn ridgers, cultivator ploughs and seed drills; low-cost, simple power tillers; effective irrigation and water supply by means of windmills with up to 5 ft (1.5 m) lift or small electric or diesel pumps of up to 15 ft (4.5 m) lift; hand-drills, sickles, scythes, forks, and rakes; hand-operated threshers, crushers, etc.; storage bins of up to 3 ton capacity."

The authors also support the concept of local production of basic tools by rural artisans, with the more complicated equipment to be produced by urban or rural industrial establishments. They note that "government policies must be reoriented to assist artisans in the rural areas. Major efforts are needed to encourage and revive production of hand tools by village artisans through provision of loans at concessional rates, technical assistance, provision of simple design and marketing assistance."

Farm Implements for Arid and Tropical Regions, U.N. Food and Agriculture Organization Development Paper No. 91, MF 06-242, book, 159 pages, by H. Hopfen, 2nd edition 1979, $12.25 from UNIPUB; also available from TOOL.

This is a significant resource book. The more important hand tools and animal-drawn machinery suitable for arid and tropical regions in developing countries are presented in clear descriptions and illustrations. Excellent coverage of the historical development of specific tools, such as the evolution of the moldboard plow from ancient to modern times. Included are tillage implements (from simple hand spades to water buffalo-powered cultivators), seeders, sprayers, harvesters, threshers, winnowers, handling and transport equipment, and workshop/maintenance tools.

The author stresses: "A great variety of implements has been developed indigenously all over the world, reflecting the experience handed down for many generations. The introduction of new techniques has the best chance for success when there is a full appreciation of local conditions and traditions before and during the process of introducing new ideas and improvements on the old ones."

"While this publication doesn't claim to be exhaustive, it aims to show how improvement in output can be obtained in areas where it is most needed. It is in fact oriented toward dry-farming tools, rice-growing implements and those used for row crop planting in tropical areas. The implements discussed are not necessarily representative of those found in all areas, but have been chosen because they are common in certain countries; some show how simple modifications can be made to improve performance; others provide examples of the more effective types which have been developed and which could profitably be introduced into areas where they are unknown."

Highly recommended.

Agricultural Technology for Developing Nations: Farm Mechanization Alternatives for 1-10 Acre Farms, Proceedings of a Conference, MF 06-234, May 1978, John Deere and Company, Illinois, out of print.

This collection of papers and panel discussions presents the perspectives of a range of people: World Bankers, multinational agricultural machinery manufacturers, agricultural economists, agricultural engineers and others. Useful as background reading on some of the most promising types of mechanization (broadly interpreted to include animal-drawn equipment) and some of the problems that either prevent or follow mechanization.

For mechanization: "When we began to look at agriculture in other parts of the world, we began to realize that the classic notion that labor is displaced when you increase the number of tractors does not show up in the statistics in a number of countries."

Against mechanization: "... although mechanization raises the productivity of labor, in the conditions prevailing in most Latin American countries its benefits have gone mainly to swell the profits and rents of the large landlords and the wages of the few tractor drivers and other machinery operators .... It may be roughly estimated that about three workers are displaced by each tractor in Chile, and about four in Colombia and Guatemala."

What to mechanize: "Mechanization seldom contributes much to the level of crop yields, except in the form of pumps for irrigation." "In Japan ... the thresher was more beneficial to farmers than the power tiller."

Ensuring socially useful mechanization: "To maintain ... a rational growth of capital in a low-income economy, small farms are better suited than large ones, for the small farmers do not experience the same pressure to substitute capital for labor; no one wants to mechanize himself out of a job."

Rural Africa Development Project: An Example of Farm Land Survey Techniques Using Local Resources, MF 06-285, handbook, 26 pages of text and 19 pages of sample charts, by R.D. Mann, 1974, £11.95 from ITDG.

Report by an ITDG joint project in Zambia. Presents a technique that uses local people without special agricultural training to determine the details of the farming calendar, including the cropping sequence and labor bottlenecks.

"Development plans are missing a link with the dominant type of production unit in agriculture, the smallholder." The author attempts to develop a methodology for determining the needs and circumstances facing the small farmer. He notes that the small farmer "himself is the key to essential information about his activities and his whole environment. His short term and long term memory are excellent, and the data gathered will be meaningless if put through a computer."

The report includes a method for the production of charts which enable the survey team to combine the variables of climatic patterns, crop planting and harvesting, livestock enterprises, off-farm equipment, and more on a single calendar chart. This makes the labor bottlenecks quite evident. Sample questionnaires and charts are included.

A farm-machinery-needs survey system is then described and used in combination with the labor chart to provide "guidelines on which action is taken in engineering development, farm-level testing and modification of equipment, and training procedures for initiating rural craftsmanship and small-scale local manufacture in rural areas" (see following entry).

An interesting model of a low-cost survey technique.

Horse-Drawn Farm Implements, Part II: Preparing the Soil, MF 06271, book, 84 pages, by John Thompson, 1979, out of print; parts 1,3, and 4 still available from John Thompson, 1 Fieldway, Fleet, Hants., United Kingdom.

Each of John Thompson's books on historical agricultural implements gives a sense of the many variations once used. **Preparing the Soil** is a look at animal-drawn cultivators, harrows and rollers. Readers interested in ideas for low-cost harrows and rollers in particular will find them here. Old illustrations are combined with text from agricultural handbooks and encyclopedias of the last century.

Old Farm Tools and Machinery: An Illustrated History, MF 06-250, book, 188 pages, by Percy Blandford, 1976, $36.00 from Gale Research Company, 835 Penobscot Building, Detroit, Michigan 48226-4094, USA.

This book covers tools and machinery from small farms in Great Britain, Europe, and the United States from the past hundred years. The author briefly looks at animal power gears, carts, steam engines, and the early tractors. Of greater interest, and complete with illustrations, are the chapters on agricultural equipment, most of it capable of being animal-drawn. These include a variety of plows, a cable plow pulled by a stationary steam engine, an excellent collection of seeding devices, manure and fertilizer spreaders, spades, forks, rakes, hoes, harrows, cultivators, reaping machines, hand harvesting tools, mowing machines, and tools related to dairy production. There are thirty photographs and more than 150 simple line drawings. The brief text and drawings are usually enough to communicate the basic ideas and principles used in this book, but you wouldn't be able to make any of this equipment from this information alone. Nevertheless, the book is a great source of ideas.

The Employment of Draught Animals in Agriculture, MF 06-241, book, 249 pages, CEMAT, 1968, English translation 1972 by FAO, $19.50 from UNIPUB, also available from TOOL.

"This manual is mainly concerned with the application of animal draught equipment, a form of agricultural mechanization predominant in the tropical regions of Africa."

The difficulties and disadvantages of introducing engine-driven equipment have become evident in many parts of the world, most notably in Africa, where draft animals historically have been rarely used. Animal-drawn equipment for mechanization appears to represent the more appropriate technology for many of these areas.

This book begins with draft animals (power, training, housing, feeding, harnessing methods). There is an extensive and very good section on animal-drawn implements with valuable notes on animal power gears. Following this is a discussion of the rural skills and equipment available for implement and harness production and repair. The final section presents economic considerations and includes a simple method for calculating the costs of animal power.

An excellent book.

Animal Traction, MF 06-287, Peace Corps Appropriate Technology for Development Series Manual M-12, book, 244 pages, by Peter R. Watson, 1981, available to development workers from Peace Corps; also available from ERIC (order no. ED241772) and NTIS (accession no. PB85 245074/AS).

"This manual is a practical guide to the selection, care, and training of draft animals, and to the equipment and field techniques used in animal powered farming systems .... It is also a guide to animal traction extension, describing how instructors can teach these skills to farmers and other agents." No prior experience with draft animals is assumed in this clearly written and comprehensive book. Includes a brief discussion of some of the possible drawbacks to introducing animal traction to new areas.

Animal Traction in Africa, MF 06-265, book, 490 pages, by Peter Munzinger 1982, DM60 (approximately US $22.50) from GTZ; also available in German and French.

This lengthy volume contains a thorough compilation of facts, some of them surprising, on draft animals as they are currently used in Africa. "The situation of dairy cows in Africa differs so fundamentally from that of dairy cows in Europe that values determined in Europe can only be applied to Africa with extreme caution. The milk yield of the African cows is considerably lower, with an average of between 2 and 5 liters per day .... With an additional supply of nutrients for the animals' working requirements, there is no reason to assume that there may be a milk loss given the relatively low yields. Investigations in Senegal revealed that the weight development of Djakore calves whose mothers were used for draught work and received a working ration was significantly better than that of calves whose mothers did not work."

The equipment section offers some new insights as well. Chapters on crop growing, economic aspects, and sociology round out the general treatment of the material. These are followed by four case studies of draft animal use in different African countries.

Most of the material here is relevant anywhere draft animals are now used or may be used in the future.

Harnessing and Implements for Animal Traction, MF 06-294, book, 243 pages, by Paul Starkey, 1989, DM 36.00 from GATE.

One of a series of books produced as revisions to **Animal Traction in Africa** (see review), this is the best reference yet on harnesses and implements, drawing from much recent experience in Africa. The author dampens some of the recent enthusiasm about "improved harnesses," noting that the claims for improved performance have often been poorly documented, while he knows of no examples in which "improved harnesses" have been widely accepted by the farmers for whom they were intended. Also covered is equipment for transport (packs and carts), and unconventional equipment that serves a variety of purposes. The author has years of direct experience in this work, and has thoroughly reviewed the literature allowing him to provide a state-of-the-art view from the practitioner's perspective.

One of the things that confounds researchers in this field is the difficulty of obtaining precise comparative measurements of power output and efficiency --given the differences between animals and soils-- and the imprecise nature of the tasks of field preparation. This topic is explored usefully in a discussion of working rates.

The book concludes with an exploration of the problems of local production of equipment.

Recommended.

Animal Power in Farming Systems, MF 06-293, book, 363 pages, edited by Paul Starkey and Fadel Ndiame, 1988, DM 48.00 from GATE.

Conference proceedings of a 1986 meeting of people involved with animal traction in Africa, with papers in English and French describing experiences in Senegal, Nigeria, Mali, Sierra Leone, Liberia, Togo and other locations in West Africa. The audience for this book is limited to readers who are already heavily involved with animal traction projects as these proceedings suffer from the usual limitations of the genre (unrelated, overlapping articles). The general reader is directed to the other recommended books in this section on animal traction.

The Draft Horse Primer: A Guide to the Care and Use of Work Horses and Mules, MF 06-240, book, 400 pages, by Maurice Telleen, 1977, $17.95 from Rodale.

The work horse "is a source of power that reproduces itself, with good care is self-repairing, consumes home-grown fuel, and contributes to the fertility of the soil. Horse farming and organic farming are very comfortable with one another."

This book is interesting for several reasons. First, it shows that some North Americans have either stayed with horse-drawn farming equipment (e.g., the Amish) or are now going back to it. (In the United States, "the demand for draft horses has risen significantly since 1960"). Second, it captures some of this practical wisdom which normally passed from farmer to farmer. The author draws from his own experience and brings together "material from booklets published by our land grant schools during the twenties and thirties when they had an active interest in heavy horses as a major source of agricultural power."

Telleen discusses the breeds of draft horses used in the United States, what to look for when buying, and basic care of these animals. He presents 70 pages on animal drawn machinery, 50 pages on harnesses and hitches, and 22 pages on logging with horses. Because horse-drawn equipment has historically been far cheaper than mechanized equipment, a smaller farm can finance it.

A thoughtful book that illuminates the potential role of the draft horse in a small-scale, ecologically-sound agriculture.

The Harness Maker's Illustrated Manual, MF 06-246, book, 333 pages, 1977, $20.00 from North River Press, Box 309, Croton-on-Hudson, New York 10520, USA.

This is a reprint of a book first published in 1875, when animal-powered transport was normal in the United States. It describes how to make harnesses for horses and mules.

"This book originated from a desire to furnish harness makers with a condensed practical guide suited to the workshop, office, salesroom and stable. It treats leather as furnished to the harness maker by the currier, its texture, strength, adaptability for specific uses; how to cut, fit, and finish; measuring for a harness; complete tables for lengths and widths for cutting the various classes in use, whether for carriage, farm, or road; bridles, halters, horse-boots, mountings, bits, etc."

The language used is slightly out-of-date and may at times present trouble to

the reader. The instructions on horse harness construction and design are excellent.

The Harnessing of Draught Animals, MF 06-270, 92 pages, by Ian Barwell and Michael Ayre, 1983, £7.50 from ITDG; also available from TOOL.

The type of harness used has a significant effect on the useful power that can be obtained from a draft animal (oxen, horses, donkeys, mules). This volume summarizes what is known about different improved harnesses in basic principles and in a variety of design examples. Improved harnesses could mean that a single animal could accomplish the job now performed by two animals, in certain situations, or that a single animal or team of animals could cover a larger area, travel a longer distance, or pull a heavier load than was previously possible.

The Animal-Drawn Wheeled Tool Carrier, Information Bulletin 8, MF 06264 booklet, 13 pages, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), 1983, out of print.

Wheeled tool carriers represent an important innovation in equipment for use with draft animals. Different attachments are fitted to the basic unit for the different operations of plowing, harrowing, cultivating, etc. The major drawback of the tool carrier is that it costs too much for most small farmers. This short booklet nicely introduces this tool, with many photos to illustrate the many applications.

Animal-Drawn Wheeled Toolcarriers: Perfected Yet Rejected, MF 06292 book, 161 pages, by Paul Starkey, 1988, DM 24.50 from GATE.

One of the most notable books published on appropriate technology in recent years, this volume demands attention because it does two things extraordinarily well. First, it provides an exhaustive review of the worldwide developments of a single technology: the animal-drawn wheeled tool carrier. The sheer comprehensiveness of this review is impressive and constitutes a challenge to other authors writing on other technology topics as well. Secondly, this is a widely relevant, cautionary tale about technology development and how a "successful" label circulates much faster than disappointing field results.

This is the story of a very promising technology that has never quite bridged the gap to become adopted by and affordable to local farmers. The wheeled tool carrier is a multipurpose agricultural tool with a range of attachments. It has capabilities that generally exceed those of traditional technologies while being far less costly than engine-driven mechanized equipment. Thus it falls neatly into the category of intermediate-level technology. Yet this device, with variations that have been tried in thirty different countries, has never convinced local farmers that it was worth the full expense.

To date about 10,000 wheeled toolcarriers of over 45 different designs have been made. Of these, the number actually used by farmers as multipurpose implements for a period of several years is negligible. The majority have either been abandoned or used as carts. Interestingly, lighter, cheaper toolbars without wheels have been far more successful, with some 350,000 sold worldwide.

The hows and whys of this tale should be important to all who would work on appropriate technology development. Small-farmer participation in research has evidently been lacking, limited to field testing of subsidized equipment. It is likely that designers emphasized durability at the expense of affordability. In seeking

multifunctionality, too many compromises were made, with the result that for most applications the tools are overbuilt and too heavy. Perhaps most fundamentally, this was a technology developed by engineers and research institutions, not entrepreneurs and farmer/inventors, and kept alive by subsidies and research funds without regard for the kind of poor investment that it really represented for farmers. The lack of market demand was never believed to be a fair indicator of farmers' views on the technology.

There is much more to the story, and we recommend it highly.

The Agribar Operator's Manual: Field Operations, MF 06-291, book, 55 pages, by R.K. Bansal, 1989, $5.80 to less-developed countries, $17.40 to highly developed countries, Rs. 84 in India, from ICRISAT, Patancheru, Andhra Pradesh 502 324, India.

This manual, intended for use by farmers, does a nice job of illustrating the multiple uses of a toolbar. The many photos and drawings assist the farmer in changing the tools on the toolbar and using each configuration properly and effectively. Whereas toolbars have never caught on the way their creators had hoped, this is an interesting example and a thought-provoking case. A good idea book for people who might wish to further explore variations and applications of the toolbar concept.

The Tropicultor's Manual: Field Operations, MF 06-278, booklet, 62 pages, by R.K. Bansal, 1985, US $1.90 to less-developed countries, US $5.70 to highly developed countries, from ICRISAT, Patancheru P.O., Andhra Pradesh 502 324, India.

The most famous wheeled tool carrier is probably the tropicultor, developed by Jean Nolle. This booklet of photographs with English instructions shows the operator how to attach the various tools and use the unit to perform all needed field operations.

Carts, AGL No. 44, MF 06-233, dimensional drawings, 8 pages, 1973, ITDG, out of print in 1985.

Detailed drawings are given for 3 different cart designs. The method of fabrication is clear from the drawings. The first two designs require the use of the ITDG Metal Bending Machine (see review) for fabrication of the wheels; the third design uses old car wheels. The first two designs use wood block bearings. The bodies of all 3 carts are made of wood.

Carrying capacity is given as 700 and 1400 lbs. (318 and 636 kg) for the first two carts; no capacity information is given for the cart that uses old car wheels.

The Handcart Handbook, MF 06-269, booklet, 48 pages, by David Tresemer, 1985, $4.50 plus postage and handling from Ag Access, P.O. Box 2008, Davis, California 95617, USA.

"Use it to move dirt and rocks; transport firewood; harvest produce; carry transplant trays, soil and compost; move light, bulky loads (hay, brush, leaves) and heavy bulky loads (lumber, trash, ladders, furniture); and transport small animals and feed. This cart can also serve as a portable tool chest, sawhorse, and stepstool."

This is a small and informative report based on the author's extensive research and testing of specially designed multi-purpose handcarts. It is filled with

contemporary photos, historical illustrations, and detailed line drawings to enable readers to construct their own carts and related equipment. The topics covered include the elements of a good cart, using a cart effectively, how to build your own cart improving an existing cart, and accessories to increase the cart's usefulness.

The author is co-founder of Green River Tools, a trading company based in Brattleboro, Vermont, which specializes in manufacturing quality handtools from all over the world. This company is dedicated to providing durable tools which increase productivity, improve and maintain the user's health and enhance the environment. They also distribute a number of provocative research reports (many written by David Tresemer) on a variety of topics, including acid rain, tropical deforestation, beneficial birds, tool design to fit the human hand, and natural growing media. A catalogue and publication list is available from the address listed above.

Agricultural Green Leaflets, MF 06-230 to MF 06-233, plans for agricultural equipment, ITDG.

The following plans were offered by ITDG but are out of print in 1985. Most of these tools were designed for agricultural conditions in Africa.

These leaflets were originally intended for distribution to experienced agricultural engineers in the field, and the descriptive text is often brief. This is unimportant in most cases, but for some of the equipment, the precise use is unclear to anyone unfamiliar with African agricultural practices. Construction details are quite easy for anyone to understand.

4—Kabanyalo Toolbar, MF 06-230, dimensional drawings, 5 pages.

This is a locally-built (and locally repairable) steel plow that also functions as a cultivator/weeder. A simple skid is used instead of a depth wheel.

5—Chitedze Ridgemaster Toolbar, MF 06-230, dimensional drawings, 6 pages, origin: Malawi.

This is a locally-built and repairable combination steel plow, ridged and cultivator. "The unique design of this toolbar is that it combines lightness with adequate structural strength, the main parts being fabricated from rectangular hollow section mild steel."

6—Prototype Multi-Purpose Ox-Drawn Tool, MF 06-230, dimensional drawings, 3 pages, origin: Nigeria.

This is a prototype of a tool to be used for ridging, splitting ridges, cross-tying, weeding, and breaking capped soil in the furrows. The tool frame was designed with an offset beam to avoid blockage when lifting groundnuts. The share is adjustable to allow these different operations to be carried out.

10—Clod Crushers, Two Designs, MF 06-230, dimensional drawings, 3 pages, origin: Malawi.

"These two simple and cheaply-constructed implements are used for reducing the size of dirt clods in cultivated land prior to ridging up the soil." They are both

animal-drawn, and use wooden pegs on rollers to break up the clods as the implement rolls over them.

11—Ox-Drawn Tie-Ridger/Weeder Implement, MF 06-230, dimensional drawings, 3 pages, origin: Malawi.

"This implement is an attachment only, designed for use with the 'EMCOT' ox-drawn ridging plow." It can be used for cross-tying during ridging and for both cross-tying and weeding after ridging. Precisely what "cross-tying" means is not made clear for anyone unfamiliar with the technique. Ridging and cross-tying, it is claimed, have resulted in substantial crop yield gains on certain free-draining soils in Africa. This attachment (with the EMCOT plow) cut the labor requirement for use of this technique in land preparation and weeding by an estimated "60% when compared with cultivation by hand."

Fabrication is straightforward and uncomplicated, requiring some welding. The instructions for field use are vague.

12—IDC Weeding Attachment for EMCOT Plow, MF 06-230, dimensional drawings, 3 pages, origin: Nigeria.

"This attachment enables weeding in ridged row crops to be carried out by animal power instead of by hand." However, this is only an attachment to be used with the EMCOT plow. "The tool ... can be adjusted for height and also for width according to the row spacing. The sides of the ridges are remade by the ridger body following behind." Essentially, the attachment consists of two steel blades that are pulled along through the earth on the sides of the ridges.

13—Adjustable Width V-Drag Ditcher/Bund Former, MF 06-230, dimensional drawings, 3 pages, origin: U.S. Dept. of Agriculture.

"This implement is used for making irrigation ditches, and can also be used to construct low-height contour embankments for border irrigation. When making earth ditches for conveying water to crops or drainage channels, a furrow is first opened with a plow (running down and back the required number of times according to the depth required) along the line of the ditch. The V-Drag is then used with the runner board riding in the furrow bottom, the crowder board deflecting the soil sideways. Weight can be added by the operator standing on the runner board. The depth of cut can be increased by placing additional weight towards the front of the implement and/or lengthening the hitch." Animal-drawn.

14—Sled-type Corrugator Irrigation-Furrow Former, MF 06-231, dimensional drawings, 3 pages, origin: U.S. Dept. of Agriculture.

"The function of this implement is to make small furrows, or corrugations, for distributing water over a field. The corrugations are run down the slope of the land. This implement can be used after the field has been broadcast seeded or before row-crop planting. The implement design shown can be modified in size to suit animal-draught or tractor-hitching as required." This tool is essentially a sled with four runners that is dragged (loaded) over a field.

15—Single-Row and Three-Row Rice Seeders, MF 06-231, photoprints, 3 pages, origin: Zambia.

Photoprints only. Two pages on the single-row seeder and one page on the triple row seeder. This set of plans asks for more local imagination and ingenuity than most ITDG plans do—somewhat hard to understand.

These implements carry out direct seeding of rice fields. They have probably little or no application to Southeast Asia, for example, because they were designed to allow a person to cultivate a larger area (such as in sparsely populated areas of Africa). Where available land is already under intensive cultivation, such equipment would probably lower the total production per unit of land.

16—Rotary Weeder for Row-Planted Rice, MF 06-231, photoprints, 1 page.

A single page with four photos. The rotary weeder is a very simple piece of equipment, only about 11/2 feet long at the bases with a long handle. Measurements are English units only. Two rotary, star-blade clusters are pushed along between two rows. A blade follows the two clusters.

17—Multi-Action Paddy Field Puddling Tool, MF 06-231, photoprints, 1 page, origin: Japan.

Photoprints with English units only. Some imagination would have to be used by whomever would build from such plans. However, the basic principles are quite clear from the photoprints. Ox-drawn. Apparently, the farmer simply follows along behind, controlling the animal only. Some weights may need to be attached for effective use.

27—Cassava Grinder, MF 06-231, dimensional drawings, 10 pages, origin: Nigeria.

The exact application of the cassava grinder is not made explicit. No text is included, only assembly instructions. This is a bicycle-pedal, chain-driven grinder. Production is straightforward; certainly possible on a local level.

28—Rotary Corn (Sorghum) Thresher, MF 06-231, dimensional drawings, 10 pages, origin: Nigeria.

This set of plans has no real text, only a few words with each drawing. Harder to understand than most ITDG plans. This unit, operated with a hand-crank, is actually for guinea corn (sorghum). Probably operated by two people.

29—IDC-Bornu Groundnut Lifter and IT Groundnut Lifter, MF 06231, dimensional drawings, 8 pages, origin: Zambia and Nigeria.

This set of dimensional drawings has two items. The IDC-Bornu groundnut lifter is only an attachment for an EMCOT plow. It is pulled by a draft animal, with two depth wheels and a plow-like bar for lifting up the groundnuts.

The IT groundnut lifter is a complete piece of equipment in itself. "A lightweight lifter suitable for groundnuts grown on 75 cm spaced ridges in sandy soils. Suitable for manufacture by village blacksmiths." The minimum equipment required would be a forge, anvil, hammer, tongs, chisel, and punch. This groundnut

lifter has no wheels. A flat bar is dragged across the ground, with a person steering it from behind. Animal-drawn.

30—IT Granule Applicator, MF 06-232, dimensional drawings, 14 pages, origin: Nigeria.

This fertilizer applicator fits on a toolbar in place of a mechanical weeder. These plans include a calibration chart for the applicator at various flows and row spacings.

Some of the drawings are not very clear, but the unit should be reproducible. The materials and dimensions can be altered to fit local conditions.

31—IT Expandable Cultivator, MF 06-232, dimensional drawings, 7 pages, origin: Nigeria.

"A lightweight cultivator designed for weeding of crops planted in 70-90 cm spaced rows in sandy soils, to be pulled by one or two oxen or donkeys. Tines are individually adjustable for depth, making the implement suitable for flat or ridge cultivation." The width is also adjustable for the unit as a whole.

This design requires a lot of hole drilling or punching, and thus accuracy in measurement.

32—Seed Dressing Drum (Hand-Operated), MF 06-232, dimensional drawings, 5 pages, origin: Malawi.

Fertilizer and seed are poured into the top of the drum; it is rotated 20-40 times, and the mixture is poured out from the bottom. "It was found that this drum had a capacity of 30 lbs. (13.6 kg) of soya beans or maize, and 38 lbs. (17.2 kg) of fertilizer when filled correctly. In a durability test, a total of 1.5 tons of fertilizer was mixed without signs of damage. The drum was also used for seed-dressing of groundnuts and maize with satisfactory coverage performance and no apparent adverse effect on germination."

The fairly simple design can certainly be made by local draftspersons with very few tools.

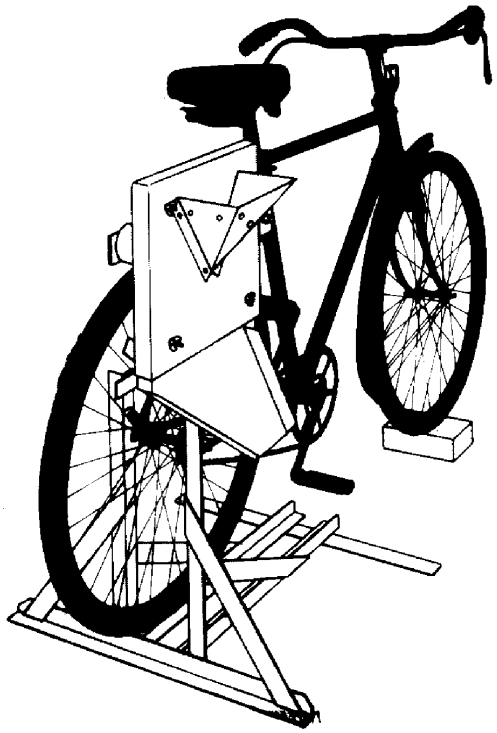
33—IT High-Clearance Rotary Hoe, MF 06-232, dimensional drawings, 7 pages.

"This animal-drawn implement is designed for seeding of crops grown on ridges at 75-90 cm spacing. It cultivates both sides of one ridge at a time and therefore, unlike cultivators drawn between the ridges, does not require straight and parallel ridges for efficient weeding .... This implement is not suitable for use in very hard soil conditions. It can be used in wet soil and has been used successfully for weeding cotton while water was standing in the furrows."

36—The Weeder-Mulcher, MF 06-232, dimensional drawings, 8 pages, origin: India.

"This animal-drawn self-cleaning weeder was originally developed for use in sugar-cane plantations (by the Indian Institute of Sugarcane Research). It is designed to destroy weeds, leave a mulch on the soil surface to conserve moisture and give a high work output per day (up to 5 or 6 acres of row crop work per 8 hour day). It can be used on most row crops with a spacing of 30 inches (75 cm) or more .... The blades

can easily be replaced by a village blacksmith."



37—Foot-Powered Thresher, MF 06-232, drawings, 5 pages.

This treadle-operated thresher was designed for rice. Five workers and a thresher can handle 1000 kg of dry paddy or 500 kg of wet paddy daily. The plans are easy to understand. "A bit complex for manufacture at the village level, but easy enough for a simple machine shop."

38—The "Rasulia" Bladed Roller Thresher, MF 06-233, dimensional drawings, 4 pages, origin: India and Iran.

This implement was seen in use in Iran, and subsequently built in India by Ed Abbot at the Friends' Rural Development Centre in Rasulia. It is pulled by a draft animal, with the driver seated on the unit. It is estimated to be 60% more efficient than the traditional Indian method of using bullocks to trample the harvested crops.

Uses wooden bearings which are not described.

41—Harrows: High-Clearance Peg Tooth (East Africa), Triangular Spike Tooth (India), Flexible Peg Tooth (Iran), and Japanese Harrow, MF 06-233, drawings, 8 pages.

These harrows can all be pulled by animals. The function of a harrow is to prepare seed beds by breaking soil clods, cover seeds after broadcast seeding, and control weeds. Several of these harrows are designed to leave weed residue on the soil surface to conserve moisture.

The Scythe Book, MF 06-273, book, 128 pages, by David Tresemer, 1982, $6.95 plus postage and handling from Ag Access, P.O. Box 2008, Davis, California 95617, USA.

This is a detailed guidebook for the scythe, a traditional cutting tool for moving hay, cutting weeds, and harvesting small grains. The author presents his extensive research on European and North American designs and covers the equipment, sharpening, techniques, uses, and accessories in detail. The book is loaded with illustrations, historical references, and anecdotes encouraging a resurgence in the popular understanding and use of this versatile tool. The lightweight "Austrian-style" version, with a straight snath (or handle) and razor-sharp hammered blade, is favored over the "American" version, with its curved snath and stamped blade. For parts of the world where increased productivity in agricultural operations (such as grain harvesting, forage cutting, or composting) is called for without resorting to power equipment, the scythe may become a valuable intermediate technology option.

"The most elaborate and most beautiful invention for laying out grain more neatly to the side in scything is the grain cradle .... It was really a different tool, quite like a scythe in principle, but with a rack of three to five wooden tines curved to follow the shape of the blade. At the end of the stroke, the straws would be bunched together and supported by the tines. The cradler would then tilt the whole thing to the left and let the cut grain slide out in a neat bundle. In the middle of the nineteenth century there were a million cradle scythes being used in the northeast United States alone ...."

Rice: Postharvest Technology, MF 06-253, book, 394 pages, edited by E. Arguello, D. De Padua, and M. Graham, 1976, IDRC, out of print in 1985.

This large volume covers all the technical aspects of rice postharvest technology: harvesting, threshing, drying, storage, parboiling, milling, and handling. It also describes "some of the anatomical and biochemical properties of the rice grain in relation to postharvest processing problems."

This book was compiled from material used in a training course on post-harvest technology in the Philippines. It is not an appropriate technology manual but rather a reference book on the current state-of-the-art equipment for rice processing operations. It could be useful to small independent groups and university-based organizations that need to know as much as possible about the principles used in the standard commercial designs while working to develop lower-cost alternatives that will benefit even the smallest farmers.

Winnowing Fan, VITA Technical Bulletin No. 39, MF 06-260, 4 pages, out of print in 1985.

A portable machine from the Philippines for winnowing rice. This design is hand operated, but it could be adapted to use pedal power or a small engine. The drawings and text are easy to understand.

The Winnower, MF 06-261, booklet with dimensional drawings and assembly information, 35 pages, 1984, TOOL, out of print.

The authors claim the winnower is easily produced, operated, and maintained. It is operated with a hand crank, but could certainly be adapted to use a pedal-powered chain-drive system. Dimensions and materials are given for each part of the winnower. This unit was designed from an earlier prototype with consideration given to conditions in developing countries.

A Hand-Operated Winnower, Rural Technology Guide No. 11, MF 06-281, booklet, 26 pages, by J. Beaumont, 1981, free to recipients of British aid, £1.62 to others from NRI.

This design for a simple enclosed winnowing fan for separating grain from chaff can be made of wood or sheet metal with simple tools. "This winnower was designed for use with the hand-operated sunflower seed decorticators developed by TPI but it can be used for a wide variety of materials." Photos, drawings, and step-by-step instructions are provided.

A Pedal-Operated Grain Mill, Rural Technology Guide No. 5, MF 06-272 booklet, 32 pages, by G.S. Pinson, 1979, £0.80 from NRI.

Complete instructions for the production of a grinding mill for grains and legumes. The mill and supporting stand are used with an ordinary bicycle, which can be quickly connected and disconnected. The rear bicycle wheel drives a rotor at about 5000 rpm to break up the grain. Wire mesh controls the size of the flour product. "The mill works best on hard, brittle grains such as maize (corn), millet and sorghum and on legumes such as soya beans."

Although the mill is of steel construction, it is intended for use over brief periods to meet the daily needs of individual households. It is not designed for continual, intensive use. No cost estimates are provided. An alternative wooden frame using some bicycle parts is shown. Design modifications could eliminate the more difficult metalworking tasks (lathe and milling work), and also reduce some of the other costs. Some field reports indicate excessive tire wear is a problem with the bicycle-attached version.

Small Scale Maize Milling, Technology Series Technical Memorandum No. 7 MF 06-297, book, 143 pages, ILO / UNIDO, 1984, 17.50 Swiss francs from ILO.

Traditional techniques of corn (maize) milling have the twin disadvantages of being quite time-consuming and may be inefficient in converting raw material into usable product. This book will give you a useful overview of such topics as the approximate output of the various choices of technology and the space requirements for establishing a new milling operation. Much of this information, however, is better covered elsewhere, especially in the manuals that specifically cover commercially available equipment.

Cereal Processing, Food Cycle Technology Source Book No. 3, MF 06-299 booklet, 69 pages, UNIFEM, 1988, from UNIFEM, 304 East 45th Street, Room FF-614, New York, New York 10017, USA.

This volume contains only brief coverage of the rather broad topic of small-scale technology for cereal grain processing with some illustrations. Of greatest interest are the sixteen short case studies of projects that attempted to improve local processing technologies.

Bell Alarms and Sack Hoists in Windmills, MF 06-238, booklet, 16 pages, by H. Clark and R. Wailes, 1973, Newcomen Society, out of print.

This is a study of the clever ways in which two important functions were accomplished in windmills and watermills: 1) warning the miller when the grain was low (using bells); and 2) lifting the heavy sacks of grain and flour inside the mill (using hoists that took power off of the windmill or watermill via a drive shaft).

Introduction of Animal-Powered Cereal Mills, MF 06-295, book, 70 pages, by Wulf Boie, 1989, DM 19.80 from GATE.

Grinding grain is a very time-consuming daily task for people, particularly women, in many parts of the world. Traditional technologies such as hand-operated stone mills, stone mortars, and pounders suffer from low productivity, while motorized mills are often far away and may cost the customer too much in cash or a percentage of the crop. In West Africa, a customer base of 1000 to 1500 people is needed to support a motorized mill. This book looks at an experimental animal-powered mill as another choice of technology that can operate on a smaller scale in a village with as few as 100 people.

This mill system, which has been tried in five West African countries, involves production by local craftspeople and modifications to meet local preferences regarding the final milled product. Maintenance is greatly simplified as compared with motorized mills. Most of the mills are being operated by women's cooperatives.

The first part of the book is devoted to general considerations important to the successful introduction of these mills and the organization needed to operate them.

The second part covers the design and construction of the mill. The basic design is much simplified compared to conventional animal power gears, which require very strong components that are difficult to make. "In comparison with conventional power gears, the principle of the 'runner wheel power gear' has the following main technical advantages: 1) for the often problematic first gear stage of the power gear, a concrete path that can be easily constructed locally and a universally available car wheel are used; 2) since the grinding unit runs round in a circle with the animal, long subterranean shafts and cardan joints can be dispensed with, and 3) the frictional wheel principle effectively protects the power gear (as well as the machine) against overload."

Root Crop Processing, Food Cycle Technology Source Book No. 5, MF 06300, booklet, 74 pages, UNIFEM, 1989, from UNIFEM, 304 East 45th Street, Room FF-614, New York, New York 10017, USA.

The technology choices for the small-scale processing of tropical root crops such as potatoes, cassavas, and yams are summarized with drawings of simple equipment from around the world. Four short case studies of development projects on improved processing techniques are included.

A Feeder to Improve the Performance of a Hand-Operated Groundnut Sheller, Rural Technology Guide No. 4, MF 06-267, booklet, 17 pages, by G.A. Collins, L.D.G. Coward and G. Pinson, 1977, free to recipients of British aid, £1.00 to others, from NRI.

This is a construction manual for a device that controls the number of groundnuts (peanuts) dropped (fed) into a hand-operated groundnut sheller. The result is less effort in use and fewer broken kernels. Drawings and instructions are clear, and the feeder should be easy to make if the metalworking tools are available. Wood could be substituted for many of the steel parts, but the authors do not discuss this. The feeder is designed to be attached to existing models of groundnut shellers.

Treadle-Operated Peanut Thresher, Complete Technical Drawing No. 20, MF 06-258, five 24' by 36' sheets of technical drawings with three pages of instructions, ITDG, out of print.

This is a simple piece of equipment, but the tolerances are small enough to require relatively accurate crafting. Probably best if built by a small workshop that would produce dozens of units. Standard sizes of lumber are used (English measurements only). The plans may need to be adapted for the use of locally available materials.

A Hand-Operated Bar Mill for Decorticating Sunflower Seed, Rural Technology Guide No. 9, MF 06-282, booklet, 31 pages, by J. Beaumont, 1981, free to recipients of British aid, £1.78 to others, from NRI.

A simple machine to remove hulls from sunflower seeds which can be made in a workshop. Requires bearings, pulleys, steel and wood as materials and a lathe and welding set as tools. Drawings, photos, and step-by-step instructions are included.

"This type of decorticator is suitable for removing the husk from the smaller, high oil-bearing types of sunflower seed. It will process about 20 kg (40 lbs.) of seed per hour." To be operated by 1-2 persons.

Small Scale Oil Extraction from Groundnuts and Copra, ILO Technical Memorandum No. 5, MF 06-274, book, 111 pages, 1983, $10.50 from ILO; also available from VITA, ITDG, and TOOL.

A look at the steps involved in removing oil from peanuts (groundnuts) and dried coconut (copra) using small-scale mechanized equipment, this volume should be helpful in either starting a business or in identifying where in the process technical improvements may be made. "It provides detailed technical and economic information on small-scale oil extraction mills using either small expellers or power ghanis, and processing between 100 tonnes and 220 tonnes of materials per year. An economic comparison between these small-scale plants and medium to large-scale plants is provided."

The traditional technologies of rural areas are either ignored or only briefly mentioned. "An animal-powered ghani (oil press) can process 5 to 15 kg of seeds at a time. An improved version of the ghani has been developed in India. Known as the Wardha ghani, it is larger and more efficient than the traditional ghani and can crush charges of seed of up to 15 kg in approximately 1.5 hours or close to 100 kg per

day."

Small Scale Processing of Oilfruits and Oilseeds, MF 06-288, book, 100 pages by Hans-Jurgen Wiemer and F.W.K. Altes, 1989, DM 24.50 from GATE.

Producing oil from oilseeds has traditionally been very time-consuming while freeing only a relatively small percentage of the total oil available. This book discusses the development of attractive alternatives to the traditional techniques that can theoretically free up the time of rural people, especially women, for more productive activities. Depending on which technology is used and who owns it, some or all of the cost of milling may be paid for in kind with the extra oil extracted.

This thorough and recommended reference takes the reader from basic project considerations, particularly social factors, through the various oilseeds and oil fruits, to an examination of a variety of small-scale technologies. This is a good place to look at a variety of hand-operated presses. Case studies are provided.

Oil Extraction, Food Cycle Technology Source Book No. 1, MF 06-298, booklet, 47 pages, UNIFEM, 1987, from UNIFEM, 304 East 45th Street, Room FF-614, New York, New York 10017, USA.

A short overview of small-scale technologies for oil extraction from oil seeds and nuts. Includes eight case studies of projects.

Mechanics in Agriculture, MF 06-249, book, 702 pages, by Lloyd J. Phipps, 1983, 1992 edition $43.95 plus $4.00 shipping and handling from Interstate Publishers, Inc., P.O. Box 50, Danville, Illinois 61834-0050, USA.

This is a comprehensive text for courses in vocational agriculture, divided into five parts: equipping and using a farm workshop, engines and implements, buildings, electrification, and soil and water management. Illustrations and excellent instructions on the use of all kinds of hand and power tools make this an encyclopedia of modern American farm mechanics. The text is particularly strong on explanation of principles of operation, maintenance, repair, and safety for tools and implements. Though it was compiled for use by American secondary school students entering a capital and energy-intensive agriculture, the book covers many topics of interest to agriculturalists everywhere. Examples include repairing and sharpening hand tools; making sketches and reading blueprints; understanding concrete; soldering and oxyacetylene welding; blacksmithing and working sheet metal; using rope and leather; and fundamentals of engines and electric motors.

A good reference book.

Small Gas Engines, MF 06-255, book, 256 pages, by James Gray and Richard Barrow, 1976,1988 edition $24.00 (paperback) or $29.00 (clothbound) from Prentice Hall, Englewood Cliffs, New Jersey 07632, USA.

Small gas engines are very common in most parts of the world. They are used in motorcycles, electric generators, water pumps, rototillers, winnowers, boats and many other devices.

This book introduces the theory of small gas engine operation. It does a detailed and thorough job of presenting the basics of repair and maintenance. Understandable to the beginner and also valuable to those who already know

something about the subject.

Recommended.

How to Repair Briggs and Stratton Engines, MF 06-247, paperback book, 182 pages, by Paul Dempsey, 1984, $9.95 for paperback, $12.95 hardbound, from TAB Books, P.O. Box 40, Blue Ridge Summit, Pennsylvania 17214, USA.

Briggs and Stratton engines power small pumps and agricultural implements all over the South. Though it is written for North Americans, this book could be valuable wherever these small engines are being used.

The author "describes repair and maintenance procedures for all current and many older Briggs and Stratton engines. These procedures extend to all phases of the work, from simple tune-up and carburetor repairs to the serious business of replacing main bearings and resizing cylinder bores. The material is organized by subject and by engine model and divided as much as possible into steps that are easy to follow." Clear line drawings and text explain the basics of four-cycle internal combustion engines and the adjustment and repair of ignition systems, carburetors, and pull-starters. The section on engine disassembly and overhaul includes standard machining clearances and dimensions as well as replacement part identification numbers.

Repair and Maintenance of Stationary Diesel Engines, Rural Mechanics Course 3, MF 06-301, by John van Winden, 1990, book, 144 pages, Dfl. 14.00 from TOOL.

This reference book was developed for use in a four-year course for rural mechanics. It provides the necessary information for technical training on water and air-cooled 1, 2, 3, and 4-cylinder stationary diesel engines, including dismantling, checking parts and repairing certain elements, reassembling, and proper operation and maintenance.

The excellent and numerous illustrations provide a clear idea of how small diesel engines work and the most common repair steps. Included is a useful guide to starting and running problems.

Small type and regular use of technical terms will present challenges to readers uncomfortable with English, making this book perhaps most valuable as a teaching tool for instructors rather than a textbook for students.

Readers already knowledgeable about the operation and repair of small gasoline engines will find much that is familiar here. They will benefit from the clear portrayal of the systems that are unique to diesel engines.

Small-Scale Solar-Powered Irrigation Pumping Systems: Technical and Economic Review, MF 06-275, book, 188 pages, by Sir William Halcrow and Partners in association with ITDG, September 1981, World Bank, out of print.

An extensive examination of the technical and economic feasibility of both solar photovoltaic pumps and solar thermal irrigation pumps for use by small farmers in developing countries. Equipment options and performance are discussed. With the conclusion that these pumps are much too expensive at present, attention is given to exploring various assumptions about future costs of solar pumps vs. engine-driven pumps.

A shorter, easier to read summary of the issue that draws on much of the same material is contained in **Solar Photovoltaics for Irrigation Water Pumping** (see

review).

The Potential for Small-Scale Solar Powered Irrigation in Pakistan, IDS Commissioned Study #1, MF 06-283,41 pages, by Michael Howes, December 1982, $4.50 plus $1 postage (or £2.25 plus £0.50 postage) from Publications Office, Institute of Development Studies, University of Sussex, Brighton BN1 9RE, England.

This report on 14 solar irrigation pumps in Pakistan concludes that significant price reductions (from 1982 levels) will be necessary before such pumps can be expected to be economically competitive with other high-cost alternatives currently in use (animal-powered Persian wheels, diesel deep tubewell pumps) in Pakistan.

Solar Photovoltaics for Irrigation Water Pumping, MF 06-276, working paper, 17 pages, by Urs Rentsch, 1982, Swiss Francs 6.00 from SKAT; also from ITDG.

This is a good summary of the equipment-matching and financial requirements necessary for irrigation pumps driven by solar electric cells. The author concludes that with liquid fuel cost increases and dramatic solar cell cost declines, photovoltaic pumps would become competitive with small engine-driven pumps for small plots with low pumping heads. This combination of circumstances is still many years away, however. If solar cell costs dropped to zero, the costs of solar pumps would be at a minimum of about $3/peak watt due to the costs of the structure, wiring, motor, pump, transportation and installation. The capital costs of the solar pump, even under these favorable assumptions, would be as much as 50 times as great as those of a manually operated pump. "The Rower pump, for example, costs about US $10-13, while a corresponding solar pump would cost at least US $600" (at $3/peak watt). Credit and subsidies would be required for small farmers to be able to afford the pumps.

Solar Water Pumping: A Handbook, MF 06-296, book, 130 pages, by Jeff Kenna and Bill Gillett, 1985, £12.50 from ITDG.

Small PV solar water pumps offer the promise of directly converting renewable energy sources into valuable agricultural production and better health through improved water supply.

"This book describes the technology and, most importantly, it shows that there are some conditions under which solar pumps already can provide the best solution to local water needs. Furthermore, it quantifies these conditions, and it offers a methodology which water supply specialists can use to compare and evaluate available pumping options. The reader is led step by step through the necessary analyses, including determination of pump requirements, specification of solar pump performance, and comparison of economic data. As a result, he or she can obtain a clear picture of the viability of solar pumping."

Costs for photovoltaic cells are continuously dropping, and the cost estimating procedures shown here can be used with current prices substituted.

Lightweight Seeder/Spreader, Plan No. 596, MF 06-248, 2 pages, by Clarence A. Martin, $1.50 from Popular Mechanics.

These are brief but complete plans for the standard American lawn seeder/fertilizer spreader. It may have some value with modifications for seeding

grasses in small farming operations or for other seeding activities. The distribution and rate of seed flow could be modified for other seeding needs.

The seeder is made of 18-gauge aluminum, bent, drilled, and screwed together. Uses two small wheels.

Chain Link Fence Making Machine, VITA Technical Bulletin No. 25, MF 06-259 20 pages, $5.25 (overseas orders add $3.00 for surface mail, $5.00 for airmail) from VITA; also available in Spanish and French; also available from TOOL.

These are step-by-step instructions for making and using a hand-operated machine to make chain link fencing. There are drawings and photos. "The machine here is designed to produce fencing up to 244 cm (96 inches) but can be varied to produce fencing of any height. The size of the openings (can be varied) .... The machine described here requires number 12 or 14 wire but could be modified to take larger wire." A very clever, easily made device.

"In Botswana, the machine has become the basis of a small fence manufacturing business which serves as a source of employment and produces fencing which is far more affordable locally than is the imported fencing which was the only material previously available."

Of course this unit requires the use of wire (probably imported in most countries). For most fencing needs, traditional alternatives exist and are probably more appropriate. Barbed wire should also be cheaper as it uses much less wire per linear foot of fence.

Oil Soaked Wood Bearings: How to Make Them and How They Perform, MF 06-233, leaflet with drawings and text, 10 pages, information from tests done in Zambia, ITDG, out of print.

The authors consider the characteristics of wood to be used, how to determine the size of the bearing required, and oil-soaking in the case of high-moisture content of the wood to be used. The oil used was groundnut (peanut) oil or discarded engine oil. Three types of wood bearings are presented and evaluated: solid block, split block, and bush bearings. "The drilling of radial holes for lubrication purposes is only recommended by Pearson for the bush type of bearing. He found that if lubrication holes were drilled in block bearings, not only were the bearings weakened but also the holes acted as dirt traps."

Hardwood is required. The bearings are well-suited to low-speed applications such as in carts and water wheels.

Highly recommended.

Making Coir Rope, Technical Bulletin No. 44, MF 06-260, leaflet, 8 pages, VITA, out of print in 1985.

A step-by-step presentation of the process of making coir rope from coconut husks. The necessary equipment can be made out of wood, and most of this equipment is shown: a fiber combing board for separating fibers, hand-cranked single and multiple twisting reels, and a strand block and strand guide for the final steps in rope making. The text is at times confusing and misleading, and the reader will have to be careful.

Some of the basic concepts can also be applied in making wire rope.

Eight Simple Surveying Levels, Agricultural Green Leaflet #42, MF 06233, drawings with text, 17 pages, ITDG, out of print in 1985.

These levels, made of wood and rubber or clear plastic tubing, were built and evaluated by an ITDG team. Details are given on the construction, accuracy, and usefulness of each device. All the levels are made using simple hand tools and are cheap and easy to construct. These levels are quite sufficient for most rural drainage, irrigation, roadmaking, building and other earthmoving work where extreme accuracy is not needed.

ADDITIONAL REFERENCES ON AGRICULTURAL TOOLS

The Rower Pump describes a low-cost, hand-operated pump that is used very successfully in small-plot irrigation in Bangladesh; see the pumps section of WATER SUPPLY.

Fichier Encyclopedique du Developpement Rural contains leaflets in French on agricultural tool, such as a sugar cane crusher; see GENERAL REFERENCE.

The Book of the New Alchemists describes the greenhouse and fish tanks combination used in the Ark; see GENERAL REFERENCES.

Greenhouses used for both food production and home heating are described in ENERGY: SOLAR.

Rural Small Scale Industry in the People's Republic of China discusses the relationship between the decentralized agricultural machinery industry and farming; see LOCAL SELF-RELIANCE.

Small Farm Development: Understanding and Improving Farming Systems in the Humid Tropics estimates the effects of various small-scale power sources added to small farms; see AGRICULTURE.

Surface Irrigation contains drawings and photographs of low-technology and mechanized equipment for use in land preparation for irrigation and water control; see AGRICULTURE.

Grain storage bins and dryers are shown in CROP STORAGE.

The Management of Animal Energy Resources and the Modernization of the Bullock Cart System includes a discussion of needed cart and harness improvements for these farm vehicles; see TRANSPORTATION.

The Use of Pedal Power for Agriculture and Transport in Developing Countries examines the potential applications of pedal power for driving agricultural equipment; see ENERGY: GENERAL.

Design for a Pedal Driven Power Unit for Transport and Machine Uses in Developing Countries lists crop processing equipment suitable for pedal power; see TRANSPORTATION.

TRANSPORTATION examines small vehicles, wheelbarrows, and carts, many of them important in small-farm operations.

Small-scale milling equipment driven by waterpower is described in many of the entries in ENERGY: WATER.

Aspects of Irrigation with Windmills and **Syllabus for Irrigation with Windmills** are in ENERGY: WIND.

Manege: **Animal-Driven Power Gear** is well-suited to driving most postharvest processing machinery; see ENERGY: GENERAL.

Liklik Buk has numerous drawings and photos of agricultural tools; see GENERAL REFERENCE.