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Animal traction in Zambia: status, progress and trends 1991

Report prepared by

Paul Starkey, Henk Dibbits and Emmanuel Mwenya

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Summary

Background

A five-year investment plan for animal traction in Zambia had been prepared in 1985. In 1990, it was decided to review the progress made since that plan, and obtain a new picture of animal traction in the country. To achieve this, a three person team visited all provinces during a four-week period in late 1990. The team comprised an international specialist in animal traction, the national Animal Draft Power Coordinator and his counterpart. They contacted over 200 people, including Ministry of Agriculture officials, staff of development projects and financial institutions, farmers and manufacturers. Site visits were made to farms, workshops and factories. Many published and unpublished documents were reviewed. Questionnaires were issued to all agricultural extension units (camps) through provincial and district offices to obtain estimates of draft animals and implements.

The initial findings of the mission were presented to a meeting in February 1991 attended by Ministry of Agriculture officials, staff of animal traction development projects and representatives of aid donors. Part 1 of this report presents an overview of animal traction in Zambia and discusses some key issues raised during the mission and the follow-up meetings. Part 2 of the report summarizes some of the key observations of the field visits, drawing heavily on the information supplied to the mission by people working in the provinces.

National animal traction status

About 240,000 draft animals are employed in Zambia, with 120,000 plows, 30,000 ridgers, 20,000 cultivators and 5,000 planters. About 60,000 sledges and 30,000 animal-drawn carts are also used. Nearly all work animals are oxen. Observations suggest that draft cows are increasingly being used, particularly within four-animal teams, but no data are available on the numbers of female animals employed in the different provinces. The national population of donkeys is low: only about 1500 donkeys are used for packing and carting. There is growing interest in the potential for employing donkeys.

The status of animal traction varies markedly between provinces and districts. The distribution of work animals is illustrated schematically in Map 1.

Animal traction in the north of Zambia

In Northern, Luapula, Copperbelt and North Western Provinces, where annual rainfall exceeds 1100 mm, fewer than 10,000 draft animals are employed in total. Constraints include limited ownership of cattle, small numbers of steers, lack of knowledge of animal traction and extensive farming systems based on shifting cultivation. In some northern areas, trypanosomiasis severely restricts cattle keeping, but the spread of other diseases in the north of Zambia is often limited by the low population density of cattle.

In much of the north, animal traction is increasing steadily from its very low level, assisted by development projects and by farmer migration. As the technology is quite new, support services (including implement supply and repair) are poorly developed. Few animal-drawn carts are available, but farmers who have been assisted to obtain these have found them highly profitable. Farmers' ability to invest in animal traction is determined largely by credit availability and by marketing opportunities. Animal traction for cultivation and transport is likely to rise noticeably in these areas provided efficient crop marketing systems can be developed.

Animal traction in the west and south

In the west and south of the country, cattle are common in the tsetse-free zones, and animal traction has been used for many years. Areas exist where 90% of farmers employ draft animals for cultivation and transport. Not all farmers own work animals, and the proportion of farmers hiring or borrowing animals can be high. In these areas, traditional sledges are widely used, being more affordable than carts.

Overall, animal traction is increasing in the west and south as cattle populations continue to multiply and to expand their range. Cattle and work oxen can now survive and work in areas, such as Kaoma, that previously presented critical tsetse challenges. In these areas of introduction, training and support services may be needed. Elsewhere in the west and south, the main constraints appear economic, with the need for improved crop marketing opportunities to justify further investment in animal traction. Institutional credit is seldom available to assist farmers purchase draft animals and implements. There are also supply constraints, as present systems for the supply and distribution of implements and spares are only adequate along the line of rail.

Tsetse flies still restrict the keeping of cattle in many areas. In the Southern Province (and further north along the line of rail) the tick-borne “corridor disease” has been causing significant mortality within herds in the traditional sector. Corridor dis-

ease increases the risk involved in owning draft animals and also reduces the supply of steers. The disease may lead to a temporary fall in the number of working animals, and to an increase in the employment of work cows, as available females are used to replace lost work oxen.

Animal traction in central and eastern Zambia

The situation in central and eastern regions is mixed. There are areas of long-standing animal traction use, and others with little animal power. Constraints are mainly economic and associated with limited opportunities for profitable marketing of crops. In some areas where tsetse exist, few cattle are available and animal traction knowledge and support services are very limited.

Economic and social issues

Most recent adopters of animal traction have been supplementing available hand labour. In so doing, they have usually increased their total production by extending their total cultivated area. This has increased manual labour requirements for weeding, as few farmers weed with draft animals, particularly in the early years of adoption. Around provincial centres and along the line of rail, animals have sometimes replaced tractor ownership or tractor hire services that have become unavailable or unaffordable. On several commercial farms, animal power is used to complement tractor power, particularly for transportation.

The profitability of animal traction depends largely on the profitability of crop cultivation. Many farmers have had great difficulties marketing their produce and receiving timely payment. The problem has been greatest for maize, so farmers have tended to increase their cultivation of cash crops such as sunflower and soya. Improvements in purchasing arrangements for maize, rice and other commodities would almost certainly stimulate investment in animal traction. All farmers and development projects experience problems due to high inflation and interest rates.

Gender differences in the use of, and benefits from, animal traction generally reflect prevailing rural traditions. Most owners and users of work animals in Zambia are men. Boys are commonly expected to tend work animals. Although it is not very common for women to plow or help to control working animals, this may be increasing. In the Western Province, up to one third of households are headed by women, but if they own oxen these are generally looked after and worked by male relatives. Projects and training institutions in several areas of the country are increasingly trying to involve women in animal traction.

Implements and implement manufacture

Farmers appear generally satisfied with the common "Safim" designs of plow: about 12,000 - 15,000 are purchased each year. About half of these are made in Zambia by Northland and Gameco and half are imported from Zimbabwe. Farmers seem quite tolerant of manufacturing defects, such as those observed in past years in Northland plows. This may be partly attributable to the limited choice that farmers have had. Northland, which used to have a virtual monopoly, ascribed its problems to "jobbing" techniques, old equipment and subsidised competition. Zimbabwe plows have a good reputation, and appear to be the most popular plows available. A large consignment was imported in 1985, with EC assistance.

A Dutch-financed scheme was initiated in 1984 in which the government-backed firm "Lenco" assembled plows manufactured by the Dutch firm Rumptstad. The first plows were assembled in 1985, but the initial 4450 plows were widely judged by the farmers to be too heavy. Sales were very slow. Lenco subsequently assembled a lighter design of Rumptstad plow, using components imported with SIDA assistance. Sales remained low and Lenco resorted to selling them at below cost price. With further Dutch assistance, workshop machinery has recently been installed at Lenco to allow it to manufacture (as opposed to assemble) Rumptstad-designed plows and a range of other implements.

Several smaller manufacturing initiatives have been undertaken by firms and projects. A large consignment of lightweight Italian plows and ridgers was recently imported for use in the Southern Province. Initial test results and the reaction of farmers suggest that the plows may be too weak and of unsuitable design. One of the ridgers appears to have potential as a weeder.

Animal-drawn transport

Simple animal-drawn sledges are widely used in the west and the south. They are cheap, easy to maintain and can be dragged along sandy paths and roads. Sledges have limited carrying capacity and animal-drawn carts appear to offer greater social and economic benefits. In some areas they have proved effective and economically attractive for transporting maize and rice. Some provincial cooperative unions are actively encouraging ox carts for maize transport. In comparison with other countries in Africa, the number of ox carts owned in Zambia is low, and the animal-powered transport sector appears underdeveloped.

Most animal-drawn carts in the country are made from scrap vehicles. Various "appropriate technology" designs with wooden wheels and bearings have

been developed and promoted. Among the organizations involved have been University of Zambia Technology Development Advisory Unit (TDAU), Kasisi Mission (Lusaka Province), North Western IADP and Katopola Agricultural Engineering Centre (Eastern Province). Diffusion has been very limited and few such carts have been used by farmers for long.

A comprehensive series of on-farm tests of cart designs was recently carried out by Magoye. Carts based on steel axles, roller bearings and pneumatic tyres appeared most appropriate. This conclusion is supported by experiences of Muzama Crafts in North Western Province. When it introduced locally-made carts based on imported axles and tyres, adoption was rapid, and the use of animal-drawn transport increased rapidly in Kaoma and Zambezi Districts. Similar positive experiences, on a smaller scale, have been reported by Msokhocika Project, Eastern Province. Lenco, has been selling small numbers of technically good, but expensive carts. It has plans to market a cheaper ox cart, based on imported axles.

The bearing firm "SKF Zambia" recently attempted to meet the demand for locally-made steel ox cart axles. Its original hub design used ball bearings. About 2000 hub units have been sold, but various problems have been reported, and repairs are extremely difficult. SKF is therefore developing a new hub design, using roller bearings.

Research

Much recent research relating to animal traction has involved the testing and development of implements. The Regional Research Station at Magoye has been undertaking on-station and on-farm implement testing, with some replicated on-station trials. Several organizations have worked with ox carts, emphasizing practical development rather than objective research. Standardized methods for testing implements and carts have been developed at Magoye. They combine on-station testing with subsequent farmer evaluation. Such rigorous, objective testing should be valuable, particularly if carried out prior to product marketing. In practice, several recent donor-supported initiatives have imported and marketed implements without waiting for such testing.

Socioeconomic studies assessing the impact of animal traction on farming communities have been sponsored by projects in the Northern, North Western and Western provinces. Very few research findings relating to animal traction in Zambia have been published internationally or widely circulated within the country.

Training

Many provinces have small centres for training extension workers and/or farmers in animal traction. Artisanal training is particularly strong in the east. A national animal draft training centre has recently been established at Palabana. It will undertake in-service training and it is developing practical facilities, training methods and instruction materials. Several Zambians have benefited from training in animal traction in Zimbabwe, and a training manual for Zambia, based on Zimbabwe materials, has recently been financed by SIDA. The University of Zambia, the Natural Resources Development College and the Zambia College of Agriculture have been giving increasing attention to animal traction in their curricula, but all claim to lack good teaching materials.

Impact of research and extension

During recent years, the main impact of the extension services on animal traction has been in the areas of new introduction. In these areas, the long-standing extension messages on how to train draft animals and how to use basic implements appear to be useful to farmers unfamiliar with work animals. In other areas, where draft animals are widely used, there seem few, if any, recent examples of changes in animal traction technology attributable to the research and extension services. The range of implements used is still very limited, with most farmers using only a "Safim-type" plow, with its regulator removed. Although the research, extension and training services have various recommendations relating to animal management, yoking, implement use and diversified uses of animal power, there is little evidence of these being readily adopted by farmers already familiar with animal traction. A reassessment of future animal traction research-extension needs in the light of farmer responses to existing recommendations appears necessary.

Liaison and information exchange

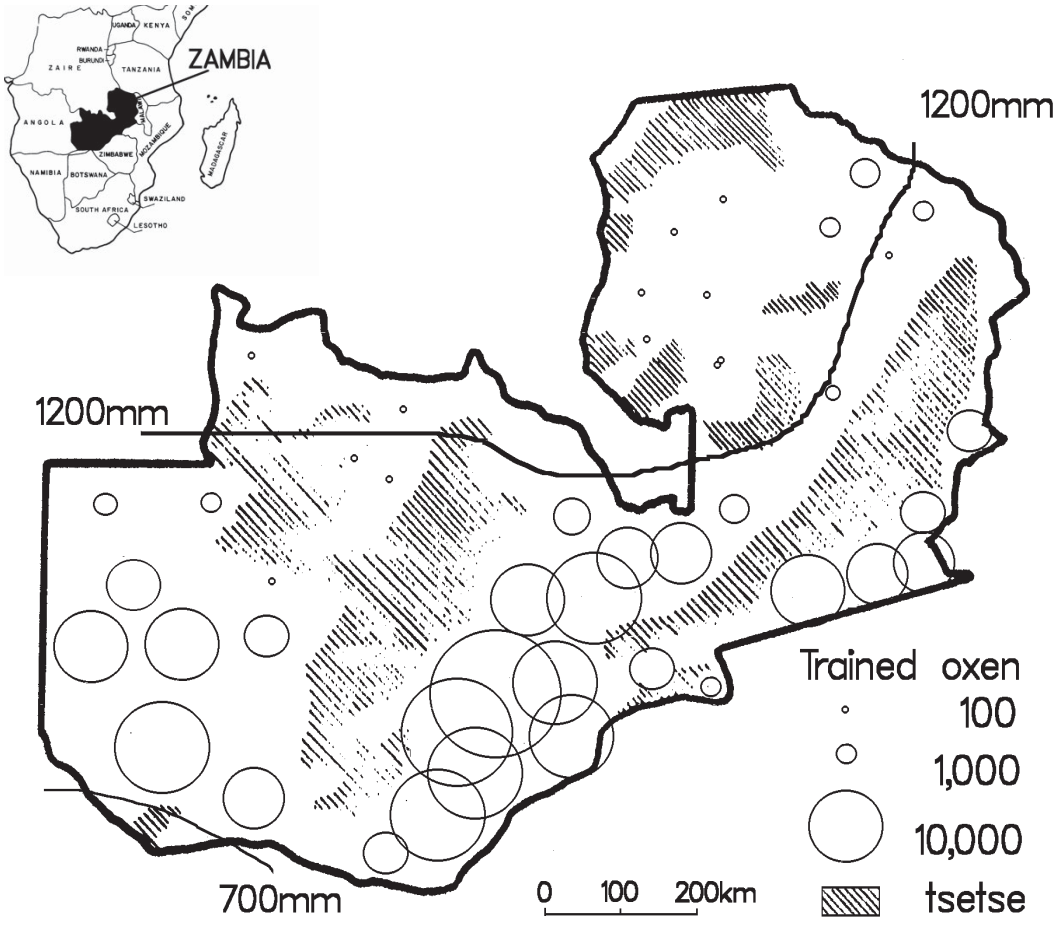
Information exchange between the various projects and agencies involved in animal traction varies considerably. Coordination and liaison at provincial and national levels is improving, but strategy formulation and information exchange would be assisted by the production of clear, candid and concise reports of research-extension findings and actual project experiences.

Outlook for animal traction

Draft animals are extremely important in Zambian farming systems and they already contribute significantly to crop production and marketing. It is likely that animal traction will continue to increase in most areas of the country, particularly if crop marketing

systems can be improved. While hoe farmers will continue to adopt animal traction, there is little chance that current animal-users will be able to adopt tractor power in the near future. At present, only a small proportion of farmers use animal power for weeding, although weeding is considered a bottleneck. Further research-extension efforts in this area may identify the constraints and facilitate adoption. If suitable and affordable axles and wheels could be made more available, animal-drawn carts could increase significantly in Zambia, with many important social and economic benefits.

Map 1. Schematic presentation of the numbers and distribution of work oxen in Zambia.
The numbers of work oxen are represented by circles . The size of each circle is approximately proportional to the number of trained oxen in that district. The shaded areas on the map are considered to be of relatively high tsetse challenge. The map also indicates broad rainfall zones by giving the approximate position of the 1200 mm and 700 mm isohytes.
The inset shows the position of Zambia in Southern Africa.
Sources: Tsetse distribution after Müller (1986).
Work oxen population figures from Tables 1-9 of this report.



Preface and acknowledgements

Since the 1985 animal draft power investment plan (MoA, 1985) there has been no systematic attempt to review of the status of animal traction in Zambia. By commissioning this report, the Animal Draft Power Coordinator Project has attempted the daunting task of providing a detailed analysis of the animal traction situation in the country, highlighting areas of progress, apparent constraints and observed trends.

This report has been prepared over a period of several months, and contains information from many sources. Much information derives from personal discussions with many people currently working with animal traction in Zambia and from a wide-ranging literature review. This report also contains statistics obtained from questionnaires given to agricultural extension staff in all provinces. Personal observations derived from field visits are also included in the report.

Much of the information from the different provinces was collected during four weeks of extensive travel throughout Zambia in late 1990. During this time the team had discussions with policy makers, development workers and farmers in all nine provinces. The main findings of this mission were subsequently presented to a meeting of Ministry of Agriculture officials, staff of animal traction development projects and representatives of aid donors in February 1991. Following this meeting, a draft report was prepared and circulated for comments, observations and further detailed discussions. The team members also analysed the initial responses to the questionnaire survey, and revisited the provinces where the information seemed incomplete or needed verification.

This publication, which is the final report of the review exercise, attempts to summarize all aspects of the review in two parts. Part 1 contains the authors' overview of animal traction in Zambia and their analysis of certain key issues. Part 2 provides more details of the organizations contacted in each province and the observations of field visits. Within Part 2, ideas and information supplied to the mission are reported, whether or not the mission members agreed with the information. The authors hope that the views of the people concerned have been adequately presented.

The team is only too aware of the dangers of trying to provide a national review, when each of the nine provinces merits its own detailed analysis. In many ways it was unreasonable for such a review team to attempt to make a series of lightening visits to the provinces and then make pronouncements about the national situation, project achievements and the needs of farmers. The time was too short to appreciate and understand the complexity of the local farming systems in each of the provinces. It was also insufficient to comprehend all the internal and external pressures on the organizations involved in agricultural development. The team therefore wishes to apologize in advance, should anything they say appear to be inaccurate or unfounded. Clearly time was too short to obtain a comprehensive understanding of past events and present realities. The team is also aware of the danger of using the expertise of hindsight to be critical of past initiatives: any implied criticism is intended to be constructive.

The mission team wish to express their thanks to all who facilitated their work. The authors are greatly indebted to all ministry officials, project staff, development agents, farmers, researchers, manufacturers, artisans and others who gave up their time to provide information. The mission would not have been possible without the great assistance of the staff of the Ministry of Agriculture headquarters and Ministry staff in the provinces. All persons who provided information, and all who helped in completing and analysing the questionnaires are to be greatly thanked. Particular appreciation goes to Mr. Mantel Sindazi for information concerning implement manufacturing. Warm hospitality was received in all provinces, and the team is most grateful for this.

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Paul Starkey, Henk Dibbits, Emmanuel Mwenya
July 1991

Acronyms and abbreviations

ADP	Animal Draft Power (Animal Draught Power)
ADP-CP	National Animal Draft Power Coordinator Project
ADP-RDP	Animal Draft Power Research and Development Project, Magoye
ADP-TP	Animal Draft Power Training Project, Palabana
ADP-WP	Western Province Animal Draft Power Project
AES	Agricultural Engineering Section, Department of Agriculture
AETC	Agricultural Engineering Technical Committee
ARPT	Adaptive Research Planning Team
AT	Animal Traction
BV	Limited company (Dutch)
CARO	Chief Agricultural Research Officer
CBPP	Contagious Bovine Pleuropneumonia
CCU	Copperbelt Cooperative Union
CD	Cattle Development
COMET	Copper Mines Enterprise Trust
CPCMU	Central Province Cooperative Marketing Union
DAE	District Agricultural Engineer
DANIDA	Danish International Development Agency
DAO	District Agricultural Officer
DDSP	District Development Support Programme
DGIS	Directorate General for Development Cooperation, Ministry of Foreign Affairs, The Hague
DVTCS	Department of Veterinary and Tsetse Control Services
ECF	East Coast Fever
EC	European Community
FAO	Food and Agricultural Organization of the United Nations, Rome
FINNIDA	Finnish International Development Agency
FMDU	Farm Machinery Development Unit
FTC	Farmer Training Centre
GRZ	Government of the Republic of Zambia
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit, Germany
HS	Haemaerrhagic Septicaemia
IFAD	International Fund for Agricultural Development, Rome
ILO	International Labour Organization, Geneva
IMAG-DLO	Instituut voor Mechanisatie, Arbeid en Gebouwen - Dienst Landbouwkundig Onderzoek (Institute of Agricultural Engineering), Wageningen
IRDP	Integrated Rural Development Programme
ITDG	Intermediate Technology Development Group, UK
K	Kwacha currency (at time of review mission the approximate exchange rates were US$1=K40 and UK£1=K80)
KADICU	Kaoma District Cooperative Union
KAEC	Katapola Agricultural Engineering Centre
LCU	Luapula Cooperative Union
LCU	Lusaka Cooperative Union
LDP	Land Development Programme, Western Province
LENCO	Lusaka Engineering Company, Lusaka
LIAC	Larenstein International Agricultural College, Deventer
LIRDP	Luangwa Integrated Rural Development Project
M.Sc.	Master of Science degree
MAWD	Ministry of Agriculture and Water Development, Lusaka (subsequently re-named)
MDM	Name of an engineering company based in Kitwe
MoA	Ministry of Agriculture, Lusaka
NCAE	National Centre for Agricultural Engineering

NCU	Northern Cooperative Union
NEI	Nederlands Economisch Instituut (Netherlands Economics Institute)
NGO	Non Governmental Organization
NORAD	Norwegian Agency for International Development
NRDC	National Resources Development College, Lusaka
NWCU	North Western Cooperative Union
NWIRDP	North Western Integrated Rural Development Programme
ODA	Overseas Development Administration, United Kingdom
PAO	Provincial Agricultural Officer
PDTI	Palabana Dairy Training Institute
PTA	Preferential Trade Area (Eastern and Southern Africa)
PVC	Polyvinyl chloride
PVO	Provincial Veterinary Officer
RDP BV	Name of a consultancy company based in The Netherlands
RRS	Regional Research Station (Magoye)
SADCC	Southern Africa Development Coordination Conference
SDP	Smallholder Development Project
SIDA	Swedish International Development Agency
SIDO	Small Industrial Development Organization
SKF	Name of a multinational engineering and bearing company, based in Sweden
SNV	A major development and volunteer organization based in The Netherlands
SPCMU	Southern Province Cooperative Marketing Union
TDAU	Technology Development Advisory Unit, University of Zambia, Lusaka
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization, Vienna
UNZA	University of Zambia, Lusaka
US$	United States dollar
VAP	Village Agricultural Programme
VODP	Village Oriented Development Programme
WPCU	Western Province Cooperative Union
ZADL	Zambia Agricultural Development Ltd
ZAFFICO	Zambia Forestry and Forest Industries Corporation
ZATCO	Zambia Agricultural and Trading Cooperative Ltd
ZCA	Zambia College of Agriculture, Monze and Choma
ZCF/FS	Zambia Cooperative Federation Financial Services
ZCF	Zambia Cooperative Federation
ZS	Zambian standard

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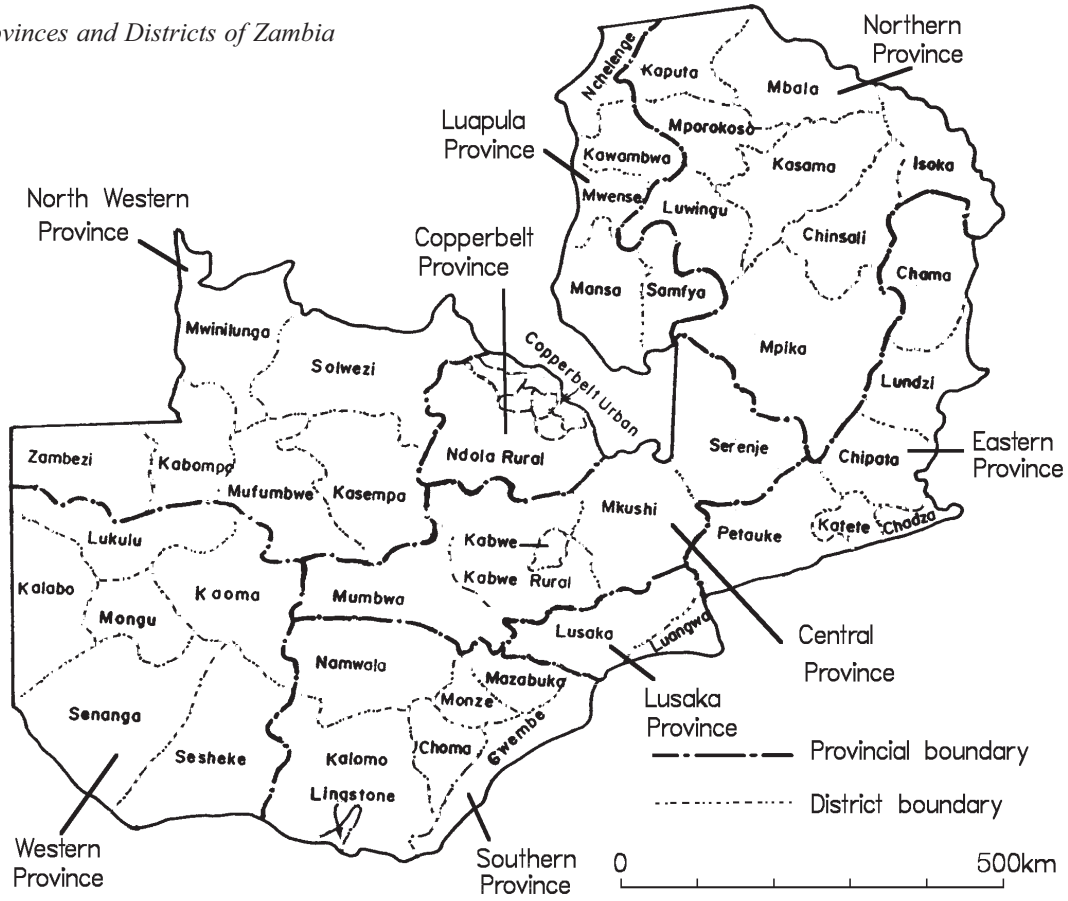
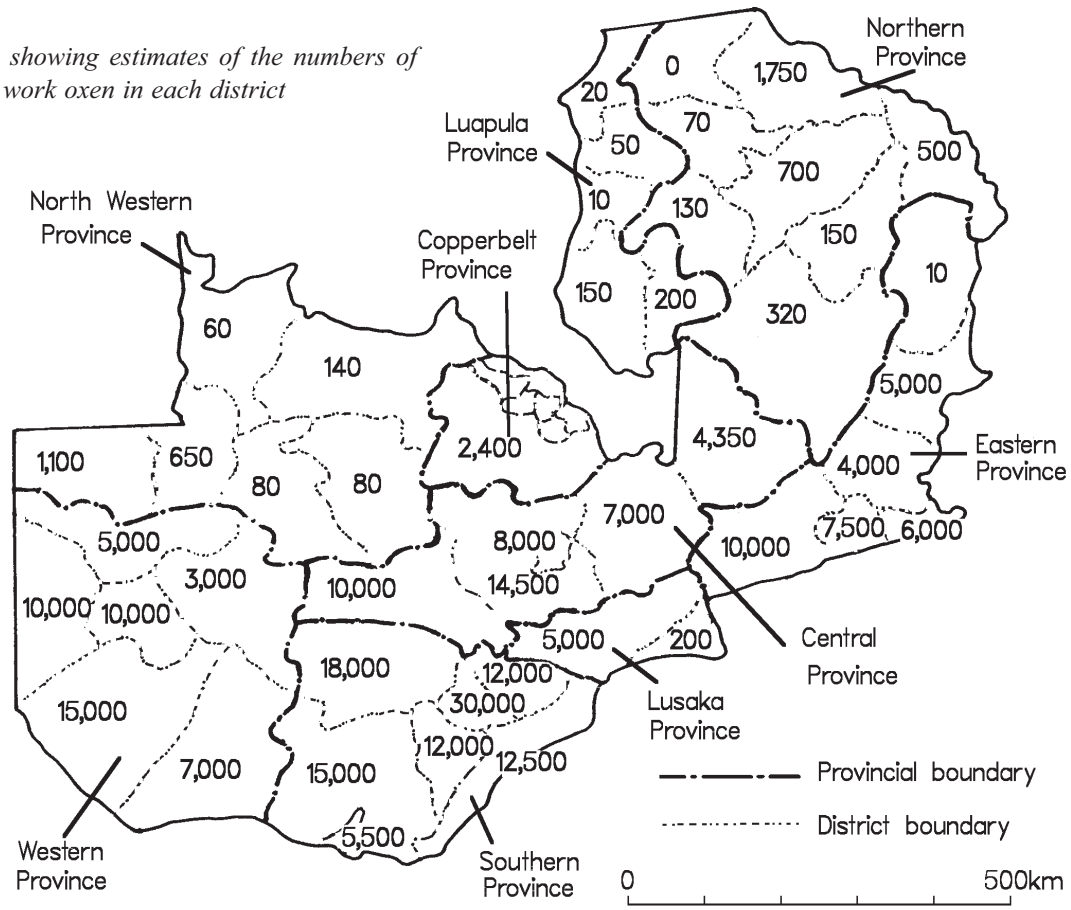
Part 1

Overview of each province
Discussion of key issues
Conclusions

Map 2.
The Provinces and Districts of Zambia



Map 3.
Zambia showing estimates of the numbers of trained work oxen in each district



Overview of present situation

Northern Province

The Northern Province, comprising nine districts in the northeast of the country, is dominated by woodland ecology. It is sparsely populated, with about 750,000 people living in its 148,000 km^2. The rainfall is about 1100-1400 mm per year. The traditional *"chitemene"* system of shifting cultivation is still widely practised, although, in some areas, population pressures are limiting the length of the fallow periods. The cattle population of 100,000 is quite low. About 90,000 cattle are owned in the traditional sector and 11,000 in the commercial sector. Cattle tend to be concentrated in those parts of the province near the Tanzanian border, including Mbala and Isoka Districts, where cattle keeping is traditional. Kasama and Chinsali districts also each have over ten thousand cattle but in Kaputa, Mporokoso, Mpika and Luingu Districts very few cattle are found. The movement of cattle from Mbala, Isoka and Nakonde to other districts is restricted by veterinary regulations designed to prevent the spread of East Coast Fever, which exists in the border area. The tsetse challenge is thought to be highest in Kaputa District, where cattle are virtually absent. It is reported that herd productivity is generally low in the Northern Province.

Only a small proportion of the farmers in the province uses animal traction. In many areas, the rapid adoption of animal traction seems unlikely due to the combination of small numbers of cattle, low human population density, limited marketing opportunities and bush-fallow cultivation systems. Nevertheless there are areas where animal traction is increasingly being adopted.

The 1985 Animal Draught Power (ADP) investment plan assumed that 4200 work oxen were in use in the Northern Province. This had been calculated as 40% of the estimated 10,600 "oxen and tollies". (For many years cattle censuses have been recording the number of "oxen and tollies"; there seems no clear definition of "tollies", but these are generally assumed to be castrated males, older than "calves", and younger, or smaller, than "oxen".) The 1985 investment plan projected that by 1990 the number of work oxen would increase to 8000. In fact, by 1990 the total number of "oxen and tollies" had risen to 12,000, but the number of work oxen in use is estimated at only 3600. Since there is a widespread conviction that the number of draft animals has been increasing in recent years, it is assumed that the 1985 estimate was inaccurate.

Animal traction is concentrated in the Mbala, Isoka and Kasama East Districts. There are few development projects working in these areas. Most cattle are found in the Isoka, Mbala and Chinsali Districts. It is quite possible that animal traction technology has been spreading informally by farmers in contact with Tanzania. Significant extension efforts in animal traction started in the late seventies. They have been implemented mainly by organizations and projects based in Kasama and Mpika, where cattle numbers are relatively low. Ministry of Agriculture (MoA) programmes working with animal traction have included the Village Agricultural Programme (VAP), Integrated Rural Development Programme (IRDP) Mpika, IRDP Kasama and the Rice Development Project. The MoA has designed and implemented an animal traction education programme for primary schools. Cinci wa Babili (an organization sponsored by the Catholic church) and the Zambia College of Agriculture at Mpika have also been assisting farmers to obtain and train oxen. These organizations are all operating in areas where animal traction is quite new and most farmers do not use oxen. Between them the various projects distributed about 1200 oxen between 1982 and 1989, with numbers increasing from 50 oxen in 1982, to 400 oxen in 1989. In 1990, about 1000 oxen were in use in Kasama and Mpika Districts. Also, in 1990, a small herd of donkeys was imported from Botswana for use in a rural roads programme.

One of the projects introducing work animals has been the Rice Development Programme. This has found that farmers can successfully and profitably use work oxen for rice cultivation. Provided animals are available for purchase, it is expected that numbers of oxen used for rice production will increase significantly during the coming years from the 120 animals now employed.

In much of the Northern Province, farmers are not accustomed to owning and handling cattle, and oxen are not readily obtainable in some districts. Thus introduction schemes have generally started slowly, constrained by shortages of easily available animals and by the labour-intensive training required to counteract farmer unfamiliarity with cattle.

Tick-borne diseases can pose health problems for work oxen, with East Coast Fever present near the Tanzanian frontier. Outbreaks of rinderpest and foot and mouth disease have also occurred in these border areas. Trypanosomiasis is likely to limit the introduction of cattle in some areas, notably Kaputa District in the very north of the country. Although the cattle population is relatively low (so that diseases are not easily spread), the veterinary services are also quite limited. This, together with the high demand for meat, means that new adopters of animal traction have tended to respond to animal sickness by slaughtering one or both animals.

The ban on moving cattle from Mbala, Isoka and Nakonde districts has restricted project options for supplying cattle. Projects have tended to supply animals purchased from Zambia Agricultural Development Ltd (ZADL) ranches at Mbesuma in Chinsali District and Kangwishi in Mporokoso District. However, output from these ranches is low (about 200 head per year). Even if, with improved management, output was increased to 300 per year, this would still be below the apparent demand.

Following initiatives taken by the MoA provincial agricultural engineering section, a provincial Animal Draft Power Steering Committee was established in 1988 and remains active. All projects and financial institutions involved in animal traction are represented in the Committee. In order to improve the efficiency of project activities relating to animal traction, MoA has proposed a Provincial Animal Draft Power Project. Under this, the animal traction activities of VAP, IRDP and the Rice programme would be merged. The various projects are already cooperating, and the new arrangements could start in 1991, provided funding can be obtained for the new programme.

The supply of ox-drawn implements in the Province is reported to be very erratic. In many districts, implements and spare parts are not available. The Northern Co-operative Union (NCU) attempts to keep some animal-drawn implements and spares in the provincial headquarters at Kasama. NCU is not sure of the demand in the various districts, and so few implements are sent out of Kasama. Consequently externally-funded projects tend to buy implements from outside the province for supply to the farmers. There are few support services for animal-drawn implements, but blacksmith training is due to start at the Vocational Training Centre near Kasama. Few animal-drawn carts exist in the province, but where they have been introduced, they appear to be profitable. Ox carts have proved particularly effective and profitable in the rice growing areas. Elsewhere the demand for carts is likely to depend on whether an effective maize purchasing system can be developed for the province. The present uncertainties and delays in maize marketing arrangements constitute a major constraint to smallholder agricultural development in the province.

Table 1. Estimates of the numbers of cattle, trained work oxen and steers in the Northern Province

	Work oxen[1]	Total steers and oxen[2]		Total cattle population[3]		
		Tradn[4]	Com[4]	Tradn[4]	Com[4]	All
Kasama	700	1 265	108	9 079	1 138	10 217
Mbala	750	3 435	780	14 714	5 196	19 910
Isoka	500	4 480	0	45 567	0	45 567
Chinsali	150	1 522	170	16 160	2 795	18 955
Mpika	320	710	144	2 461	687	3 148
Luwingu	130	293	93	1 416	543	1 959
Mporokoso	70	233	7	1 262	1 570	2 832
Kaputa	0	0	0	0	0	0
TOTAL	**3 620**	**11 938**	**1 302**	**90 659**	**11 929**	**102 588**

1. *Estimates of trained work oxen from questionnaire survey, site visits and mission discussions.*
2. *Numbers of steers and oxen based on "oxen and tollies" classification within the provincial livestock census reports of the Department of Veterinary and Tsetse Control Services (DVTCS).*
3. *Cattle population derived from 1989/90 DVTCS livestock census figures.*
4. *Classification into "Traditional sector" and "Commercial sector" as DVTCS census.*

Luapula Province

Luapula province is sparsely populated, with 450,000 people living in 50,500 km^2. The rainfall ranges from 1100 mm to 1400 mm. Bush-fallow agriculture remains dominant, although annual cropping of land is common around towns and large villages. Traditionally much of the population has been associated with fishing in Lake Bangweulu and the Luapula River, and fishing and fish marketing remain important. Cattle are rarely kept by farmers, and the total cattle population in the traditional sector remains low, at about 8300. A few ranches have been established, notably by the parastatal company Zambia Agricultural Development Ltd (ZADL), and the commercial herds total about 2500 animals.

Animal traction is a relatively new technology. It is thought that fewer than 100 oxen were in use in 1985 and that 430 oxen were being employed in the province in 1990. Many of these had been introduced as a result of recent credit programmes. These had been arranged by Luapula Cooperative Union and the Lima bank, in cooperation with MoA and the Finnida-supported Cattle Development/Animal Draught Power Programme. In the mid 1980s, the success rate of animal traction introductions was low, with many farmers deciding to sell their animals for slaughter. Recently the situation has improved, possibly due to better extension/training facilities and follow-up.

The low number of cattle in the province is a major constraint. In 1990, the Lima bank had 50 oxen loans available, but, owing to difficulties in obtaining oxen, only 17 of these were taken up. To help overcome this constraint in the long term, a programme is being initiated to enable selected farmers to develop small breeding herds. With a low population of cattle, infectious and tick-borne diseases do not now pose a major threat to cattle.

There might be a significant potential for ox carts in the province, although this system of transport is little developed. Few ox carts are in use, but those farmers with ox carts who were interviewed reported high incomes from hire fees.

The present low demand for implements seems to be met at provincial level by the cooperative union. If demand continues to increase, it is likely that implements will have to be available at district, as well as provincial, level. Blacksmiths are being trained and supported to make spare parts; they may become important if demand for spares and maintenance begins to grow.

Table 2. Estimates of the numbers of cattle, trained work oxen and steers in the Luapula Province

	Work oxen[1]	**Total steers and oxen**[2]		**Total cattle population**[3]		
		Tradn[4]	Com[4]	Tradn[4]	Com[4]	All
Mansa	150	585	37	2 983	634	3 617
Samfya	200	625		2911		2 911
Mwense	10	26	195	1 033	1 867	2 900
Kawambwa	50	334		1302		1302
Nchelenge	20	60		103		103
TOTAL	**430**	**1 630**	**232**	**8 332**	**2 501**	**10 833**

1. Estimates of trained work oxen from questionnaire survey, site visits and mission discussions.
2. Numbers of steers and oxen based on "oxen and tollies" classification within the provincial livestock census reports of the Department of Veterinary and Tsetse Control Services (DVTCS).
3. Cattle population derived from 1989/90 DVTCS livestock census figures.
4. Classification into "Traditional sector" and "Commercial sector" as DVTCS census.

Copperbelt Province

The Copperbelt Province covers an area of 31,014 km^2, which is 4.2% of Zambia's total area. Although the province is the second smallest in the country, it contains the largest population (approaching two million) with a density of about 60 persons per square kilometre. Mining is the major economic activity in the province and this directly and indirectly supports a large urban population. Some of the urban population cultivate small pieces of land inside and outside the towns, but most of agricultural production derives from the surrounding rural areas. Of the 1,577,000 ha of agricultural land in the province, 307,000 ha are under cultivation. Average rainfall is about 1200mm.

There is little tradition of cattle keeping and so animal traction is a relatively new technology. Most soil tillage is performed by tractors or hand hoes, but in recent years tractor ownership and hire have become increasingly expensive. The 1985 Investment Plan estimated that there were 1250 trained oxen in the Province. A detailed survey of one area in Ndola Rural District in 1988 suggested that there were about 1000 trained oxen in use. The total for the province may be in the region of 2400. Since there have been few promotional activities relating to animal traction in recent years, most farmers adopting and using work oxen would have done so without the assistance of development projects. Animal traction technology is informally diffusing into the Copperbelt from other provinces: a recent survey suggested that over 40% of oxen owners were migrants from other areas (SDP, 1989).

The promotion of animal traction in the province is said to be constrained by a shortage of steers, as cattle are not numerous in the province. The provincial herd is estimated at only 62,000, and most of these (48,000) are raised on commercial ranches. Most of the animals consumed for meat are imported from Southern, Central or Western Provinces (those from the Western Province have to be slaughtered within 24 hours). Until recently, animal health was not considered a major constraint to animal traction, but the small outbreak of corridor disease in 1989 demonstrated the need for vigilance in tick control.

The proximity of urban centres makes marketing of produce relatively easy. It also makes it easy for thieves to steal and market animals. Crime is a major problem near the Zaire border.

The province has many manufacturing companies established to service the mining industry. Some of these manufacture ox-drawn implements, using their available tools and "jobbing" techniques. Companies with agricultural engineering divisions include Northland Engineering, MDM Engineering and SKF. Northland Engineering is the largest producer of implements in Zambia. It supplies implements to all provinces and sometimes exports to other countries. SKF, a bearing manufacturer, supplies axles for ox carts.

The Smallholder Development Project (SDP), supported by the European Community, is promoting animal traction in an area of Ndola Rural District. To date, the project, which started in 1988, has concentrated on preliminary activities such as information gathering and assessment. By December 1990, it had assisted about 30 farmers to obtain oxen and implements.

The Ministry of Agriculture has few other externally-assisted development projects in the Province. MoA personnel have little access to motorized transport. The parastatal timber company, ZAFFICO, is using some oxen for extracting logs from its plantations.

Table 3. Estimates of the numbers of cattle, trained work oxen and steers in the Copperbelt Province

(Notes as Table 4)	**Work oxen**[1]	**Total steers and oxen**[2]		**Total cattle population**[3]		
		Tradn[4]	Com[4]	Tradn[4]	Com[4]	All
Luanshya	50	88	154	1 003	5 580	6 583
Chiliaboabwe	0	58	311	256	1 341	1 597
Kitwe	0	0	3 115	0	12 276	12 276
Kalulushi	0	0	500	0	1509	1 509
Chingola	0	0	3 528	0	20 325	20 325
Mufulira	0	0	729	0	1 365	1 365
Ndola Rural	2 350	3 874	558	15 951	5 397	21 348
TOTAL	**2 400**	**4 040**	**8 896**	**17 210**	**47 793**	**65 003**

North Western Province

North Western Province contains large areas of sparsely populated woodlands. It has relatively high annual rainfall of 1100-1400 mm. Farming systems are mainly based on shifting cultivation, with the *chitemene* system of forest-fallow (or bush-fallow) cultivation being common in the Solwezi, Kasempa and Mwinilunga Districts. Such systems depend almost entirely on human labour, using simple hand tools such as hoes and axes.

There are approximately 60,000 cattle in the province, of which about 2000 are trained work oxen. The cattle are concentrated in the west, towards the border with Angola, where the tsetse challenge is low. Zambezi and Mwinilunga Districts are the most important cattle areas, with 35,000 and 13,000 cattle respectively. These districts provide most of the steers used for animal traction in the province. There are few restrictions on cattle movement. The ZADL parastatal ranch in Solwezi and the Kabukafu cattle breeding unit in Kasempa are other, much smaller, sources of oxen.

Animal traction has had a long tradition in the west of the country, notably in Zambezi District, where cattle ownership is common. Cattle and animal traction have been spreading eastward into Kabompo, a trend recently assisted by the North Western Integrated Rural Development Project (NWIRDP). Although Mwinilunga District has some herds of cattle, few animals are used for work. It is said that this is partly due to the traditional herding system, which does not encourage docility in animals. Animal traction is still a rare and new technology in Solwezi, Kasempa and Mufumbwe. In these districts, animal traction has been introduced on a small scale as farmers have immigrated from other provinces and settled. Some adoption has been as a result of small extension programmes assisted the Norwegian Agency for International Development (NORAD) and the International Fund for Agricultural Development (IFAD).

Animal traction in the province has been boosted by the GTZ-supported IRDP working in Zambezi, Kabompo and Mufumbwe Districts. NWIRDP, in cooperation with the North West Cooperative Union (NWCU) has been assisting the adoption of oxen and ox carts. It has produced several detailed reports relating to this. More recently the NWCU has started a small IFAD-supported animal traction programme in Kasempa, Solwezi and Mwinilunga Districts. So far about 30 pairs of oxen have been introduced into this area under this scheme. Collaboration between the NWIRDP-supported and the IFAD-supported programmes is envisaged. Zambia Cooperative Federation Financial Services (ZCF/FS) has been providing credit for animal traction. In both areas, ox carts are considered to have great potential, with social and economic benefits.

Within the province, there is liaison and collaboration between the various organizations involved developing animal traction. In 1988, a workshop was held for people working in animal traction in all districts, and a provincial work oxen programme was drawn up.

Table 4. Estimates of the numbers of cattle, trained work oxen and steers in North Western Province

	Work oxen[1]	**Total steers and oxen**[2]		**Total cattle population**[3]		
		Tradn[4]	Com[4]	Tradn[4]	Com[4]	All
Solwezi	140	510	25	2 646	1 338	3 984
Kasempa	80	73	25	426	241	667
Mufumbwe	80	92		215		215
Mwinilunga	60	604		13 060	1 335	14 395
Kabompo	650	1 040		5 485	15	5 500
Zambezi	1 100	3 199		34 630		34 630
TOTAL	**2 050**	**5 518**	**50**	**56 462**	**2 929**	**59 391**

1. *Estimates of trained work oxen from questionnaire survey, site visits and mission discussions.*
2. *Numbers of steers and oxen based on "oxen and tollies" classification within the provincial livestock census reports of the Department of Veterinary and Tsetse Control Services (DVTCS).*
3. *Cattle population derived from 1989/90 DVTCS livestock census figures.*
4. *Classification into "Traditional sector" and "Commercial sector" as DVTCS census.*

Western Province

Western Province covers an area of almost 130,000 km^2 and has a population of about 550,000. About 30% of the rural households are headed by females. Average annual rainfall ranges from less than 760 mm near Namibia in the south, to 1150 mm in the north. About 10% of the Western Province is classified as lowlands or wetlands, and these are often areas of high agricultural potential, such as the large flood plain of the Zambezi and the Lui River Valley. Lowlands also include the low lying, poorly drained areas known as "pan dambos", which provide dry season grazing. Much of the Western Province is part of the uplifted Kalahari-Okavango basin, and some soils are Kalahari sands with low agricultural potential. Kaoma District is considered by many to have relatively high agricultural potential. However, it has few cattle or work oxen. This may be associated with the high tsetse population along the borders the Kafue National Park.

The Western Province has a long tradition of cattle keeping and 510,000 cattle are owned. The total cattle population is increasing by about 2% per annum. Within the province the social and geographical distribution of cattle is highly skewed. Cattle are least common in the maize-growing Kaoma District. Cattle play an important role in the social and economic life of the Lozi people, and this has been stressed in several agricultural research reports. Although about 35% of households are female headed, few female farmers own cattle or oxen. Fishing and forestry are also important in the traditional economy. Crop production is often considered a secondary activity for Lozi farmers.

The use of animal traction is well-established in much of the Western Province. About 50,000 of the 87,000 oxen in the province are used for work. Animals, usually hitched in teams of four or six, are widely employed for transport and for cultivation. Through traditional systems of loan and hire, many people who do not own cattle can have access to work oxen, and the majority of fields are cultivated using oxen.

Animal traction use dates back several generations. Animal-drawn sledges play an important role in rural transport, carrying seeds, fertilizer, consumer goods, crops and plows. In comparison with sledges, there are few ox carts, and these are mainly used near towns, or on rural trading routes (to Angola and elsewhere). Animal-drawn cultivation has existed in the province for many years, and has been steadily increasing for at least fifty years. Now, in some areas, 90% of farmers plow with oxen, the majority hiring or borrowing from the minority who actually own oxen.

Recent animal traction initiatives started in 1980, with the establishment of the Longe Ox Training and Supply Centre in Kaoma District. The Looma Oxen Supply and Training Centre was established in 1981. Animal traction work was also undertaken by the Cattle Development Programmes and the Adaptive Research Planning Team (ARPT). There is a Western Province Animal Draft Power Programme supported by The Netherlands. This was started in September 1989 and is attempting to operate throughout the province. It is mainly carrying out training activities, but has assisted with schemes to supply cattle, animal-drawn implements and ox carts. There is no formal Animal Draft Power Steering Committee in the province, but some animal traction discussion takes place within the provincial livestock committee.

The Department of Veterinary and Tsetse Control Services (DVTCS) is concentrating on preventive disease control measures. Curative assistance is not generally available. The risk of mortality of adult animals is quite high, at about 7%.

Table 5. Estimates of the numbers of cattle, trained work oxen and steers in the Western Province

(Notes as Table 6)	**Work oxen**[1]	**Total steers and oxen**[2]		**Total cattle population**[3]		
		Tradn[4]	Com[4]	Tradn[4]	Com[4]	All
Lukulu	5 000	7 800		66 468		66 468
Kalabo	10 000	19 329		105 501		105 501
Mongu	10 000	16 106		90 185		90 185
Kaoma	3 000	4 698		21 891		21 891
Senanga	15 000	26 429		158 898		158 898
Sesheke	7 000	12 942		69 851		69 851
TOTAL	**50 000**	**87 304**		**512 794**		**512 794**

Southern Province

The Southern Province covers 85,000 km^2, which is 11% of the area of Zambia. Annual rainfall is 700-900 mm. Cattle are economically important in the province. The one million cattle in the Southern Province account for 40% of the national herd. Of the 890,000 cattle in the traditional sector, 277,000 are "oxen and tollies", and of these about 105,000 are trained animals.

The cattle population grew during the early 1980s but recently it declined slightly in the traditional sector as a result of corridor disease. This tick-borne disease is seen as a major constraint to cattle production and animal traction, but many farmers still do not dip their cattle regularly. The K5 per animal dip charge has been a major barrier.

Most smallholder farmers own cattle and use work animals for crop production. Animal traction has been well-established for many years, and is carried out with little external assistance. Farmers select and train their own work animals and use them extensively for plowing, weeding and transportation. Oxen are the main work animals, but cows are also worked. Plowing with teams of four animals is common, although pairs are also used. In one recent survey, 90% of farmers were reported to own oxen and plows. In this survey, 53% of farmers owned a cultivator, 48% a harrow, 20% a ridger, 7% a seeder and 45% an ox cart. Some large-scale commercial farmers use work oxen, mainly for on-farm transport.

The province has a small number of donkeys (600-1000) that are used for pack transport. They are mostly found in Gwembe South. In a recent survey, it was reported that they regularly make return trips of over 120 km to carry goods to and from markets. Some donkeys are used for carting, plowing and cultivation, in which case they are usually yoked, like oxen.

The Magoye Regional Research Station is located in the Southern Province, and this is the base for national-level testing and research relating to animal traction equipment and tillage. The Dutch-supported Animal Draught Power Research and Development Project has developed standards for the on-station and on-farm testing and evaluation of plows and carts. Tests have indicated design faults and weakness in many carts and several plows. On-station tillage trials have demonstrated the effectiveness of ridgers for weed control, and the relative efficiency of the traditional system of hand-metering maize seeds. Trials to demonstrate differences between various locally-available plows (design, stage of wear, adjustment) in weed control and crop yield have not yet yielded conclusive results. The province also includes the important livestock research centre of Mochipapa, in Choma.

The Ministry of Agriculture lacks any donor-supported animal traction initiative at provincial level, and MoA staff feel constrained by lack of

Table 6. Estimates of the numbers of cattle, trained work oxen and steers in the Southern Province

	Work oxen[1]	Total steers and oxen[2]		Total cattle population[3]		
		Tradn[4]	Com[4]	Tradn[4]	Com[4]	All
Livingstone	5 500	14 056	2 561	47 218	10 554	57 772
Kalomo	15 000	37 595	7 245	114 810	54 166	168 976
Choma	12 000	39 239	6 370	122 516	36 583	159 099
Gwembe	12 500	34 232	0	110 994	0	110 994
Monze	30 000	77 103	4 916	244 333	22 976	267 309
Namwala	18 000	46 730	0	167 813	0	167 813
Mazabuka	12 000	28 140	14 902	82 811	65 432	148 243
TOTAL	**105 000**	**277 095**	**35 994**	**891 495**	**189 711**	**1 081 206**

1. Estimates of trained work oxen from questionnaire survey, site visits and mission discussions.
2. Numbers of steers and oxen based on "oxen and tollies" classification within the provincial livestock census reports of the Department of Veterinary and Tsetse Control Services (DVTCS).
3. Cattle population derived from 1989/90 DVTCS livestock census figures.
4. Classification into "Traditional sector" and "Commercial sector" as DVTCS census.

transport and resources. As animal traction is an accepted part of most local farming systems, development initiatives in the province aimed at smallholder agriculture usually have some activities relating to animal traction. An example of this is the GTZ-supported Gwembe integrated rural development programme. MoA staff are concerned about developing the skills of local blacksmiths to support animal traction.

The Cooperative Union has recently started paying farmers with ox carts to transport maize from satellite depots to main depots. Under a new plan (developed by the Logistic Planning Unit), satellite depots will be phased out and farmers will be expected to deliver maize to the 80 major depots. To facilitate this, a substantial increase in the number of ox carts is envisaged. It is intended that the depots should stock animal traction equipment and spares and provide animal traction support services, such as puncture repairs, blacksmiths workshops and possibly dipping facilities.

Most plows sold by the cooperative union and private retail outlets come from Zimbabwe. These plows have a very good reputation for quality and price, and spare parts are generally available along the line of rail. The Northland plow is considered acceptable but too expensive. The first Rumptstad/Lenco plow had been unpopular, as farmers found it too heavy. An Italian-funded project has recently imported 8,500 lightweight Italian plows and ridgers. These will be sold cheaply to farmers. They have yet to be evaluated by farmers. Two of the three plow designs failed initial tests at Magoye, but one of the ridgers was found to be competent.

Figure 1. Demonstration of weeding technology at Magoye Regional Research Station, Southern Province.

Notes for Table 7 (opposite).

1. *Estimates of trained work oxen from questionnaire survey, site visits and mission discussions.*
2. *Numbers of steers and oxen based on "oxen and tollies" classification within the provincial livestock census reports of the Department of Veterinary and Tsetse Control Services (DVTCS).*
3. *Cattle population derived from 1989/90 DVTCS livestock census figures.*
4. *Classification into "Traditional sector" and "Commercial sector" as DVTCS census.*

Central Province

Central province covers 93,374 km^2 and shares boundaries with all other provinces of Zambia. Annual rainfall varies from over 1100 mm in the north-east to 800 mm in the south.

The province is an important producer of many arable crops including maize, sorghum, sunflower and soya beans. These crops are mostly grown by emergent and traditional farmers, although there are also some large, commercial farms. While tobacco is grown on some commercial farms, most large farms concentrate on livestock. About 175,000 cattle are maintained in the commercial sector, and the majority of these are in Chisamba District, between Lusaka and the Copperbelt. There are about 310,000 cattle in the traditional sector, and 80% of these are found in the west and south of the province, in Mumbwa and Kabwe Rural (Chisama and Chibombo) districts. Mkushi and Serenje Districts to the north and east have 13,000 and 9000 smallholder cattle respectively.

In 1989, there were 100,000 "oxen and tollies" in the traditional sector, and it is estimated that 36,000 of these are employed for work. Animal traction is well-established in the south and west of the province, it has been increasing gradually in the past 25 years. Over 80% of the work animals in Central Province are to be found in Kabwe and Mumbwa districts, where farmers are experienced in selecting and training their work animals without external assistance. Farmers in Serenje District are not traditional cattle keepers, and most use hand cultivation. Only about 3% of the work animals are to be found in Serenje District, an area of recent introduction. In the mid 1980s, the IRDP (Chinsali-Mpika-Serenje) was working in Serenje, and assisted early adopters of animal traction. IRDP undertook socioeconomic studies and concluded that animal traction led to extensification (that is the cultivation of larger areas, with lower inputs and outputs per unit area). Animal traction technology was found to be economically beneficial as the area expansion more than compensated for the slight reduction in yield per unit area. IRDP regarded shortage of steers as a critical constraint and so animal supply centres were proposed. These did little to alter the overall supply situation.

Animal disease can be a serious problem in the province. Prophylaxis against trypanosomiasis is recommended in some areas. Corridor disease has recently increased mortality, mainly in the central areas. Quarantine regulations restrict the movement of cattle from Mumbwa.

There is no donor-supported provincial animal traction programme. The Ministry of Agriculture is assisting the training of work animals in the areas of introduction. It has also arranged plowing competitions. An EC-supported smallholder maize project organized animal traction loans for 500 farmers. Repayment rates were high, but only 60% of farmers continued with animal traction, with many cashing-in their loan benefits by selling or slaughtering their animals. In the follow-up programme, emphasis will be placed on loans for implements and carts rather than animals.

Wooden sledges are quite widely used. Ox carts are made by small workshops, using materials derived from old vehicles. The Copper Mines Enterprise Trust (COMET) has proposed establishing further cart-manufacturing capabilities. Implements are sold by the cooperative unions and by some private dealers, and supply appears adequate. Spare parts are scarce, although artisans in Mumbwa district have been trained to make shares and other plow parts.

Table 7. Estimates of the numbers of cattle, trained work oxen and steers in the Central Province

	Work oxen[1]	Total steers and oxen[2]		Total cattle population[3]		
		Tradn[4]	Com[4]	Tradn[4]	Com[4]	All
Mumbwa	10 050	41 740		126 843		123 843
Kabwe Rural	14 500	27 300		76 607		76 607
Chisamba	4 500	12 318	18 652	44 215	98 263	142 478
Kabwe Urban	200	562	10 938	1 760	43 612	45 372
Kapiri Mposhi	3 300	8 801		36 642		36 642
Mkushi	2 000	4 592	5 911	13 184	32 989	46 173
Serenje	1 350	4 493		9 304		9 304
TOTAL	**35 900**	**99 806**	**35 501**	**308 555**	**174 864**	**483 419**

Eastern Province

Eastern Province covers an area of about 69,000 km^2. Only about half of this is considered to have agricultural potential, and a small part of this (about 250,000 ha) is actually cropped. The annual rainfall varies between 870 mm and 1100 mm. The low-lying and tsetse-infested Luangwa valley runs from Chama in the north to Petauke in the south and contains a large population of wild animals. Most farmers in the Eastern Province are hoe cultivators but animal traction is rapidly being adopted in some areas. There is little commercial ranching, and most of the 270,000 cattle are maintained in numerous small herds in the traditional sector. The supply of draft animals is only a problem in tsetse-infested areas, such as Chama District. The major health problems are trypanosomiasis (throughout the Luangwa valley and its bordering areas) and tick-borne diseases such as East Coast Fever.

Animal traction has become well-established in the south along the Mozambique border in the more fertile areas away from the Luangwa valley. About 10,000, 7500 and 6000 work oxen are used in the Petauke, Katete and Chandiza Districts respectively. Oxen are also quite widely used in the relatively tsetse-free eastern strip of the province along the Malawi border, and 4000 and 5000 oxen are employed in Chipata and Lundazi districts respectively. In these areas ridgers are widely used for primary tillage, and along the Malawi border, more ridgers than plows are owned.

The MoA started an ox training programme in 1975 which helped establish or expand animal traction in several areas. It found that its own success made continued promotion superfluous, for in areas where MoA ox trainers formerly operated, farmers started training oxen for themselves and for fellow farmers. MoA still conducts mobile oxenization courses where necessary. The Luangwa IRDP is starting to promote animal traction into the areas bordering the Luangwa valley. As this is a zone of introduction, training is considered necessary, as is routine prophylaxis.

The province has many traditional blacksmiths and carpenters and several projects and organizations aim to train and support them. Raw materials are being supplied to blacksmiths through the FAO Agricultural Mechanization Project and the provincial cooperative union. Some blacksmiths make complete plows and ridgers, which together with spare parts, are marketed through primary cooperative societies and hardware shops. Several entrepreneurs manufacture ox carts, using old car axles, sometimes bought in from Malawi.

The Katopola Agricultural Engineering Centre, supported by SIDA, tried for many years to promote the manufacture of wooden implements and ox carts with wooden wheels and wooden bearings. This scheme apparently had almost no success, and none of the trained carpenters are making wooden wheels for carts. The Msekhocika Project, supported by Austrian aid, started using similar wooden-wheeled carts, but changed to promoting the manufacture of carts based on imported axles and wheels. This programme was much more successful and its carts are increasingly used in the project area.

Table 8. Estimates of the numbers of cattle, trained work oxen and steers in the Eastern Province

	Work oxen[1]	Total steers and oxen[2]		Total cattle population[3]		
		Tradn[4]	Com[4]	Tradn[4]	Com[4]	All
Chama	10	50		417		
Lundazi	5 000	11 835		39 593		
Chipata	4 000	10 562		43 397		
Chandiza	6 000	17 876		62 888		
Katete	7 500	18 916		57 928		
Petauke	10 000	23 378		65 958		
TOTAL	**32 510**	**82 617**		**270 181**	**3 449**	**273 630**

1. *Estimates of trained work oxen from questionnaire survey, site visits and mission discussions.*
2. *Numbers of steers and oxen based on "oxen and tollies" classification within the provincial livestock census reports of the Department of Veterinary and Tsetse Control Services (DVTCS).*
3. *Cattle population derived from 1989/90 DVTCS livestock census figures.*
4. *Traditional" and "Commercial" classification as census. District statistics not available for commercial.*

Lusaka Province

Lusaka Province was created from part of Central Province in 1980. With an area of 22,000 km^2, it is relatively small and its potential arable area is estimated to be 304,000 ha, of which about 60,000 ha is cultivated. In terms of population and economic activity, the province is dominated by the capital city, and about 80% of the population live in the urban centres of Lusaka, Kafue and Chilanga. About half the rural population stays in the fertile plateau areas to the west of Lusaka. Another 30% live in the densely populated Soli wa Manyika agricultural area south of Chongwe, which produces much of the maize of the province. The low-lying valleys along the Lusemfwa, Luangwa and Zambezi Rivers are dry, hot, sparsely populated and prone to drought. The annual rainfall in the agricultural areas is about 700-800 mm.

The highly-mechanized commercial farming sector is strong near Lusaka city and along the line of rail. The presence of a mechanized commercial sector, together with the workshop support available in the urban centres, means that tractor hire is a viable option for many smallholder farmers. While almost half the farmed area is in the commercial sector, much of this is used for animal grazing rather than crop production. Of the total cropped area, 70% is cultivated by smallholders.

There are about 40,000 cattle in the traditional sector, of which 11,000 are "oxen and tollies". In 1988 the number of working oxen was estimated at 3300. More recent estimates suggest the number of work animals has risen to 5200. In the 1988 survey, it was reported that there were about 1600 plows, 1000 harrows, 1000 cultivators, 570 ridgers, 330 planters and 650 ox carts owned by farmers in the province. Not all were in working order.

The provincial Ministry of Agriculture office acknowledges that most of the development of animal traction in the province is a result of the farmers' own efforts. Little attention was afforded to animal traction before 1988. Animal traction is now being promoted by the Department of Agriculture, through ox training courses. About 60 farmers were trained between 1988 and 1990. There is no donor-assisted provincial animal draft programme, and a provincial animal power committee has yet to be established. The provincial MoA office tends to be overshadowed by the presence in the province of the national MoA headquarters.

Several important institutions involved with animal traction are based in Lusaka Province. These include the University of Zambia (UNZA), and its Technology Development Advisory Unit (TDAU) and the Natural Resources Development College (NRDC). A national training centre for animal traction has recently been established at Palabana. The Kasisi Agricultural Training Centre is a small church-supported organization that has been actively developing and testing appropriate technologies since the early 1980s. It gained somewhat of a national reputation with its development and promotion of wooden-wheeled ox carts, nicknamed "Flintstone carts".

Lusaka, being the centre of many commercial and manufacturing activities, has a good supply of implements, ox carts and veterinary drugs. Among the commercial producers of equipment are Lenco and Gameco. Among the importers are Zambia Cooperative Federation Commercial Services Division (ZCF-CSD) and AFE Ltd. Implements and spares are inevitably more difficult to obtain in the rural districts, of which some, such as Luangwa, are 200 km from Lusaka.

Table 9. Estimates of the numbers of cattle, trained work oxen and steers in Lusaka Province

	Work oxen[1]	Total steers and oxen[2]		Total cattle population[3]		
		Tradn[4]	Com[4]	Tradn[4]	Com[4]	All
Luangwa	200	605		1 086		
Lusaka East	3 000	6 462		25 634		
Kafue	2 000	3 866		12 779		
TOTAL	**5 200**	**10 933**		**39 499**	50 000	89 499

1. *Estimates of trained work oxen from questionnaire survey, site visits and mission discussions.*
2. *Numbers of steers and oxen based on "oxen and tollies" classification within the provincial livestock census reports of the Department of Veterinary and Tsetse Control Services (DVTCS).*
3. *Cattle population derived from 1989/90 DVTCS livestock census figures.*
4. *Traditional" and "Commercial" classification as census. District statistics not available for commercial.*

Table 10. Estimates of the total numbers of cattle, trained work oxen and steers in Zambia

	Work oxen[1]	Total steers and oxen[2]		Total cattle population[3]		
		Tradn[4]	Com[4]	Tradn[4]	Com[4]	All
Northern Province	3 620	11 900	1 300	90 660	11 930	102 590
Luapula Province	430	1 630	230	8 330	2 500	10 830
Copperbelt Province	2 400	4 040	8 900	17 210	47 790	65 000
North Western Prov.	2 050	5 520	50	56 460	2 930	59 390
Western Province	50 000	87 300	0	512 790	0	512 790
Southern Province	105 000	277 100	36 000	891 500	189 710	1 081 210
Central Province	35 900	99 810	35 500	308 560	174 860	483 420
Eastern Province	32 510	82 620	n/a	270 180	3 450	273 630
Lusaka Province	5 200	10 930	n/a	39 500	50 000	89 500
ZAMBIA TOTAL	**237 110**	**580 850**	**81 980**	**2 195 200**	**483 170**	**2 678 370**

1. Estimates of trained work oxen from questionnaire survey, site visits and mission discussions.
2. Numbers of steers and oxen based on "oxen and tollies" classification within the provincial livestock census reports of the Department of Veterinary and Tsetse Control Services (DVTCS).
3. Cattle population derived from 1989/90 DVTCS livestock census figures.
4. Classification into "Traditional sector" and "Commercial sector" as DVTCS census. (This information is not available for all provinces).

Figure 2. Plowing with oxen on a large farm in the Southern Province.

Discussion of some key issues

Inflation and interest rates

The overall national economic situation affects all farmers and all organizations working with farmers. Inflation is now very high, and the purchasing power of the Kwacha has been decreasing rapidly during the past year. As the inflation is associated with devaluation, the upward spiral of prices has tended to start with goods and services with a foreign exchange component. Village-based producer prices have reacted to the upward movement in prices, but have tended to lag behind. The result is that farmers' margins have been squeezed, and their purchasing power reduced.

Government departments and projects have found that the purchasing power of their annual Kwacha-based budgets has decreased. Some have found it difficult to implement programmes planned and budgeted when the Kwacha was more valuable. Government departments (such as the veterinary department) selling purchased items "at cost" have found that their generated income has been insufficient to replace their stocks. All revolving funds are very susceptible to high inflation, unless goods are always sold at their future replacement price.

Associated with the high inflation are high rates of interest. Commercial interest rates as high as 40% tend to discourage both borrowing and investment, unless very high rates of return are envisaged. High inflation may make it unwise to save and economically sensible to borrow. One can repay loans in devalued currency, provided one has the income to meet the high interest payments. However, small farmers are not sure of inflation-linked income, and so are reluctant to take such a risk.

With high interest rates, manufacturers and retailers find it expensive to maintain stocks of slow-moving items. This a particular problem if there is customer resistance to frequent price rises, which is the case with animal traction implements. Thus high interest rates tend to reduce both the quantity and the range of animal traction implements held by suppliers.

With inflation higher than interest rates, credit-giving organizations have seen the value of their capital reduced. Funds established to give loans for animal traction may have retained their nominal value in Kwacha terms. Nevertheless, they have been greatly reduced in value, as the prices of oxen, carts and plows has risen dramatically.

The problem of inflation and interest rates is a national one, and is not specific to animal traction. Nevertheless it is an important constraint that is affecting farmers and organizations.

Marketing

Animal traction in Zambia is heavily dependent on the profitability of crop cultivation. Crop cultivation is not the only benefit of work animals. Animal-drawn transport is important, being socially and economically beneficial. The growth in size of individual working animals can also be significant, as it can lead to large "capital gains" at the time of disposal. Nevertheless, for animal traction to be viable, there is usually the need for a profitable system of cropping and this requires a suitable market for the harvest. Successful marketing is important for all farmers (not just animal traction users) but it is particularly critical for those farmers investing in draft animals and implements for the first time. Many of these take out loans, and their repayment requires cash income.

Maize marketing has been a particular problem in Zambia in recent years. Small farmers have been encouraged to grow maize, but many farmers have had difficulties marketing their maize, and receiving timely payment. Controlled prices have made it difficult for the cooperative unions to recover the costs of maize collection in the more isolated areas. During the time of the mission, bags of maize from the previous season were still stacked at farms and at the roadside for collection in several provinces. Farmers were complaining forcefully that they had not received payment. In some areas, such as the Northern Province, the marketing of maize was cited by several people as the single most important factor affecting animal traction. Unless farmers were assured of a market, they would not take on new loans, and those with outstanding loans would be tempted to sell their animals to meet their repayments. Improvements in maize purchasing would stimulate investment in animal traction.

Rice marketing can also be a problem in some areas. In the isolated parts of the Lui River Valley in Western Province, some farmers use animal traction, but much high potential land remains uncropped. The farmers argued that if it were easy to sell their rice and purchase plows, many more farmers would use animal traction, and overall production would be higher.

Animal health

Patterns of animal disease greatly influence the distribution and use of animal traction in Zambia. Working animals are susceptible to the major cattle diseases, but few diseases and conditions are specific to draft animals. Those conditions associated with work, such as yoke galls and harness sores, do not appear to be of major importance in Zambia (although some unpleasant examples were seen by the mission). It is possible that the stress of work makes draft animals more susceptible to disease, and that low levels of disease or parasite infestation reduce working ability. Nevertheless the authors are not aware of any scientific or anecdotal reports of such interactions being important in Zambian farming systems.

The major cattle diseases are important in determining the size and productivity of the cattle populations in each province and district, and thus influence the availability of animals for work. The main diseases also largely determine the probability of individual animals dying, and thus influence the economic risks and costs of investing in work animals.

Trypanosomiasis

Trypanosomiasis is still a major cattle disease that restricts cattle keeping in many areas. Trypanosomiasis may be, or may have been, largely responsible for the small cattle numbers in some districts, and the lack of cattle-rearing traditions in some areas. Tsetse control measures, notably the use of insecticide-impregnated decoys, are continuing. Whether or not it is a direct result of reduced tsetse infestation, cattle now seem able to colonize new areas. Animal traction is playing a major role in this, as it provides a strong incentive for people to adopt cattle husbandry.

In several districts in the Northern, Luapula and North Western provinces cattle are being moved into new areas, as part of the oxenization programmes. Movement of cattle for draft work is also taking place in Kaoma, in the Western Province and Petaukwe in the Eastern Province. In some cases (e.g. in the Luangwa valley in the Eastern Province) oxen exposed to high tsetse challenge are provided with prophylactic doses of *Samorin*. As land is cleared for agriculture, and as population pressures increase, the habitat of tsetse flies is reduced. This, together with the tsetse control initiatives, suggests that cattle will increasingly be able to survive in these new areas, and that animal traction will be able to expand numerically and geographically.

Tick-borne diseases

The tick-borne disease East Coast Fever (*Theileriosis*) is enzootic in parts of Zambia, notably in the east and northeast. Although this disease can be fatal, local animals tend to be fairly resistant. The disease can be controlled by regular dipping.

A more serious, and relatively recent, problem is corridor disease, a tick-borne *Theileria* similar to East Coast Fever. This serious and often fatal disease has effected the Southern Province, and to a lesser extent Lusaka, Central and Copperbelt Provinces. Corridor disease has caused a drop in the overall cattle population in the south.

A form of treatment is available, but it is expensive. In any case, veterinary staff do not have the resources to provide treatment services throughout the province. While there is some work on a form of vaccination (disease inoculation combined with treatment dose), this is unlikely to be available and affordable soon.

The disease can be controlled by regular dipping, and thus the commercial cattle herds have not been seriously affected. The traditional herds, with less rigorous dipping regimes, have been badly hit in some areas. Unless widespread dipping is adopted, which few people expect to happen, it is likely that many work animals maintained in traditional herds will die in the coming years.

The disease is likely to lead to a reduction in the profitability in animal traction in affected areas. Many farmers in the infected zones depend on animal traction, and they are unlikely to revert to hand cultivation. Thus there may well be an increase in the hiring of work animals, and, consequently, a slight reduction in the timeliness of operations. An increase in the use of cows for work may be seen, as surviving animals, whether male or female, are brought in as reserves to make up work teams when oxen die.

Dipping

Corridor disease, East Coast Fever and other tick-borne diseases can be controlled by spraying or dipping with acaricide, but almost all provincial veterinary offices reported problems with this practice. Government dipping services used to be free, then stood at 50 ngwee or K1.00 for a time. The more recent increase to K5 per head per dip has discouraged farmers from dipping. Most Provincial Veterinary Officers have noted a decline in the number of farmers bringing their animals for dipping. During discussions with farmers, the mission was told on several occasions that the cost of dipping was prohibitively high.

Based on the cost of the dip, and the risk of loss of an animal, the costs are not actually excessive. However, they do require a cash outlay that farmers do seem to find difficult, both financially and psy-

chologically. Payment for dipping is particularly complicated for herds owned by several people, as long-standing, traditional arrangements have yet to adapt to the cash-flow requirements necessitated by dipping costs.

In areas infected with corridor disease, weekly dipping between November and April is recommended (dipping every five days may be needed in the more extreme cases). Some farmers have dipped intermittently to save money, but in so doing, they have not provided their animals with adequate cover. Intermediate dipping makes it difficult for farmers to see clear differences between mortality in dipped and undipped herds. With occasional dipping, animals may well sicken and die soon after a dip, due to infection and incubation in the "unprotected" period between dips. In such circumstances, farmers and their neighbours will become even less convinced of the value of dipping.

In the Western Province, corridor disease is not a problem and the tick challenge is not sufficiently serious for dipping to be a prerequisite for successful cattle keeping. In such circumstances, the veterinary service considers that it is reasonable to allow animals to be exposed to ticks, so they may build up acquired immunity. Constant low exposure to ticks is often preferable to intermittent or unreliable dipping.

In the northern provinces, the low density of cattle makes it unrealistic to contemplate the provision of dip tanks accessible to all farmers. In such cases bucket spray pumps can be used, and these are included in some oxen loan packages. In most provinces, chemical dip solutions were available through the veterinary services, although not at all times. In some provinces, revolving funds are being established to improve the situation. Some people contacted pointed out that few farmers were aware of the importance of dilution rates and safety procedures - an observation that might equally apply to some extension staff.

Other diseases

Foot and mouth disease is seldom fatal, but it can affect an animal's ability to walk, which is a serious problem for a working animal. It is not common in Zambia, occurring mainly near the Tanzanian border, and it does not seem a critical constraint. Contagious bovine pleuropneumonia (CBPP) is sometimes encountered near the Angolan border. Black quarter, haemorrhagic septicaemia (HS) and anthrax do occur, but they can be vaccinated against, and offer no special threat to work animals.

Veterinary restrictions

Sanitary regulations, designed to stop the spread of disease, do affect the ability of projects to purchase work animals. All parts of the country can be affected by temporary bans, designed to isolate disease outbreaks. In the northern province, it is not permitted to move cattle into the western districts (where animal traction is being introduced) from the cattle-raising districts near the Tanzanian border. Cattle exported from the Western Province have to be slaughtered within 24 hours, although cattle raised in Kaoma are now exempt from this.

Animal quality and quantity

Several different breeds are used for animal traction, including Zambian Zebu (towards the east), Barotse (towards the west) and Tonga (towards the south and central). In addition, cattle obtained from ranches may be derived from crossbred Boran, Afrikander, Brahman, Sussex or other exotic breeds.

All breeds seem capable of performing draft work and there is no suggestion that animal quality is a limiting factor. The imported breeds are generally larger and more powerful than indigenous breeds. It is likely that indigenous animals will be more hardy and disease resistant than imported breeds (although the mission encountered no evidence of this). Within breeds, individual animals differ in size and temperament, and some will be better than others. Such differences between individuals are likely to be more important than differences between breeds. The present system by which farmers and organizations choose the breed that is most readily available, and then select individual animals on merit, seems to be working well.

Some people felt that a move to larger animals was desirable. This could either be achieved in the short term by using larger breeds, or in the longer term by selective breeding of local breeds. With larger breeds, more farmers might use two rather than four animals. However, there are both disadvantages and advantages of large size. Large animals require more feed than small ones, although one large ox may require less than two small ones. Individual large animals are more expensive, and entail greater risk (one accident or death is more serious for a farmer that owns two large animals than four smaller ones). Also, as draft animals often have multiple social and economic functions, a large number of smaller animals is useful for economic flexibility. Large breeds are probably preferable in those few cases where animals are maintained for specialized work functions (on commercial farms, for forestry, for road construction and for full-time transport). The team believes that in most cases, small farmers will be

better off with the available indigenous breeds, selecting individual animals that suit their needs and budgets.

Animal supply

The shortage of available animals was commonly cited as a major constraint to the adoption of animal traction in certain provinces and districts. Yet there is no shortage of potential draft animals in the country as a whole. The problem is one of distribution. Moving cattle from areas of surplus to areas of deficit is difficult to organize and is expensive in transport. It involves risks of injury and disease and may be restricted by veterinary regulations.

Given the problems of moving animals large distances, it would be best, in the long term, if all districts had sufficient locally-raised steers for use as oxen. For this reason some projects are encouraging, and financing on credit, the establishment of small privately-owned breeding herds. One such programme is starting in Luapula, and a similar scheme has been proposed in the Northern Province. If these work they will provide an easily available and sustainable supply of young animals, which farmers will be able to purchase themselves. Such schemes appear most desirable and might usefully be encouraged in the other areas of deficit. As one project put it: the long-term sustainability of "oxen-ization" depends on "cattle-ization".

Another possible means of overcoming the oxen supply problem is by encouraging private traders to specialize in the purchase of young steers, for sale to potential oxen users in other areas. Such schemes are working to a limited extent in the Western and North Western Province, where traders buy cattle in the plains, for sale in Kabompo and Kaoma Districts. Private trading systems should be sustainable, once the traders are assured of a market and a profit. Nevertheless such trading is vulnerable to veterinary restrictions, and to the competition of butchers.

Purchase of animals from large ranches, such as those of ZADL (a commercially-orientated parastatal) and private farmers has been the preferred arrangement of most projects. Dealing with large ranches can be administratively easy for projects, as they deal in fixed prices and a single source of supply. One disadvantage is that animals from ranches are not used to close human contact and can be difficult to train. This problem was not widely reported, although one ranch in the Copperbelt has agreed to pre-train its animals prior to sale. Another problem is that it becomes difficult to match supply and demand. There have been reports of ZADL being unable to meet an order for an agreed consignment, and others when ZADL was ready to supply steers, but the authorities were unable accept and distribute them.

Some projects have attempted to set up breeding centres themselves. These have frequently been beset with problems of weak management, low productivity and commercially unsound practices. Examples include the Kabukafu Cattle Breeding Unit in Kasempa, North Western, which at one time sold animals at pre-inflation prices, at a tiny fraction of their market worth. Several MoA personnel in the provinces indicated that they favoured the establishment of oxen supply ranches, which would be run by their departments. With the recent emphasis (both in Zambia and worldwide) on reducing direct public-sector involvement in agricultural production and supporting private-sector solutions, few donors are likely to support such MoA breeding ranches.

There is more likely to be donor support for temporary district-level holding grounds. These are not intended as breeding centres, but are designed to help equilibrate supply and demand. They allow consignments of steers to be bought in from the private sector (ranches or traders), and held until they can be satisfactorily sold to farmers. Such holding grounds have been effectively used in Northern and Luapula provinces.

Implement manufacture

Introduction

Prior to 1978, most animal-drawn implements were imported into the country. They were generally of the "Safim" type, brought in from factories in Zimbabwe and South Africa. In 1978, the firm of Northland Agriculture was formed by the "jobbing" company Northland Engineering Ltd of Ndola, part of the Anglo-American group. This started producing animal-drawn implements of the "Safim" type. Since 1978, Northland Agriculture has been the major, and often the only, manufacturer of animal-drawn implements in Zambia. It has been meeting about one third of the annual demand for animal-drawn implements, the balance being met by imports, mainly from Zimbabwe.

Until recently, Northland has had little local competition. Small numbers of plows have been produced by blacksmiths, notably in the east of the country. A few "jobbing" engineering firms on the Copperbelt have made small numbers of implements. More serious local competition has started in the past few years, with the two firms of Lenco and Gameco producing significant numbers of plows. Gameco has fabricated plows using second-hand plow beams and has also assembled several thousand plows from South African components. Lenco has assembled plows from components manufactured in The Neth-

erlands and has recently built a production line for the local manufacture of these plows.

Northland Agriculture

In the five years since 1985, Northland has manufactured a total of 19,000 plows, 4000 ridgers, 3000 cultivators, 2000 harrows and 500 carts (figures from Northland, rounded). Its annual output has generally been limited by lack of steel and its own production problems, rather than by market saturation. Indeed, even when there were national shortages of plows, Northland was unable to respond effectively.

The basic design of the Northland plow has proved acceptable to farmers. For many years there has been recurring criticism within the Ministry of Agriculture of the poor quality of Northland implements and their lack of standardization. Quality does seem to have been improving in recent years, although Northland implements do not yet appear to be up to the standard of those imported from Zimbabwe. Problems of implement quality do not seem to have affected Northland's ability to sell implements: the company has not suffered from problems of unsold plow stocks.

Some of the quality and output problems of Northland stem from its system of production and its installed machinery. Northland started making ox-drawn implements using old machines and "jobbing" batch techniques (no clear production line and few accurate jigs and specialized tooling). It has continued a similar system of production for twelve years. Northland anticipates it could increase production and improve quality if it invested heavily in new plant and equipment. This would allow accurate and cost-effective production techniques to be introduced. Such investment would be expensive, in capital cost, in interest payments and in foreign exchange. It might be justified if turnover could be improved, but Northland faces competition from the Zimbabwe factories, that have easier access to steel, and may also benefit from local subsidies on steel and exports. Northland also faces market distortion from donor-assisted importation of implements and components. While Northland now seems prepared to invest in machinery and tools, it claims it is finding it difficult and expensive to obtain foreign exchange.

Northland's production has also been constrained by shortages of materials and foreign exchange. All steel has to be imported into Zambia, and this requires scarce foreign currency. Northland notes that certain sizes and grades of steel for plow beams and shares cannot be obtained locally or from Zimbabwe. To import these from South Africa requires a minimum order of 400 tonnes of each type. In 1990, Northland was able to purchase just over 1000 tonnes of steel using the foreign exchange facility of the SIDA (Swedish International Development Agency) steel programme. Payment conditions were very easy (payment in devalued local currency at a highly favourable rate of exchange, with no apparent time-limit for payment).

Northland claims that it does not need technical assistance, and that its production and its problems have been entirely due to old equipment, lack of accurate tooling and shortages of foreign exchange. Nevertheless, external visitors to the factory (including the present mission) have been given the impression that Northland could have improved both its quality and its production, through better organization and management of its existing resources.

Northland has not been adventurous in its designs, sticking to the established "Safim" range. Northland did prepare an original design of ox cart, using bronze bearings, spoked metal wheels and solid rubber tyres. It was light and had puncture-proof tyres but its bronze bearings wore rapidly. The combination of high price and weak bearings meant the cart did not sell well.

Northland claims that, with available steel and some new equipment, it could make 20,000 plows a year, as well as several thousand ridgers, cultivators and harrows. Such an estimate seems extremely optimistic, given the recent track record of the company. Nevertheless it is clear that with some investment and good management, the company could meet most, if not all, of the national demand for animal-drawn implements.

Lenco

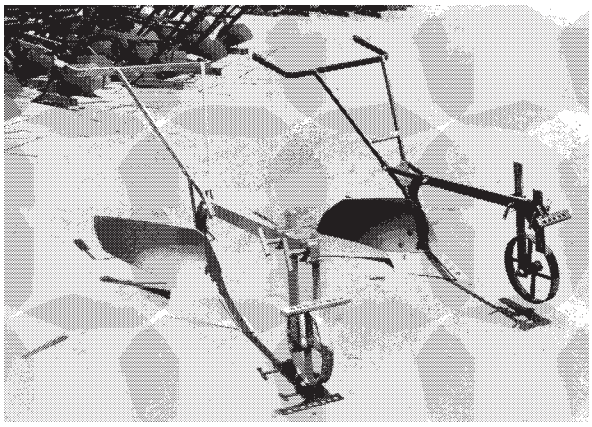
The Lenco (Lusaka Engineering Company) involvement with animal-drawn implements is two-fold. It has been making small numbers of ox carts. These have had pneumatic tyres, all-steel bodies and imported Italian axles fitted with roller bearings. The carts are acknowledged to be very good, and they were one of the few designs to be passed for quality and durability by the ADP-RDP testing unit at Magoye. Sales have been low, as the carts have been expensive, and marketing effort has been minimal. The company has sufficient axles to manufacture at least 1000 more carts. It has therefore designed a cheaper cart body, based on an angle-iron frame to which the purchase can fit wooden planks. Lenco intends to actively market these carts, which will be available as kits.

Lenco's involvement with animal-drawn implements started in 1984, when it started collaborating with the firm of Rumptstad of The Netherlands. This collaboration has been funded by DGIS, the national aid programme of The Netherlands.

In 1985, components 4450 Rumptstad plows were received for local assembly. Samples of these Rumptstad plows had been tested at Magoye and Looma (Western Province); as the plow beams were considered too weak, heavy duty plow beams were supplied to Lenco. Marketing of these Rumptstad/Lenco plows commenced in 1986, which was just after 14,000 inexpensive plows from Zimbabwe had been imported. Sales were slow, due to the temporary saturation of the market, relatively high price, problems of plow design (excessive plow weight) and limited strategies for marketing and making spare parts available. By 1990, there were still stocks of this first Rumptstad/Lenco plow remaining in warehouses.

A report was prepared for the aid programme of The Netherlands. In this it was recommended (subject to various conditions) that Lenco be assisted to move from simple assembly to full manufacturing of animal-drawn implements (Jansen and Dibbits, 1986). Although the financial models indicated such a project would be viable, it was acknowledged that the margin of profitability was very sensitive to key assumptions, including that the Rumptstad-designed plow could command a significant price premium. It was therefore recommended that the project be delayed until late 1987, to give time to assess the marketing arrangements. A project proposal was then prepared in 1988 (MoA, 1988). Rumptstad was contracted to establish a production line for ox-drawn implements. In 1990, Lenco was provided with equipment that included heat-treatment furnaces and pressing, cutting and drilling machines. Assembly jigs were supplied, as were the services of a full-time Rumptstad production engineer. The new machines, steel and components were supplied under favourable financial conditions, with Lenco providing the Kwacha equivalent retrospectively.

Figure 3. Rumptstad/Lenco plows. Left: Rumptstad Sandy II "heavy" plow assembled at Lenco. Right: Rumptstad/Lenco Sandy III plow, locally fabricated from components imported under the SIDA steel programme.



In addition to the plows, small numbers of Rumptstad multipurpose toolbars, seeders, ridgers and cultivators have been imported for testing. Plans exist for marketing a ridger body that can be bolted to the plow beam in place of the plow body.

Prior to the arrival of the production line equipment, Lenco ordered components for 2000 plows (of a modified design, see Figure 3) from Rumptstad, which were paid for under the SIDA steel support programme. Lenco received the same subsidized terms as other importers, with delayed, retrospective payment in devalued Kwacha at a favourable exchange rate. However, despite these favourable conditions, it was not able to sell these plows at a profit.

In the initial years of the programme, Lenco has not really been manufacturing plows, but has been assembling plows from components manufactured in The Netherlands. A small amount of cutting and drilling has now commenced, and the amount of manufacturing of components is due to increase rapidly during the coming two years. In the first three years, the steel will continue to be supplied by Rumptstad (it is argued that this is necessary for Rumptstad's quality control criteria). The production line being installed, will have a capacity of at least 10,000 plows a year. Lenco hopes to be able to manufacture and sell at least 5000 plows a year, but it is concerned about profitability. The Rumptstad/Lenco plow uses expensive materials, but has not yet commanded a significant price-premium over Northland or Zimbabwe plows. Lenco seems unlikely to make a profit on plows if it has to keep its prices competitive with plows manufactured with cheaper steel.

The driving force behind the Lenco "local-manufacturing" has been Rumptstad, with support from Dutch aid. There has been much work in the past five years in evaluating, modifying and redesigning the early Rumptstad designs. Lenco engineering staff have not been closely involved in this, and so have missed a valuable learning opportunity. The fact that Lenco has not recruited an agricultural engineer, and the Rumptstad production engineer does not have a direct counterpart, has given cause for concern about the long-term sustainability of the Lenco programme.

It has been six years since the Dutch-funded Lenco programme was started, but Lenco has not yet succeeded in producing implements that farmers find acceptable and affordable and that will secure a sustainable profit for Lenco. The aim of this on-going programme is still the sustainable manufacture and sale of a good range of animal-drawn implements. It

is too early to know whether this will indeed be the end result.

Gameco and other workshops

Gameco is a small "jobbing" workshop in Lusaka, that is entirely owned and managed by a Zambian entrepreneur. It started producing animal-drawn implements in 1988 and first made 1000 plows (according to its own estimates) using second-hand beams. In 1989 and 1990 it imported plow components from South Africa, making up to 3000 plows a year, as well as smaller quantities of ridgers, cultivators and harrows. The implements were all of the "Safim" type. Gameco's locally-manufactured plows were made in small batches, to artisanal standards. Its locally-assembled plows appeared to be much more uniform.

Based on Gameco's own production figures, its output has exceeded that of Lenco, and it is beginning to rival that of Northland. This seems remarkable considering that it is a very modest workshop, that undertakes small fabrication and repair work, often using scrap material. Much of its "production" has effectively been assembly work (as has Lenco's). While Gameco plows have not been made of the same quality of steel as those of Lenco, Gameco has been much more successful than Lenco in rapidly marketing its products. It has generally identified and secured markets prior to manufacturing, and thus has not had to maintain high stocks.

Gameco considers that its ability to manufacture is limited mainly by lack of local raw materials and foreign exchange for importation. Surprisingly, Gameco did not benefit from the SIDA steel-import programme. Gameco has received some support from an industrial charity in Sweden, in the form of production machinery (mainly second-hand). It intends to use this new-acquired equipment to increase the number of locally-made plow components, but is likely to continue to import plow beams, possibly from Agro-Alpha in Mozambique. Gameco is actively pursuing export markets for its plows in Angola and Namibia.

Several other workshops in Lusaka and the Copperbelt have made small numbers of implements. These include MDM Engineering, Kaleya Engineering and Gilmer Engineering. Their modest production of harrows, cultivators and spares is briefly noted in the relevant provincial reports. These are all indigenous "jobbing" engineering workshops, prepared to make agricultural implements provided designs can be obtained and markets secured. In general, they lack knowledge of agricultural operations and are unaware of the exact needs of farmers. Thus when they have copied other implements, they have tended to make simple, but devastating, design errors (for example, carefully aligning the teeth of harrows, rather than off-setting them!). They have not received significant technical assistance (although MDM did benefit from the SIDA steel import programme). They do not seem likely to have a major influence on the animal-drawn implement market in the near future.

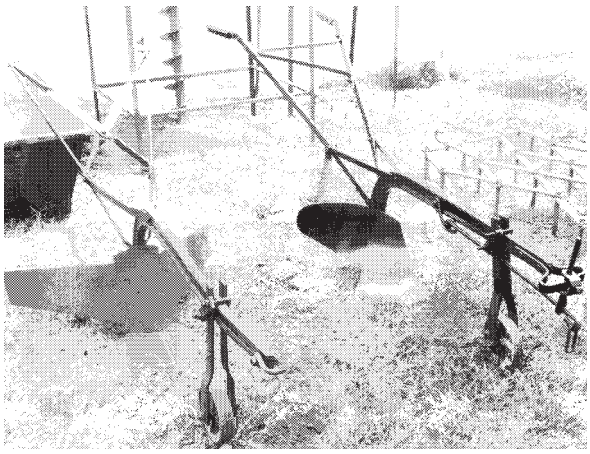


Figure 4. Gameco ridger, plow and harrow.

Manufacturing problems

Manufacturers of animal traction implements in Zambia face many problems. Obtaining steel is difficult and the capital cost of maintain stocks of raw materials and manufactured implements is very high. Market demand appears very variable, and sales (and cash-flows) can be suddenly affected when parastatals and donors import large consignments of implements manufactured elsewhere.

Perhaps the biggest problem faced by manufacturers in recent years has been the shortage of suitable steel in the country, particularly hardened steel and specialized cross-sections. There has also been a shortage of foreign exchange to allow companies to order steel. Private importations of specialized steels have been made more difficult by the large orders necessary to justify their importation (minimum orders of 400 tonnes of each type have been cited).

To a certain extent steel-supply problems have been overcome in recent years, thanks to the SIDA programme to support steel importation. Under this programme, administered by Zambia Cooperative Federation Commercial Services, firms were able to order steel from abroad. This was paid from from the SIDA-supplied funds (about US$1,000,000). The firms were then able to pay for their steel later in local currency, and a highly favourable exchange rate. (In practice, to date, very few companies have actually made their local currency payments, even at the favourable rate.) Northland has benefited most from this programme, followed by MDM Engineering, Lenco, Chipata Blacksmiths and SKF.

Since 1990, the government has made steel imported for the fabrication of agricultural implements exempt from duty and tax. This followed considerable pressure from several manufacturers, the Ministry of Agriculture and from donors supporting animal traction.

Shortage of foreign exchange has also made it difficult for manufacturers to invest in machines and tooling. Lenco was greatly assisted in this by Dutch aid, and Gameco has received some Swedish support. Other manufacturers, such as Northland, would like a scheme similar to the SIDA steel programme to help them to import machines and equipment to allow them to develop their infrastructure.

A further major manufacturing problem relates to cash-flow, capital, inflation and high interest rates. To make implements, particularly plows, manufacturers have to maintain stocks of specialist materials. Maintaining such a capital stock is expensive during periods of high interest rates (presently around 40%), yet high steel stocks are almost inevitable unless there is a convenient and reliable local source of supply. (It may be noted that during times of high inflation, it is better to maintain stocks of materials than money in the bank. This is inflation beating, but is not productive or profitable.)

Farmer demand for plows is highly seasonal, and this requires stocks of manufactured implements to be built up during much of the year, ready for the principal buying period. Such stocks are also very expensive to maintain, particularly if capital is charged at 40%. In recent years ZCF-CSD (formerly Namboard) and the cooperative unions have taken the pressure off the manufacturers by their bulk purchases of stocks. Thus the cooperatives rather than the manufacturers have had to bear the main costs of implement stockpiling.

With the serious financial difficulties experienced by the cooperative unions, they are unlikely to be able to hold large stocks of implements in future. This will put increasing pressures on the finances and the cash-flows of the manufacturers. Northland and Lenco are sufficiently well-established and resource-rich to survive these pressures, but they will naturally wish to pass on the high costs of maintaining stocks to their customers. Farmers will probably resist price rises, since agricultural produce prices tend to lag behind in the inflationary spiral. Lower sales volumes will increase cash-flow pressures on manufacturer still further.

The smaller firms and workshops are unlikely to be prepared to tie up their limited capital in slow-moving stocks. Much higher turnover, and lower interest charges, can be achieved through "jobbing" work or the fabrication of items of constant demand such as window frames and burglar bars. Small workshops are therefore increasingly likely to restrict their manufacture of agricultural implements to firm orders from cooperatives or projects.

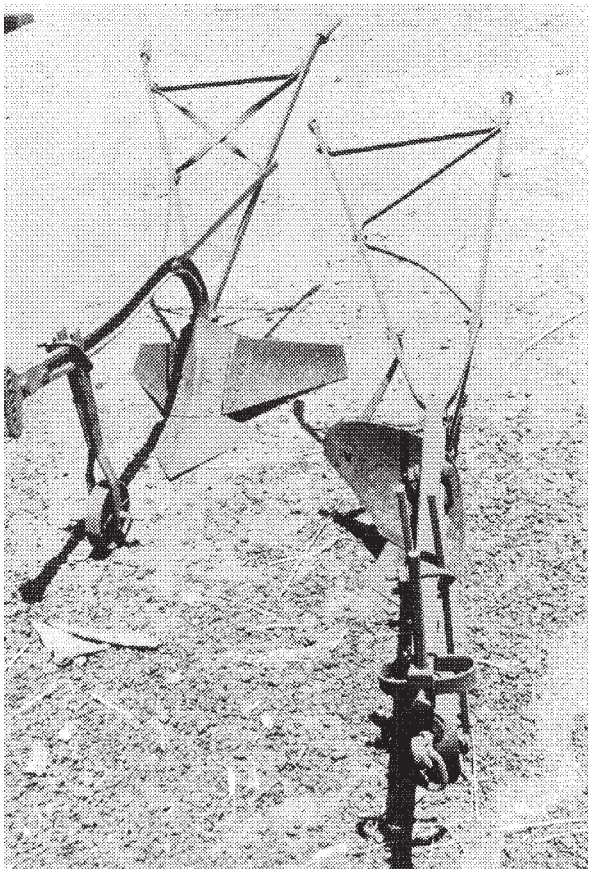
Artisanal manufacture and spare parts

In the Eastern province, several artisans manufacture plows and ridgers. Often they make use of second-hand plow beams. Some have been trained under the FAO-supported Agricultural Mechanization Project. The implements are of variable quality, but they appear to be effective and there continues to be a market for them.

The main problem for the blacksmiths is obtaining raw materials, and they can waste much time and money travelling in search of small quantities of good scrap steel. (For repairs, some blacksmiths insist that their customers search for their own spring steel, so the farmers waste time and money instead).

In the Eastern province, blacksmith support schemes have made steel available at the district or primary cooperative level. The SIDA steel programme assisted Chipata Blacksmith Service with about six tonnes of imported steel. The blacksmith support schemes have also helped blacksmiths market their plows and spares through the cooperative societies.

Figure 5. Ridger and plow made by blacksmiths in Eastern Province, under supervision of the Agricultural Mechanization Project (FAO).



The major advantage of blacksmith fabrication is that farmers can have a nearby source of implements and repairs. They can provide feedback to the blacksmith on their specific needs and desirable innovations. Blacksmith-farmer interactions were extremely important in the development of animal traction in Europe. Many modern agricultural machinery companies started as blacksmith workshops in the last century.

Blacksmiths in other districts also manufacture spare parts, notably shares and landsides, and carry out repairs. In general the supporting infrastructure is less developed than in the Eastern province. Such provision, by blacksmiths, of spare parts and repair services is considered extremely important, and should not to be underestimated. There are large numbers of plows in the country that are not in use for want of spares or repair. Results of the recent animal traction survey provided some insight into the scale of the problem. Several provinces reported some initiatives in blacksmith training and support, but it was also acknowledged that this was generally an area requiring greater attention. In the past, blacksmith training has concentrated on imparting specific techniques and skills. Little work has been attempted on teaching blacksmiths aspects of design and agricultural engineering, such as plow adjustment principles and implications of design on soil-implement interactions.

Implement supply and marketing

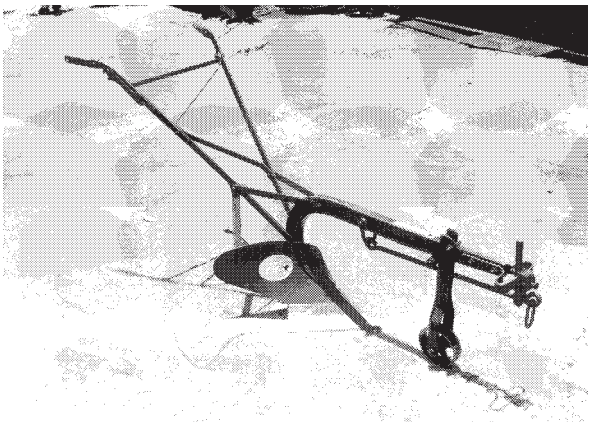
Within Southern Africa as a whole, there is no shortage of supply of animal-drawn implements. Besides the manufacturers in Zambia, several manufacturers in the region are capable of serving the Zambian market, provided foreign exchange is available and imports are allowed. Zimplow and Bulawayo Steel both have a proven track record and surplus capacity. They are well-placed in terms of geography, raw materials, infrastructure and rail transport. Provided their supplies of specialized steel continue, they are likely to continue to market well-proven implements at an acceptable price. Agrimal in Malawi, and Agro-Alpha in Mozambique also have surplus capacity, but are less well-placed and equipped. In the medium term, it seems possible that a political settlement in South Africa could lead to a major liberalization of trade in the region. In such circumstances, some South African manufacturers may try to capture some more of the market for animal-drawn implements in nearby countries.

In national terms, there has been little or no national planning or coordination between the various importing organizations and manufacturers. There have been alternating shortages and gluts, which have benefited no one.

Based on the figures given to the review mission, in late 1990, the supply position seemed good. This is a record only of apparent numbers available, with no regard for suitability or quality. Lenco had stocks of Dutch components and steel to manufacture 2,000 plows. An Italian-supported project in the Southern Province had over 6000 lightweight Italian plows. ZCF-CSD had recently received 3000 Zimbabwean plows and was expecting the arrival of 3000 Indian plows. AFE Limited was expecting the arrival of 3000 Zimbabwean plows. Some importation from Zimbabwe was also likely from other trading firms that had previously been successful in selling Zimbabwean plows. Gameco was intending to assemble/fabricate at least 2000-3000 plows in 1991, using some components from Mozambique or South Africa. Northland had recently received over 1000 tonnes of steel through the SIDA programme, and considered itself capable of manufacturing 13,000 plows in the coming year (20,000 if it were able to replace its machines). This would give a potential national supply of 30,000 plows, which would be about twice the "normal" annual demand. Even discounting the Italian plows (weak design), and Northland's apparently optimistic forecasts, it appears that Zambia, as a whole, is likely to be well-supplied for implements in the immediate future.

While plows are likely to be available within the country, this does not mean that farmers will necessarily be able to buy plows and spare parts easily. Implements are likely to be reasonably available in the towns along the line of rail, in the Copperbelt, Central, Lusaka and Southern Provinces. In the rural areas, where they are needed, they are likely to be quite difficult to obtain. The marketing unions contacted seemed to have little idea of actual demand patterns within their provinces and districts. They also have major cash-flow problems. In the circumstances, they are unlikely to provide an efficient service for the sale of implements and spares to

Figure 6. A "Master Farmer" plow made by Bulawayo Steel, Zimbabwe. Safim-type plows manufactured by Zimplow are also regularly imported into Zambia.



farmers. Implements and spare should be available in the areas directly served by donor-assisted projects (e.g. Copperbelt SDP area) or by cooperative unions assisted by projects (e.g. KADICU).

No manufacturer has built up an efficient network of distributors and agents. Manufacturers have historically relied on bulk orders to the cooperative movement and to the large outlets along the line of rail. With the present system of cooperatives increasingly being regarded as inefficient, unresponsive and almost bankrupt, there seems to be an urgent need for improved systems of distributing and marketing animal-drawn implements and spares.

Implement testing

Most plows in use in Zambia are based on the long-standing and well-proven "Safim" designs. Apparently similar plows (Northland, Gameco, Zimplow, Bulawayo Steel and Agrimal) are certainly not identical and the standardized testing of such plows should help to identify weaknesses, manufacturing defects and design problems. The ADP-RDP has not yet published detailed test reports on the range of "Safim-type" plows available. Nevertheless in preliminary tests it has identified several problems including mouldboard shape (Gameco) and wheel size/quality (Zimbabwe plows). A consignment of Indian "Safim-type" plows is due in Zambia in 1991. Distribution will be through the cooperative movement, and it is likely that by the time these plows are fully tested, all will have been sold to farmers.

Testing appears particularly important for innovative plow designs, not used in Zambia before. The very first Rumptstad plow had been tested on-station, and was found to be too weak. Heavy duty plow beams were then tested, and the plow proved effective in on-station trials. Nevertheless the Rumptstad/Lenco plow had not had been submitted for detailed farmer-acceptance trials before the major consignment was dispatched to Zambia. As a result neither Rumptstad nor Lenco escaped the embarrassment of having supplied 4500 unpopular (excessively heavy) plows. A modified, lighter design was then prepared by Rumptstad and (fortunately) ADP-RDP Magoye purchased samples for testing. This design had a light, weak beam that failed its initial test at Magoye. This independent testing appears to have saved Rumptstad and Lenco from the embarrassment of supplying another consignment of unsuitable plows to Zambia. By the time the 2000 plow components were sent in 1990, the design had been re-modified, with a stronger beam. Other modifications have also been made by Rumptstad, for reasons not relating to the ADP-RDP test. Thus the new plow being marketed by Lenco has yet to pass the full ADP-RDP testing procedures.

A large consignment of about 6000 Italian plows was recently imported without any testing at all. In late 1990, these started to be sold to farmers, and, shortly afterwards, samples were submitted to ADP-RDP for testing. Preliminary test results suggest that at least two of the makes of plows are unlikely to pass the standard tests. It seems their plow beams are quite weak, and are likely to bend irreparably during use. It is too late to change the specifications, since several thousand of them are in the headquarters of the Italian-funded project in Choma. These plows may also become an embarrassment to the agencies concerned.

The examples of the imported Dutch and Italian plows clearly illustrate the great importance of testing. They also illustrate a major problem, still to be solved. No manufacturer or supplier has yet indicated that they are prepared to wait for test results. They have been prepared to respond retrospectively, and correct mistakes. No supplier or manufacturer has yet been prepared to delay their schedules in order to avoid such mistakes being made.

Full testing, with farmer assessment, is clearly necessary to avoid all mistakes (such as unacceptable plow weight), but simple technical errors, such as plow beam strength, could be detectable very rapidly. One suggestion is that Magoye ADP-RDP should provide an express "preliminary testing service" to alert manufacturers and importers of implements. Fortunately, through informal channels, a procedure such as this was adopted in the case of the weak Rumptstad plow beams, and action was taken prior to major importation. Unfortunately, preliminary testing did not happen in the case of the Italian plows; nor will it happen for the Indian plows.

The testing of carts has also proved to be important. Unlike plows, which have been manufactured or imported in large numbers by a small number of organizations, animal-drawn carts have been made in small numbers by many manufacturers and projects. It has thus proved impractical to test a wide range of locally produced carts. Nevertheless, the detailed testing by ADP-RDP of 20 cart designs provided many lessons for Zambia, particularly in relation to axle quality (Dogger, 1990). It is clearly desirable for any new axles, whether locally made or imported, to be well-tested before they are actively promoted.

Plow design

As noted, most plows in use are derivatives of the old Safim or Victory design. This type of plow is

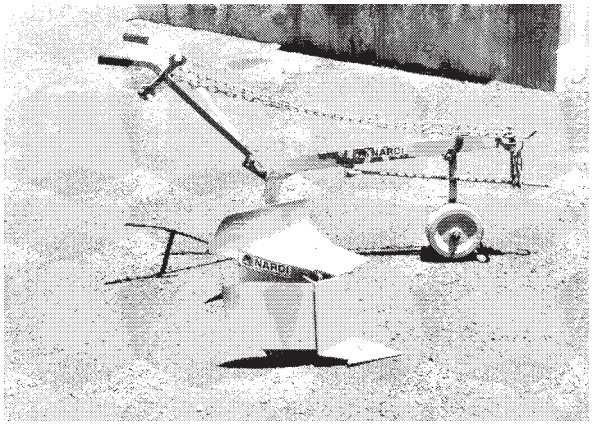


Figure 7. Nardi plow and ridger body, imported by Italian cooperation.

generally popular and has been well proven by farmers in the region. Examples of this type of plow include those of Northland, Gameco, Chipata blacksmiths, Zimplow (Zimbabwe), Bulawayo Steel (Zimbabwe), Agrimal (Malawi), UFI (Tanzania), Agro-Alpha (Mozambique), Isico (Swaziland/South Africa) and Safim (South Africa). The most common implements are those of Northland, Zimplow and Bulawayo Steel.

The two types of plow from Zimbabwe appear to be quite uniform in quality, and seem popular, although there have been complaints concerning the wheels. Plows from Northland appear to be more variable in design and quality. Agricultural engineers have been dismayed at the variation between Northland implements, particularly when poor alignment of parts has been evident. Such faults would be expected to reduce the life or performance of the implement. Nevertheless farmers seem very tolerant of such faults, and few complaints were heard. Copies of Safim plows made by blacksmiths around Chipata also have great variability, but again farmers seem to tolerate these as well.

Agricultural engineers point out that a good, well adjusted plow should lead to better plowing, with less effort for the operator and animals. Farmers almost invariably remove the front adjuster from their plows. They also seem to consider weight and strength to be the critical factors in plow design, with widespread complaints that the first Lenco plow was "too heavy". Field trials at Magoye Research Station have yet to prove that plow design or adjustment does effects yield in a consistent manner (in one year a well-adjusted plow was superior, in the following year, a worn, poorly adjusted plow gave better results).

The supposition is that, within reason, small differences in plow body design, such as those that exist between the different Safim copies, are not very critical. Farmers, it seems, can plow acceptably well with the main Safim-type designs now available. To put it another way, the conditions under which plows are generally used (environment, plowing proficiency, plow adjustment etc.) are such that small differences in plow design become masked. One difference that is evident on the farm is plow weight, and this was often cited as the reason for rejecting the first Rumptstad/Lenco plows. Strength on impact is also important, particularly in farms with many stumps, and weak plows would almost certainly be rejected by farmers. For this reason ADP-RDP Magoye rejected the second Rumptstad/Lenco plow and two light Italian plows, as their tests led them to believe these plows would bend when used by farmers.

In order that true farmer preferences can be gauged, and the weaker designs can be eliminated, farmers would have to be offered real and sustained choice. Although many makes and designs have been present in the country in the past few years, most outlets have had only one type in stock at any one time. There seem to have been few, if any, cases where farmers could actually choose between the different Safim-type plows over a period of time, and thus give the retailer feedback on their preferences.

There seems to have been little attention to brands and sources, and few farmers or depot keepers have been certain of the brand and manufacturer of their plows. While there has been a general impression that "Zimbabwe" plows have been good, there has been virtually no differentiation between the two main brands. Few people could recall whether the Zimbabwe plows they referred to had been the Mealie (Zimplow) or the Master Farmer/Silver Medal (Bulawayo Steel) plow brands.

There has, however, been some choice and brand differentiation between Safim-type plows and Rumptstad/Lenco plows. The combination of clear colour difference and obvious design differences has made it easier for people to differentiate between plow types. When offered a choice, the Rumptstad/Lenco plow has generally been rejected by farmers in favour of the more traditional plows (Safim types). This has been despite some promotion of the Rumptstad/Lenco plow as an "improved" plow by the Ministry of Agriculture and several development projects. The Lenco brand name does not seem well known: most people refer to the Rumptstad/Lenco plows as the "yellow" or the "heavy" plows.

Design of other implements

Plows are the most important cultivation implement and relatively little is known about the merits and demerits of the various ridgers, harrows, cultivators

and seeders available. Work on these implements is beginning to be undertaken by the ADP-RDP, Magoye, but this project has, quite naturally, concentrated its initial activities on plows and carts. Preliminary results have suggested that ridgers have high potential for weeding, an operation that can be a major bottleneck on farms using oxen for plowing. The animal-drawn seeders tested seem to offer few advantages over hand seeding. Further work is required, including on-farm evaluation trials of the various designs of cultivators and ridgers in different systems of use. Such work is already planned within the ADP-RDP programme.

Harness design

Most work oxen are harnessed with simple wooden withers yokes. Sometimes they are poorly finished or badly made and cause sores on the animals. Such problems appear mainly due to poor individual yokes, rather than the general design. There is no objective evidence to suggest that the common yokes are a limiting factor. There is some subjective opinion that with a little extra shaping yokes can be made more comfortable, and possibly more effective. One example of such a yoke is the Looma yoke. A few carpenters in the Western Province have been trained to make these for sale to farmers. A small number of farmers have adopted these yokes, but even in the Looma area, where these yokes have been promoted for several years, overall adoption rates remain very low. Until there are more signs of farmer enthusiasm and adoption, it may be unwise to promote such yokes vigorously. Nevertheless they may well be demonstrated during shows and plowing competitions.

Attempts were made during the past five years to assess and lightly promote the use of three-pad harnesses for single oxen. Two training courses were arranged and several people (including some commercial farmers) expressed interest in these harnesses. Nevertheless there seems to have been no adoption. One farmer explained that the beauty of animal traction was its simplicity, and the collar harness was more complicated than the yoke. There therefore seems little prospect for such harnessing systems in the foreseeable future.

There are few donkeys employed in Zambia, and farmers have tended to adapt ox yokes for use with donkeys. Although such systems may work, they appear inefficient and there is evidence that they cause injury. As donkeys may well become increasing important in Zambia, there seems scope for some adaptive research, in which farmers could assess donkey harnesses from Botswana or elsewhere.

Rural transport

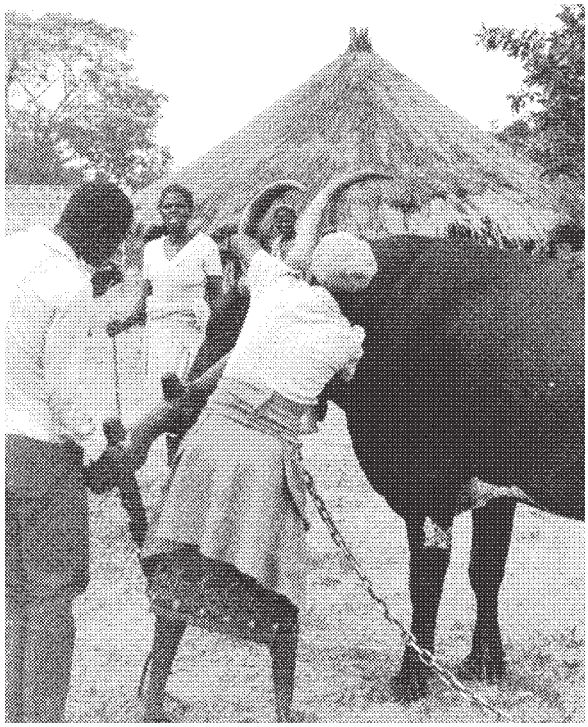
Animal-drawn transport is already very important for rural transport in some areas of Zambia, and it could increase in importance nationally.

Simple, locally-made wooden sledges of various designs are widespread in Zambia, particularly in the west. These are available and affordable and they can negotiate quite narrow paths. They are not very efficient at carrying large loads, and in some countries they have been discouraged as sledge tracks may accelerate erosion. With wheeled carts, animals and their operators can transport more goods for a similar work effort. The main disadvantages of carts are their price, their need for wide, clear paths and their greater need for maintenance and repairs.

Compared to the numbers of animals and plows in use, the number of ox carts is presently low. In some countries in Africa, including certain parts of Zimbabwe, Malawi, Senegal and Mali, most farm households own a cart. Only in a very few areas is this situation approached in Zambia.

The most obvious example is Kabompo, where carts are widely owned and seen to be in use. They are used to transport maize, vegetables, fertilizers, people, firewood, water, building materials, and many other items. As with cars, once they are obtained, the owners discover new transport uses, and new social and economic benefits. The reason for their success in the Kabompo area seems to be the combination of available credit, suitable cart design, appro-

Figure 8. Women in Western Province being trained to fit the "Looma" yoke to their animals.



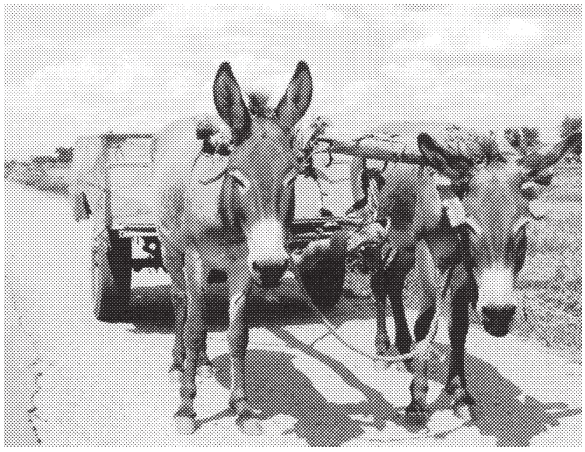


Figure 9. Donkeys, fitted with a yoke, pulling a cart made from an old pickup in Southern Province.

priate terrain and marketing opportunities. The carts have not been subsidized in terms of manufacturing cost (only in project overheads), and credit has generally been repaid. The NWIRDP is reluctant to continue to promote carts, feeling that the transport market is already saturated. The authors are not convinced of this.

Certainly a good income from hire fees may be important in cart purchase, and hire opportunities decrease as the number of carts increase. Nevertheless, carts can lead to an expansion of economic activities, so the total market may be a growing one.

In several regions in Africa, one cart per farm household is economically sustainable and socially extremely desirable. This was also the case in Europe, and in present day Europe each household wants its own car, whatever the economists say.

Several examples were given of the high incomes that can be generated by carts. Farmers near Mansa reported that in a few months they had earned more in hire fees than their carts had cost. Farmers in several provinces were reportedly prepared to pay 10-15% of the value of the grain, to have it transported a few kilometres.

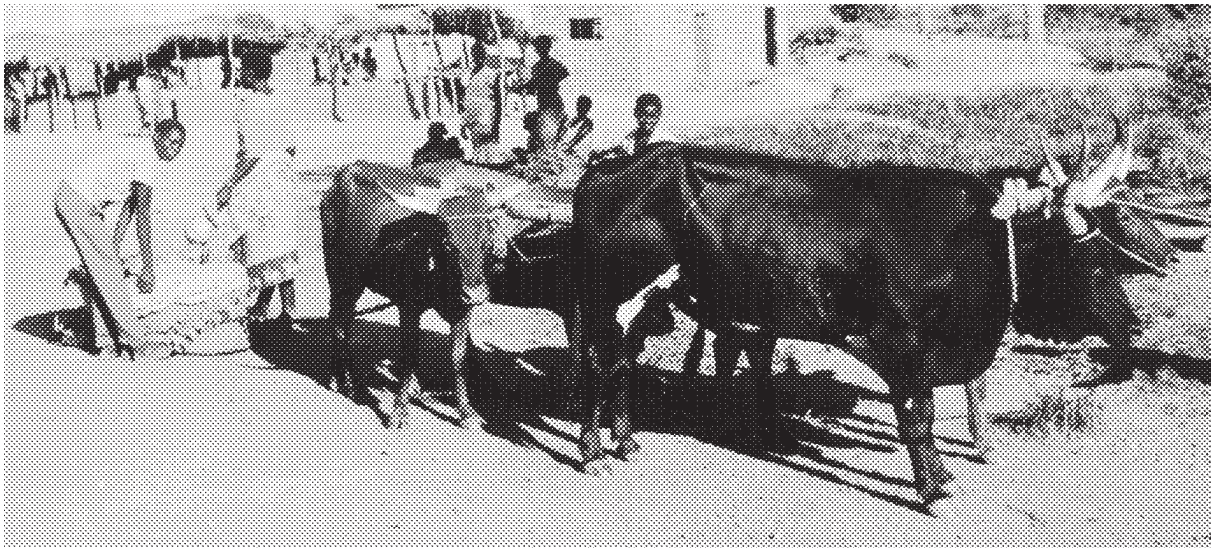
While there are examples of cart transport being highly profitable, there are also examples of small-scale cart manufacturers having problems in selling their carts. Although it may have been because their carts were not good, the explanation of the manufacturers seems very likely. The costs of the axles and wheels had risen dramatically in recent months, but the incomes of farmers had not done so. Farmers did not have the cash to buy carts, and so sales were only occurring where farmers were being helped with credit provision.

Cart design

Most carts that in Zambia have been made by local workshops from the old axles of pick-ups and Landrovers. These carts are generally strong and long-glasting, and the limiting factor is usually the shortage of scrap axles, wheels and tyres. Such carts are used in many parts of Africa.

Over the past thirty years, there have been several "appropriate technology" ox cart designs developed in Zambia. Examples include the wooden wheeled carts made by Katopola workshops in Chipata, TDAU (Technology Development Advisory Unit) carts developed at the University of Zambia and "Flintstone" carts developed at Kasisi Mission. While there have been cases of such "appropriate technology" carts lasting for over ten years, with little maintenance, they have generally suffered from serious problems with their wheels and bearings. Some have been abandoned, and some are to be seen rotting in project yards (for example at Kato-

Figure 10. A sledge with three oxen and a cow being hired to carry produce to market in Central Province.



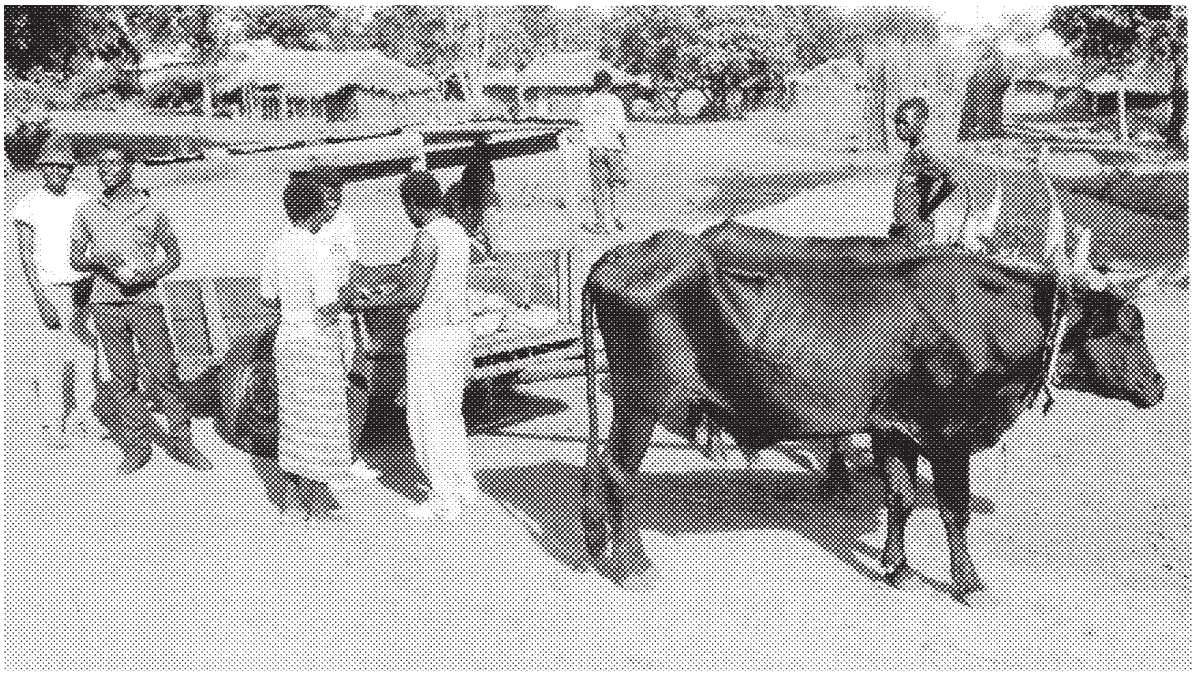


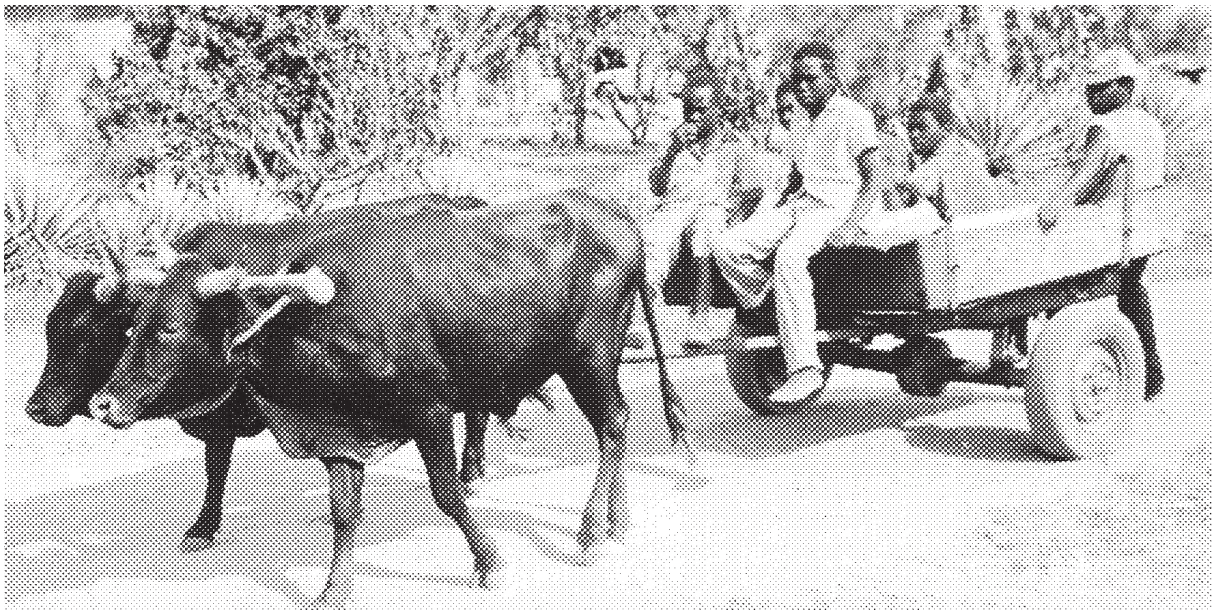
Figure 11. Ox cart in North Western Province being used to transport and sell tomatoes. The NWIADP helped to introduce ox carts, emphasising their role in the transport and marketing of maize. It was found that the carts were used for a wide variety of purposes which stimulated local trade.

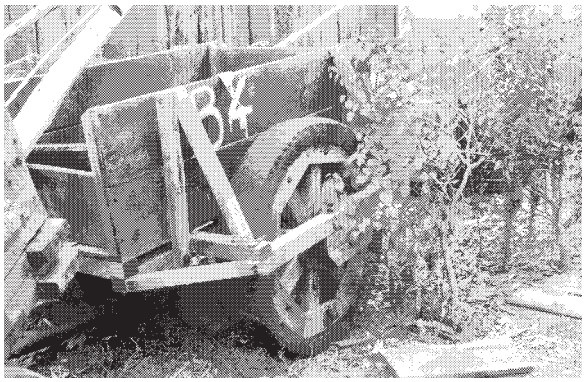
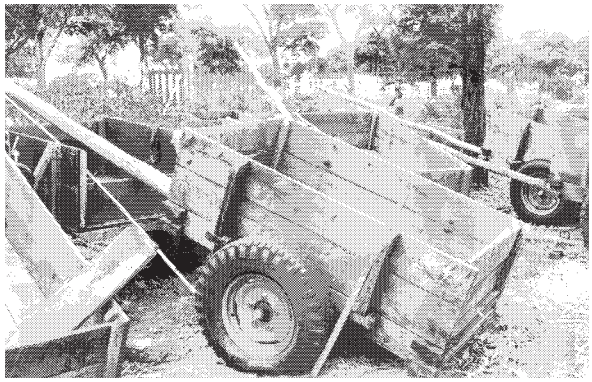
pola workshop and at Manyinga). Despite some promotion, these "appropriate technology" designs have not generally caught on. (This should not be taken as a blanket criticism of all aspects of "appropriate technology" carts: for example, one TDAU cart has recently passed an on-station test in Magoye, outperforming several other carts, although like most other carts in these trials, it failed the longer term on-farm testing).

The North Western IRDP spent much time testing a variety of wheels and axles, including some with wooden, bronze and PVC bearings. They finally standardized on steel axles with imported steel roller bearings and pneumatic tyres. These seem to have been satisfactory, and have been widely used and adopted. Several hundred are in use around Kabompo.

There are few other commercially available carts. Northland developed an ox cart, using solid rubber tyres and bush bearings. This was reported to have had major technical problems. It passed on-station tests, but failed on-farm trials carried out by ADP-

Figure 12. Ox cart made from an old axle in Lusaka Province. Most carts in Zambia are made using scrap axles.



Figures 13 and 14. One of the "appropriate technology" carts (left) with wooden wheels made in North Western Province. Such carts were subsequently abandoned in favour of carts made with imported axles using roller bearings and pneumatic tyres (right). A simple wooden cart body was retained.

RDP Magoye. It has not been widely used and it is not being routinely manufactured.

Lenco has manufactured and marketed a steel cart, using imported Italian axles fitted with tapered roller bearing and pneumatic tyres. This has been well received, and is reportedly working well in the Northern Province, in the area of the Rice Development Scheme. It was the only cart to pass both the on-station and the on-farm tests carried out by ADP-RDP Magoye (Dogger, 1990). Its main problem is its high price: not only is it expensive to purchase, it is also costly to transport as it is ready-assembled.

In view of the perceived demand and the shortage of good cart axles in the country, the engineering and bearing company SKF, developed ox cart hubs using ball bearings. This was designed to be used with Landrover (or other) rims and tyres. Launched in 1988, production has been about 500 hubs a year, sufficient for 250 carts. Response has been mixed, with some reports of complete satisfaction and some of hub failure. Carts with SKF axles passed on-station tests at Magoye, but failed the on-farm testing. Unfortunately, if there are problems with the bearings, adjustment and replacement of the bearings is virtually impossible in rural workshops, and so whole hubs have to replaced, at high cost. Although the price of the axles is high, relative to farmer income, it appears it may be acceptable to farmers, provided the axles and hubs can last for several years. A project proposal was prepared to assist SKF meet national demand (MoA, 1988). The Dutch government (DGIS) agreed to fund this, but importation of components was postponed when hub failures started to be reported. Imported components finally arrived in early 1991, but by this time SKF had decided started developing a new design. The new hubs, which will not be available until 1992, will use tapered roller bearings.

The SKF axles (and other local designs) depend on the availability of rims and tyres. In order to relieve the shortage of these, the ADP Coordinator project has imported scrap wheels and rims from Europe. The importation of complete scrap axles has also been considered. The supply of tyres and rims has been popular with the recipients, mainly development projects and institutions. However, such provision of materials is unlikely to be sustainable.

It appears that most farmers prefer carts based on roller bearings and pneumatic tyres, whether the hubs be new or are from scrap vehicles. Although these carts may seem the most expensive option, requiring higher capital and maintenance costs, the carts are durable, they can take heavy payloads and their wheels can negotiate mud and sand.

Evidence from other countries in Africa appears relevant to the Zambian experience. Wooden wheels are only common in north Africa and Madagascar. Carts made from old vehicle axles exist in many places, but seldom in large numbers, probably due to the limited supply of old axles. "Appropriate technology" options are found in several countries, but seldom in large numbers; their bearings and wheels are almost always cited as a source of problems. In contrast, the use of animal-drawn carts has been seen to increase rapidly, when a reliable supply of high-quality axles has been made available. In West Africa, there are about 100,000 carts in use in Senegal, 100,000 in Mali, and 40,000 in Burkina Faso. These are nearly all of designs based on high-quality axles assemblies using roller-bearings and pneumatic tyres.

In contrast to these West African examples, Zambia still has very few animal-drawn vehicles in relation to the number of animals used for cultivation. Cause and effect cannot be ascribed, but it seems that Zambia farmers have not yet had a good supply of affordable, high-quality carts. The exception may be in Kabompo District, where many carts have recently been adopted. Tanzania has tended to follow an "appropriate technology" approach similar to that

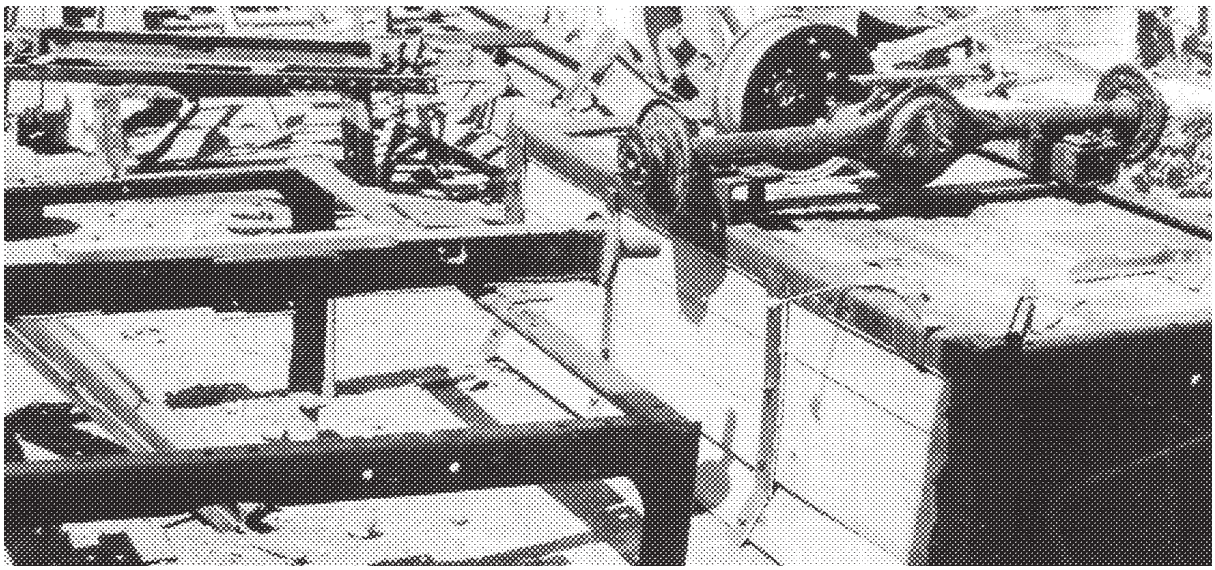


Figure 15. Local workshop making carts from scrap axles in Southern Province.

some Zambian organizations, and also has few carts in use. In contrast, private enterprise firms in Malawi have manufactured and marketed high-quality carts with pneumatic tyres. Although Malawi is a much smaller country, there are now about 20,000 carts in use, almost one cart for every two plows. Such statistics should be treated with great caution, for they are only illustrative. Direct comparisons between different countries are fraught with problems since it is not possible to separate the different supply and demand situations from the numerous other variables. Nevertheless there does seem to be evidence that farmers elsewhere in Africa can afford and maintain carts with "high-quality" roller bearing axles.

Experience from within Zambia and elsewhere suggests that the design of the body of the cart is not nearly as important as that of the axle and wheel assembly. Furthermore as bodies are generally made locally, it is easier for manufacturers to receive feedback from the users. Thus weak points can be strengthened and dimensions adjusted to accommodate the major loads.

The transport of fully assembled carts is normally prohibitively expensive. On the other hand, axle and wheel assemblies may be packaged for bulk transport, and they are also small enough to be carried on public transport. Thus the SKF approach seems very sensible, provided their design is good (the author's impression is that the SKF design should be improved to make them more durable and repairs easier).

If manufacturers (SKF, Lenco, Northland or others) make available sets of good axles, at an affordable price, they are likely to be in demand. They would be purchased by organizations such as Muzama Crafts, as well as by projects and small workshops (such as those proposed by SDP in the Copperbelt). These, or other, manufacturers might also consider a steel cart frame as an optional extra. These could be supplied in kit form for ease of transport. The frames would be assembled in rural workshops, with the cart platforms and sides being constructed locally from wood. Such kits would not sell in very large numbers, but would be attractive to project-assisted workshops with little experience of cart manufacture.

A small number of four wheeled carts are in use. Some are owned by commercial farmers, who may use the same trailer with oxen one day, and a tractor the next. One four wheel trailer has been built by the Msekhocika project in the Eastern province. This is a strong, expensive cart that is intended to be a sustainable, long-term replacement to an unaffordable pick-up. Four wheel trailers are expensive and complicated, and are unlikely to be used by small farmers. They are more efficient for pulling heavy loads, and may be preferred by animal-using commercial transporters (movement of urban goods, road building, forestry applications, etc).

Unusual applications of animal power

In Zambia, animal power is used almost exclusively for transport and soil tillage. There are a few examples of other uses such as milling and logging.

One project, supported by the German Appropriate Technology Exchange (GATE) has been installing and evaluating a few animal-powered mills. One mill was recently installed at the Msekhocika Project near Chipata, but its ground wheel and tyre were stolen, as they were compatible with those of private cars. It is too early to say whether such mills

will prove suitable for use in Zambia. In the past year, the present design suffered from excessive tyre wear and problems with the grinding stones. These are being rectified, but a more fundamental problem is the slow milling rates. In tests at Magoye, donkeys and oxen have been used to draw the mill, which has a draft of about 500 Newtons. Two millings have been found necessary with maize to give an output efficiency of 53-69% (final meal as proportion of the grain input). The output has ranged from 15 to 37 kg per hour, and has been highly dependent on the moisture content of the maize.

The Msekhocika Project in the Eastern Project has received Austrian technical assistance in the development of a mill for extracting oil from sunflower seeds. The mill apparently works effectively. Women's groups come with their own pairs of animals, and also pay a fee, currently K300 per day. Output can be 18 litres of oil during a six hour working period.

Another system designed to harness animal energy was tested at Kasisi Mission, Lusaka Province in recent years. It was a “rope engine” developed at Warwick University, in UK, and was intended to drive grinding mills and other machines. Unfortunately the installed prototype was broken by the ox that was testing it, before it could be fully evaluated. Similar problems have been experienced in other countries with this prototype design.

Oxen are used for timber extraction by Zambia Forestry and Forest Industry Company (ZAFFICO) in Ndola. It is reported that oxen are substantially cheaper than tractors for logging work. A community forestry project in Luapula, supported by the Finnish Volunteer Service, is currently investigating the use of oxen for transporting logs.

A rural roads project in the Northern Province, supported by the International Labour Office (ILO), has imported donkeys for use in its road maintenance programme. They will mainly be used for transport of materials. In other countries animals have been used to pull earth moving scoops and graders, for road construction, and historically such techniques were used by some commercial farmers in Zambia.

The specialized applications cited here are recent initiatives. They illustrate some innovative attempts to make more use of animal power. Nevertheless the total numbers of animals involved are few, and there seems little likelihood of such applications spreading widely in the coming few years.

Organizational issues

Most government-supported activities relating to animal traction suffer from chronic underfunding, exacerbated by inflation. These include MoA extension services and Ministry of Education colleges. However, there are many donor-supported projects in the country, which help maintain the government infrastructure. It appears to be relatively easy to obtain donor funds to support animal traction activities. Thus often, while “lack of funds” is strictly correct, it may also imply lack of initiative to obtain external support and/or funds.

In theory, within government ministries and projects, the position is always more important and permanent than the individual. Staff are interchangeable, and staff movements are frequent. In practice, the success of many programmes and projects is highly dependant on key individuals. The success of animal traction programmes can often be traced to the enthusiasm and vision of individuals, some Zambian nationals and some expatriates. The lack of progress

Figure 16. Four-wheeled ox cart used by the Msekhochika Project in Eastern Province as an alternative to a pickup vehicle.

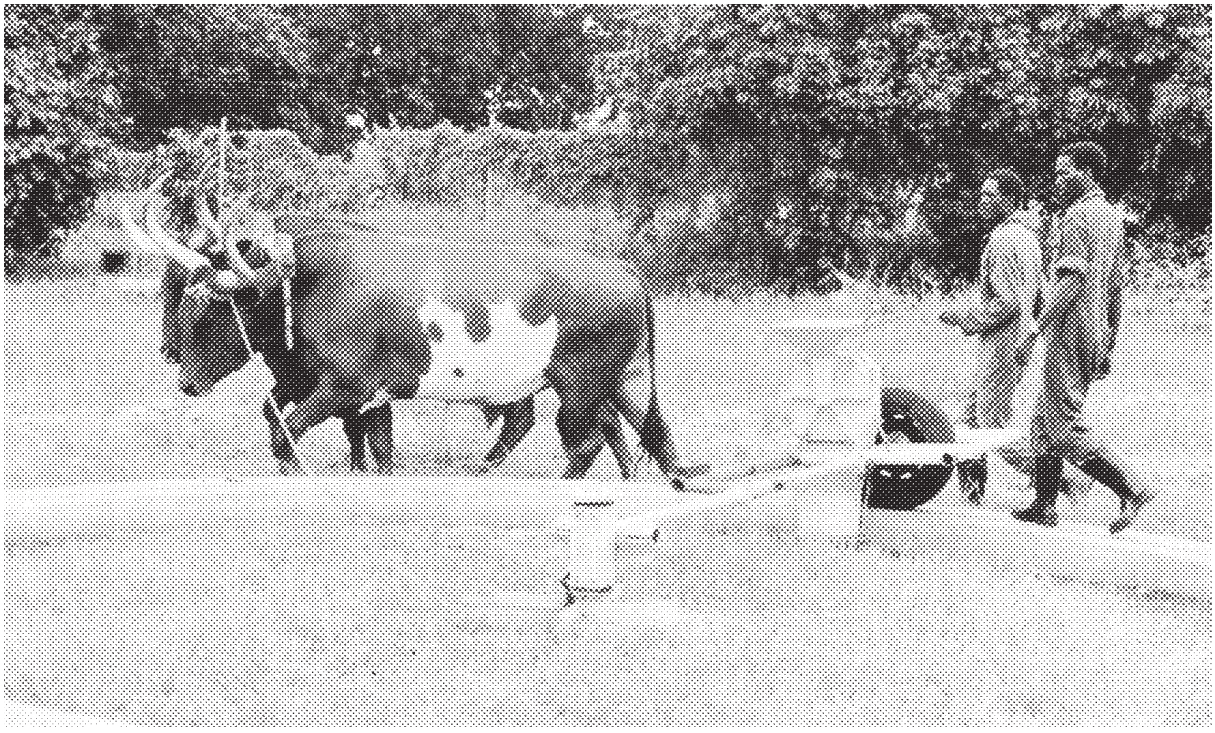


Figure 17. Animal-powered mill installed by the GATE Animal Power Project for evaluation at the Magoye Regional Research Station.

elsewhere is often more to do with the individuals (Zambians and expatriates) than the various excuses given. This situation is not restricted to animal traction, but animal power does seem an area where enthusiastic individuals without too many preconceptions can make an impact, while unenthusiastic ones merely list constraints. (Enthusiastic individuals restricted by their own ideas may also fail to make an impact). It may be difficult to use this observation in the planning of future strategies, but projects should obviously try to attract suitable individuals. When programmes appear to fail, it is important to distinguish between those problems attributable to the technology itself, and those due to human failures.

Women and animal traction

In Zambia, as in most other countries, animal traction technology is dominated by men. The main work animals are cattle, and these have numerous gender-related traditional roles.

Men and youths generally work with draft animals. It is quite rare for a woman to plow, although it is not uncommon for women to lead or encourage the animals, as a man plows. It is generally a woman, rather than a man, who drop seeds into the furrow, behind the plow. In areas where animal traction is widespread, women who do not own draft animals, usually hire or borrow oxen (and a plowman) from male relatives or neighbours. Even when women farmers own cattle, it is usually a male relative or employee who works with the animals. There are many and complex reasons for this, mainly to do with social traditions. There do not appear to be significant technical or ergonomic reasons why women do not generally plow. Although the implements are quite heavy, they can certainly be used successfully by youths and girls.

Studies in Western and North Western Provinces have shown that through hiring and borrowing arrangements, women do have access to animal power for cultivation and transport. All hirers, male or female, have to make use of the draft animals when it is convenient for the owner, which may well be after the ideal time. Although this is inconvenient, and may cause poor timeliness, it does allow women access to draft power, without the associated capital investment, management responsibilities and risks. In the Eastern Province, some women's groups have been assisted to obtain ox carts, and have reported considerable benefits from the transport.

In recent years, women farmers have been trained in animal traction at farmer training centres. Women extension workers have been trained at Palabana Animal Draft Power Training Centre. The impression gained by the present mission is that women are no more disadvantaged in relation to animal traction, than they are in society as a whole. Their more active involvement in animal traction will tend to follow automatically as more liberal social traditions evolve. Thus, while there is always a need to

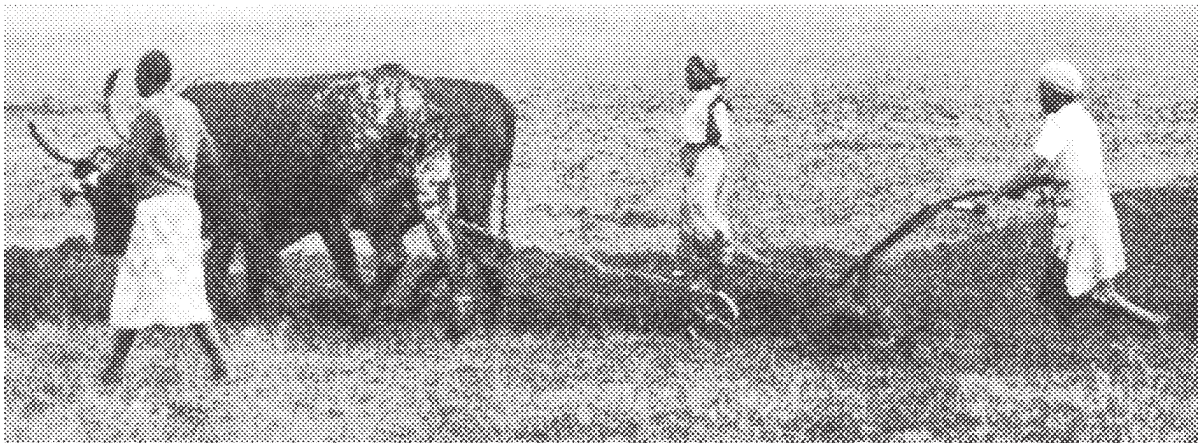


Figure 18. Women being trained to plow with oxen in Western Province.

be sensitive to gender issues, animal traction technology itself does not seem to be a major problem for women. Should donkeys start to become more popular, these may well be particularly useful for women. Donkeys are smaller than cattle, easier to train, and they have few, if any, traditional "gender" associations.

Donor-supported projects

Although all MoA projects in Zambia are the ultimate responsibility of the Government of Zambia, donors have a much influence in the planning and implementing of the projects. Sometimes the self-interest of the donors, or the implementing firms, seems to have become more important than the needs of the recipients. Two examples illustrate this point. The Italian-supported agricultural mechanization project has already benefited the Italian companies who have supplied the Italian ox plows, small tractors and consultancy services. There seems little optimism among project staff or MoA officers that this equipment will greatly benefit the smallholder farmers in whose name the "aid" is being given. Similarly, the Dutch firm of Rumptstad has already gained from the sale of its plow components (all models) and the provision of consultancy services. In contrast, its partner firm, Lenco, has gained little, so far, from the project. It first had problems shifting the first, slow-moving consignment of heavy plows and then resorted to selling the second consignment of plows at below cost price. The farmers, in whose name the money was ultimately spent, have, so far, gained very little. Both projects are on-going, and may eventually prove to be valuable for all concerned. Nevertheless, both projects have been based on the use of equipment manufactured in the donor country, rather than from an entirely objective assessment of the local needs of Zambian farmers.

Although all donors and GRZ talk of the importance of counterparts, there seem to be several examples of expatriate specialists in animal traction working alone. This wastes a major training opportunity, and greatly reduces the long-term value of the technical assistance. Two examples illustrate this point. A full-time counterpart has only recently been assigned to the expatriate national Animal Draft Power Coordinator. The Rumptstad engineer working at Lenco still does not have a direct counterpart with whom to work as he establishes the ox plow production facility.

It seems difficult for either side to justify such lack of counterparts. If expatriates are really experts, then it would seem sensible for them to have Zambian counterparts to work closely with them and learn from them. If the expatriates are not really experts, then their duties could probably be performed by Zambians anyway. In either case, Zambian nationals would appear necessary. In some cases assigned counterparts are absent due to overseas training. In such circumstances, the benefits of the technical assistance can be maximised if another person is assigned to receive the on-the-job training within Zambia.

There is much evidence that animal traction programmes need a long period to achieve results. One reason is that it takes several years for the expatriate and national experts to see through their original preconceptions to the real problems facing the farmers. The Intermediate Technology Development Group assistance to Magoye in the 1970s terminated after just four years, before the lessons learned from the initial mistakes could be start being applied. Two successful programmes, the GTZ-supported IADP in the North West and the Msekhocika Project required several years of trial and error before they arrived at suitable ox cart designs. Had they both been terminated after four years, they too would only have had

the failures to show. By continuing for over seven years, and learning from their early experiences, they have gone on to promote suitable ox carts in their respective zones. However a long time scale by itself is not a panacea: it needs to be combined with willingness to learn from experiences. The long-term SIDA-supported Katopola project in the Eastern Province still continues to promote the construction of wooden-wheeled ox carts. This is despite that fact that it has been apparent to everyone during the past five years, that these carts have not been accepted by farmers, and few, if any, are in use. Clearly long-term animal traction projects have to be responsive to farmer feedback.

This previous example illustrates another problem with some animal traction projects: they can become the slaves, rather than the masters, of their own planning matrices. The Katopola project was intended to promote "appropriate technology" wooden implements and carts. When these were found to be inappropriate, those involved did not seem to have had the vision to modify their work plans, and let their programme evolve into more viable areas. The successful NWIADP seems also to have been unnecessarily restricted its planning matrix. When its initial ox cart targets were met, the project stopped supporting the ox cart programme. This was despite the fact that farmers did not believe that the ox cart market was saturated.

Some donor-assisted projects have been insensitive in the way they have concentrated resources within provinces. MoA staff within the North Western and Copperbelt provinces made particular reference to this. While it has been quite legitimate to concentrate project activities within specific target-areas, it would have been quite possible to have done this without making staff in the provincial agricultural offices feel neglected. Small levels of support and training for provincial staff would have assisted long-term institution building, and need not have detracted from the districts of concentration.

Training and education

Animal traction has only recently become an important element of agricultural education and training. Consequently relatively few staff of the ministry and projects have had training in this field. Few graduates have skills in animal handling, plowing or plow adjustment and consequently they tend to lack confidence in these areas. Many extension workers also lack animal traction skills.

The University of Zambia does not have draft animals on its farm. Its teaching staff would be willing to improve coverage of animal traction, but with limited time available, something else would have to suffer. In any case the staff feel over-loaded, due to staff shortages, and they lack suitable texts.

The Natural Resources Development College (NRDC) of the Ministry of Agriculture has been, and still is, orientated towards tractor-based agriculture. The irony of this has not been too obvious, as the college is located in high-technology environment of Lusaka. The College's "commercial" farm uses tractor cultivation entirely, but a pair of oxen are to be found on the training farm. Some attempt has been made to improve the situation, with staff trained in animal traction in Zimbabwe. Nevertheless the staff acknowledge that the curriculum needs updating and more emphasis put on animal traction operations and implements. Lack of suitable text books was cited as a constraint.

The Zambia Colleges of Agriculture at Mpika and Monze, situated in a rural areas, have updated their curricula, and placed more emphasis on animal traction. The colleges lack text books, but their students are able to train and use draft animals themselves.

Some of the past shortcomings in training will be corrected by the Palabana Animal Draft Training Centre. This has been established to improve the training of MoA and project extension workers. Different courses will cater for various levels of staff, whether they have certificates, diplomas or degrees. All will emphasize practical issues, but attention is also being given to theory and socioeconomic aspects of animal traction. Training materials are being developed, and these may well assist the other training institutions fill their present gap.

Research and documentation

Most recent research relating to animal traction has involved either the testing and development of implements or assessing the impact of animal traction on farming communities. Very few research findings have been published. The Regional Research Station at Magoye has been undertaking on-station and on-farm implement testing, with some replicated on-station trials. Several organizations have worked on ox carts, emphasizing practical development rather than open-ended, questioning research. Socioeconomic studies concerning animal traction have been sponsored by projects in the Northern, Northwestern and Western provinces.

It has been noted that many reports have been produced that relate to animal traction in Zambia. A list of many of these references is provided as part of this report. Many documents cited are thick and verbose and lack clear and concise summaries. This makes them difficult to read, and expensive to reproduce and distribute. As a result the lessons contained within them are seldom passed on to col-

leagues and successors within the same projects, nor to other projects and organizations.

As few of the documents that are produced are widely circulated, there is little cross-referencing of publications. Few documents, whether research reports, progress reports or evaluations, contain any rigorous reviews of the available literature, whether national or international.

Few reports relating to animal traction in Zambia have been published internationally. This is regrettable, for international publications are likely to boost the confidence and standing of the authors. They also allow Zambia's experiences to be shared elsewhere, and may appear as attractive documents that are easily disseminated within the country.

There is no obvious library where someone starting work on an animal traction programme could go to learn of what has taken place before in Zambia, and what is the experience of neighbouring countries. The most comprehensive collection of documents is held in the office of the National Animal Draft Power Coordinator, in the Ministry of Agriculture in Lusaka. These documents are presently stored in various archive boxes. They could be listed, classified and more attractively presented within the Agricultural Engineering Section. Alternatively the documents (or photocopies of them) could be passed on to Palabana, to become the basis of a national collection of animal traction documents. Palabana, as a national training centre, seems a more appropriate home than Magoye. It will have many people interested in animal traction visiting it, and it is relatively accessible to students of the University or NRDC who may wish to undertake projects in this field.

Attitudes

Appropriate technology

In the 1960s and 1970s, in Zambia and elsewhere, animal traction was often considered as an outmoded and undesirable technology, that was inferior to tractorization. Such attitudes still exist in some African countries and among some donor agencies, and it would be surprising if they were not present in sections of Zambian society. Nevertheless, from the discussions held by the review mission, it seems that few, if any, people concerned with agricultural development in Zambia hold such negative attitudes. Animal traction now seems widely perceived to be an appropriate technology. The fact that some large-scale commercial farmers owning tractors are also using animal power, illustrates the view that work animals and motorized power sources can be complementary.

Narrow project vision

Throughout the country, there is a tendency for the staff of the Ministry of Agriculture and externally-assisted development projects to limit their horizons. In their presentations of the current situation, staff frequently considered only those farmers who had received official assistance. For example, in several provinces, data were provided for the numbers of draft animals and/or ox carts in use. It was often implied (and genuinely believed) that these figures referred to the whole province or selected districts, whereas in fact they related only to official extension activities. Official project figures therefore tend to underestimate the numbers of draft animals and minimize the overall growth in the use of work oxen. Often farmers have been obtaining and training animals privately, and purchasing their own plows and carts. In a similar way, project staff have tended to highlight the problems that projects have had in obtaining animals. They not always noticed that some farmers have been able to obtain animals themselves, without project assistance.

In a few cases, the review mission felt that the "constraints" noted by Ministry staff came more from past theoretical training than from close liaison with farmers. For example, some ministry staff suggested that lack of commercially-available cattle feeds and the lack of "improved" bulls were constraining the introduction of animal traction. There appeared to be no evidence that such inputs were actually required, or would be affordable or effective.

Public sector solutions

Although it appears that both aid agencies and the Zambian government (GRZ) wish to avoid further expansion of public sector, many ministry and project staff proposed public sector solutions to overcome constraints. For example, it was commonly proposed that public sector or parastatal agencies should be responsible for breeding draft animals: only in a few cases was the possibility of developing private multiplication herds mentioned.

Farmer innovation

While ministry staff have tended to emphasize extension-led innovations, there is much evidence of changes introduced by farmers. Perhaps the most obvious is the use of cows for work. The use of female animals for work is seldom, if ever, mentioned in ministry or project reports, and most ministry staff contacted thought it would be unwise, possibly even illegal. Nevertheless there is no doubt that Zambian farmers are using cows for work. Many teams watched by the review mission included one female animal. While such passing observations may not be used to estimate the proportion of cows

currently being worked, they do illustrate that the practice is more widespread than had been previously reported.

The spread of animal traction to new areas has sometimes been due to farmer innovation, rather than project initiative. In several places, farmers reported that the first person to use animal traction in the locality had been an immigrant from another province, or another country. For example, it was stated that farmers moving from the southern province, and from Zimbabwe, had brought knowledge of animal traction into specific areas in the north of the country. This is substantiated by the results of one survey from in the Copperbelt province: it was found that a high proportion of the ox-using farmers were immigrants from other areas.

Effect of 1985 investment plan

The 1985 ADP investment plan recommended that the use of animal traction in the country be encouraged, and proposed various investment strategies and provincial work programmes to achieve this. The investment plan considered that its proposed activities would directly benefit an estimated 14,240 farmers who would progress from hoes to plows. It was suggested that this would lead to an increase in area cultivated on 12,650 ha. This may have been achieved, but it is very difficult to verify this.

Unfortunately, the 1985 investment plan was not accompanied by reliable baseline surveys that would have provided a scale by which progress could have been measured. On an anecdotal basis, however, it is widely believed by farmers and by staff of the Ministry of Agriculture and development programmes that animal traction has increased in the last five years. While it seems extremely likely that the various provincial programmes have played important roles in the expansion of animal traction, it would be incorrect to ascribe conclusive cause and effect relations. The developments observed might have occurred anyway. Even in those districts and provinces with few formal ADP programmes, animal traction appears to have been increasing through the efforts of the farmers themselves.

It is noteworthy that all the persons contacted by this mission were positive about animal traction and its prospects. This cannot be dismissed as mere politeness. Many people had specific ideas and action plans they wished to discuss. Such a widespread positive attitude was not present in Zambia in the 1960s and 1970s, and even today it is quite rare to find this in sub-Saharan Africa. Again it is impossible to ascribe cause and effect. (Is the present favourable public opinion the result of the activities of the investment plan? Might it not be that the investment plan itself derived from an existing groundswell of positive animal traction interest?). Nevertheless the investment plan period did end on a high plane of public support and optimism for the animal traction technology. This must be viewed as very encouraging for those planning, implementing and funding the various animal traction programmes.

Figure 19. Farmer plowing with three oxen and one cow (back left) in Central Province. The use of cows for work seems to be a recent, farmer-led innovation.

Conclusions and recommendations

Status of animal traction

There has never been a detailed survey of animal traction in Zambia, and all data and statistics quoted in this report must be treated with caution. However there does seem to be good agreement between the results of the 1990 questionnaire survey, the data in the reports and literature reviewed, the comments of farmers, the experiences of extension workers and project staff and the field observations of the authors. This consensus allows the authors to feel confident about their presentation of the general picture of animal traction in the country.

Animal traction is extremely important in Zambia. In some areas, notably in the south and the west, the great majority (perhaps 90%) of smallholder farmers uses animal traction. In such areas animal traction seems quite stable. There seems no evidence, during the past five years, of any significant move away from animal traction to either tractors or hand cultivation. On the other hand, there are reports of yet further adoption even within regions of widespread animal traction use. In regions of high animal traction adoption, the actual number of work animals may be locally increasing or decreasing as cattle numbers expand (through long-term multiplication) and contract (through short-term disease outbreaks). Work animals are mainly used for plowing. There is a slow increase in the number of ox carts employed, but little diversification into other operations.

In most other regions of the country, animal traction is clearly increasing. In much of the north, and in some tsetse infested areas, it is still at a very low level. In these areas, animal traction may seem unimportant, if considered purely in terms of the numbers of farmers using this technology. Nevertheless, animal traction is growing in importance and is bringing social and economic benefits to adopters (notably through transport and by increasing production through area expansion). No one seems to doubt that this trend will continue in the foreseeable future. Animal traction is therefore expected to increase in Zambia in the coming years.

Recent changes

Changes in animal traction are occurring as a result of both farmer innovations and project interventions. There has been a tendency for MoA staff to consider only the project activities. The migration of farmers and technologies within the country and between countries is also important. Farmers from the southern province are bringing animal traction into central and northern regions, and farmers are bringing in ideas and technologies from bordering countries, notably Zimbabwe, Malawi and Tanzania. Examples of farmer innovations are the employment of female work animals and the use of breastband harnesses from Zimbabwe for donkeys.

In several provinces and districts, projects have accelerated the adoption of animal traction for both cultivation and transport. In the Northern province, one project has introduced animal traction for rice cultivation. Other examples of diversified uses of animal power are quite small and local.

The human resource base for animal traction is being strengthened. In the past few years, many Zambians have received practical and theoretical training relating to animal traction, that was not readily available in the previous decade. Some extensionists have been trained in Zimbabwe, and others at Palabana and Mpika. Local training for extension workers and farmers has been arranged in several provinces and districts. There is still much room for improvement, but there appears to be a definite positive trend within the country of increasing knowledge and understanding concerning animal traction.

Animal traction is widely perceived as a valuable technology that is well-suited to the economic and ecological conditions of Zambia. It seems that the "image" of animal traction within the Ministry of Agriculture, development organizations and the rural areas has improved in recent years.

General constraints

The biggest constraints to animal traction are general economic problems rather than technical ones. If farmers were able to market their produce easily, they might invest more in animal traction. With assured payments for their crops, farmers would be more prepared to take up loans to purchase animals and implements. With funds from sales, they would be more able to support private-sector solutions to the various input constraints and technical problems (including supply of animals, new implements, spare parts, drugs and training services). **The development of an efficient and reliable system for purchasing farmers' maize, at a fair price, would probably be the most effective means of boosting animal traction in the country**. Until this is achieved, programmes promoting animal traction will continue to be seriously constrained by the fi-

nancial problems of the farmers operating in farming systems of marginal profitability.

Throughout the world, farmers require credit to allow them to invest in inputs and new technologies. Zambia is no exception, and there are many examples of animal traction adoption in Zambia being dependent on credit. In most cases repayment rates for animal traction loans have been good, indicating that the technology is profitable, provided that there is credit to "prime the pump". Nevertheless the present high interest rates will deter farmers from investing in animal traction (or other technologies), particularly when marketing arrangements are uncertain.

The present high inflation will also discourage farmers from investing in animal traction, as increases in crop prices will tend to lag behind the increases in the inputs. High inflation will also rapidly erode the budgets and revolving funds of organizations currently trying to assist the development of animal traction.

Implements

Although much has been said about plow design in Zambia, farmer statements and experimental trials suggest that actual make and design do not appear to be very critical (provided they are not too weak and not too heavy). Farmers seem prepared to tolerate imperfections and design faults, provided the plows are available and affordable.

Poor designs and poor manufacturing will only be improved if farmers have a genuine and sustained choice. If farmers are to be offered choices, cooperatives and projects will have to change their present "top-down", central-planning attitudes.

Farmers do not seem to mind whether their plows are locally-manufactured or imported, provided they are affordable and spare parts are available. In the past, about one half of the plows in Zambia have come from factories in Bulawayo, Zimbabwe. The Zimbabwean plows appear popular, inexpensive and of good quality. While manufacturers in Zambia should be encouraged to meet a greater proportion of local demand, they should do so in the context of free-market competition from other manufacturers in the region. Genuine and fair competition within the region should provide farmers with real choice, and force all manufacturers to pay attention to farmer preferences in price, design and quality.

The use of ridgers and weeders is low in most districts. It is not clear whether the diffusion of these is constrained by implement design, implement marketing, or lack of appropriate and profitable systems of utilization. Studies being undertaken by the Magoye ADP-RDP may provide some answers. These trials could well be combined with a detailed on-farm study and analysis of the ways in which these implements are now being employed. Farmer feedback could also be gained from plowing competitions involving "weeding competitions".

Many animal-drawn implements are in need of repairs and spare parts. In most provinces spare parts are difficult to obtain in the rural areas. Schemes to train and equip blacksmiths have improved the situation in some districts, notably in the Eastern Province. The supply of suitable steel is one constraint to blacksmiths, that can be temporarily alleviated by project interventions. The establishment of viable, long-term mechanisms for providing training, credit and inputs for blacksmith groups should indirectly help the farmers using work animals.

Animals

In most parts of Zambia, cattle perform several productive, economic and social functions. Animal traction is just one of these, and few work animals are maintained purely for work. Staff of animal traction programmes should be aware of this, and realise that farmers' strategies may be highly rational, even if they do not seem to maximise animal traction productivity and profit.

Nationally there is no shortage of oxen, and in many provinces, supplies are sufficient for the present demand. In the long term, local supply problems can be solved by the establishment of small farmer-owned breeding herds. In the short and medium term some redistribution of animals will be necessary. In the medium term, sustainable private-sector solutions with traders or ranchers are to be preferred to public-sector cattle breeding initiatives. In the short-term the use of project-supported holding grounds, to allow bulk purchases of cattle, seems justified in some areas of introduction. For the foreseeable future, smallholder farmers are likely to find indigenous breeds of cattle highly appropriate for animal traction.

Although most work animals are oxen (castrated males), cows and heifers are also being used for work. This may be a new trend as the Zambian literature contains little reference to female work animals. The use of work cows is likely to increase. There is no reason to discourage this trend. Some agriculturalists may be concerned that this will lead to a decrease in fertility and milk production of existing cows. However, even at low rates of fertility, work cows will always give more calves and milk than oxen ever could!

The use of donkeys is also likely to increase, but numbers are now very low, and almost insignificant from a national perspective. The potential development and expansion of donkey power seem to jus-

tify some project support. In particular there is need to make available some simple donkey harnessing systems as an alternative to the present yokes.

The risks of disease in work animals are comparable to those of other cattle. The importance of disease risk, however, is greater, for farmers risk losing not only the capital value of the animal, but also the income-generating work potential. The risk of corridor disease appears to be a new, important problem, that may discourage farmers from investing in work animals. To protect newly-adopting farmers, animal insurance premiums can be built into loan packages (although such schemes can be expensive to administer). To protect the animals, a clear and determined policy is needed on tick control procedures. In several threatened areas, smallholder farmers are not yet convinced that dipping is cost-effective. It should not be beyond the combined imagination and resources of the veterinary department and the smallholder farmers to devise and implement tick-control systems that are economically and socially acceptable to all parties.

Animal nutrition does not appear to be a crucial limiting factor to animal traction in Zambia. Forage availability can be a local problem in areas of high stocking density in the south, in areas of high cropping intensity in the east and in heavily forested areas in the north. In such cases, the cheapest and easiest solution would be to improve the stocking and storage of crop residues, including maize stover and groundnut hay. Such storage is likely to be practised only if ox-drawn carts are available.

Data and statistics should be maintained on the numbers of work oxen in use in the country. The cattle census classification "oxen and tollies" should be replaced by two classes: "Trained oxen" and "Untrained steers". The possibility of including a new category (or sub-category) for working cows should be considered.

In areas where there is a demand for draft animals but few cattle available, the establishment of smallholder breeding herds should be encouraged. Cattle supplied for work purposes should not be sold to farmers below their market value for meat.

Animal-drawn transport

Evidence from several provinces of Zambia shows that animal-drawn transport has many economic and social advantages for farmers, and for the local, provincial and national economies. The valuable role that ox carts can play in maize marketing has only recently been exploited, and then only in some provinces. Animal-drawn carts can lead to agricultural and socioeconomic "synergy", with transport availability creating many new opportunities. The adoption of ox carts can stimulate agricultural production by allowing crops to be marketed, crop residues to be stored and manures to be applied. The hire of ox-drawn transport may be more profitable than the farming itself. It appears easier to develop and sustain the employment of ox carts once several are installed in a locality. Such a "critical mass" leads to specialization in puncture repairs and, as more carts are owned, more uses of animal-drawn transport are developed.

Animal-drawn transport is currently underdeveloped in Zambia, compared with many other developing countries. Large numbers of cheap and simple animal-drawn sledges are employed, but these are only efficient when small quantities of goods are transported. One reason for the low number of ox carts in use, may have been the past emphasis by projects on "appropriate technology" carts. These were ideologically impeccable, but technologically inappropriate. The wooden-wheeled carts of TDAU, Katopola, Kasisi and NWIADP have had little real impact, and are not being copied by private sector workshops.

Pneumatic tyres are the preferred choice for most farmers. The profitability of ox carts is such that puncture problems can usually be overcome, particularly once a "critical mass" of farmers has adopted the technology, and local repair services have become established.

Roller bearings for ox carts seem both durable and affordable. The axles of scrapped cars and pick-ups can form the basis for suitable carts, but their numbers are insufficient to meet the demand. There is therefore a need in Zambia for another source of strong and long-lasting cart axles of good quality. The well-meaning SKF initiative has tried to achieve this, but has yet to succeed. The axles imported by Lenco, NWIADP and Msekhoicika seem better, and have been used to produce durable carts. Further importations of such axles (or their local production), with compatible rims and tyres, seems fully justified.

Once the axles and wheels are available, cart bodies can be produced in provincial and district workshops. For convenience, several projects would be prepared to purchase basic cart frames in kit form, for local workshops to assemble and fit with planks.

Extension strategies

While it is recognised that there are many differences in animal traction between, and within, the various provinces and districts in Zambia, for the planning of extension strategies, a clear distinction can be made between areas where animal traction is

already widely used and areas where animal traction is still an innovative technology.

In areas where draft animals are little used at present, animal traction technology is slowly diffusing, due largely to the migration of farmers from other areas. In these areas of new adoption, there is evidence that Ministry of Agriculture programmes and donor-assisted projects have had some impact. The existing basic extension messages do seem to be required and have been proven to be effective (for example, how to train animals and how to use implements). The combination of extension work (farmer training), provision of inputs and the availability of credit has certainly led to farmers adopting animal traction technologies in recent years. The training of farmers and animals within villages by specialised extension workers appears to have been effective. Ministry experience in several provinces suggests that such basic training is a relatively short-term need in any one area: once animal traction has become firmly established farmers cease to require basic training. However, animal traction farmers continue to require infrastructural services (credit, supply of inputs and marketing of outputs).

In areas where animal traction is already well-established, there have been very few changes in animal traction technology that can be attributed to recent activities of the Ministry of Agriculture and its associated projects. Most farmers in the country use the same type of plow (Safim /Zimplow /Northland type, usually without a regulator) as they did five, ten and twenty years ago. Secondary tillage implements are still quite rare, and are of the same designs used twenty years ago. Ox carts are still uncommon, and most are made from scrap axles, as they were twenty years ago.

Some development projects and MoA extension agents have been advocating that farmers in areas where animal traction is well-known should adopt “improved” animal traction technology, including “improved” plow designs, “correct” plow regulation, better training of animals and use of carved yokes. There is, however, little evidence to suggest that farmers are actually adopting the “improved” techniques being advocated. This lack of adoption suggests that these “improvements” are not significantly better than the present techniques. Perhaps they are not considered by farmers to be very important because they are not addressing the key problems limiting the production, profitability or well-being of the farmers.

From the lack of changes in animal traction technology, it appears that the research, development, training and extension services presently seem to have little “adoptable” advice to offer farmers already familiar with animal traction. Until the extension services have some clear extension messages that farmers will definitely accept, it would seem that priority should be given to programmes that improve infrastructural support to farmers who are confident with animal traction technology. Such support might include facilitating the supply of inputs known to be needed, like well-proven implements and spares, ox carts, credit and, in some areas, animals. By preference these should all be supplied through the private sector, but there is likely to be an important catalytic role for public-sector organizations, including donor-assisted projects.

It seems sensible that farmer extension and training in animal traction should be concentrated in those areas of possible new adoption with most chance of success. These will normally be areas of high agricultural potential where draft animals are presently little used. Success is likely to be highest in areas with good infrastructure and easy access to markets for farm produce. Area-specific projects, assisted by appropriate donors, could well assist animal traction introduction through extension programmes (enhancing the mobility of extension workers) and by facilitating the provision of critical inputs and/or credit.

There is evidence that some projects, institutions, ministry officials and extension workers have tended to be overconfident with their animal traction advice, placing too much trust in new technology and too little trust in the farmers' judgement. Naturally, extension advice will only be adopted if it is economically, socially and technically appropriate. New designs of plows, yokes and carts will not be adopted unless they are actually better or cheaper than existing ones. Sometimes the technology promoted by organizations in Zambia has proved inferior.

One means of overcoming this problem is for farmers to be informed of various choices, rather than to receive heavy promotion of one technological option. Such options could well be presented at plowing competitions, where different plows, carts, yokes and training systems could be shown along side each other. An implement, cart or harnessing system that is affordable, and can be seen working well in the hands of another farmer, may well be adopted. Similarly farmers might be able to see that one farmer using a pair of well-trained animals can sometimes achieve the same output as three people working with a span of four. Extension workers themselves may become less dogmatic if they see that a farmer using “poor” yokes, training systems and implements can sometimes achieve as much as those using “improved” techniques.

It seems that animal traction is subject to the principle of "critical mass", and research, extension and training programmes should try to work in this direction. Animal traction and the relevant support services are quite difficult to maintain at low levels of adoption, but can become self-sustaining once it becomes common place. Thus it may be more rewarding and sustainable to strive to achieve (say) a 20% adoption rate in one area, rather than 5% adoption rates in four different areas.

Adaptive research

Research, development and extension services should try to identify means of improving animal traction utilization in areas where farmers are already familiar with draft animals. This could be achieved through one or more open-minded, farmer-orientated, multidisciplinary programmes which would aim to build on existing knowledge and experience to accelerate the evolution of ADP in Zambia.

Within pilot adaptive research/extension programmes, farmers familiar with draft animals could be facilitated to try out and assess alternative animal traction systems, such as weeding with ridgers or tine tillage techniques. To avoid wasted efforts, the techniques being assessed should all have proven to be acceptable and profitable to farmers in comparable circumstances elsewhere, preferably within Eastern and Southern Africa. Such programmes should make particular efforts to avoid preconceptions of the superiority of particular technologies. Their work should be highly orientated to the specific goal of obtaining new technical extension packages, proven by farmer adoption.

Projects

Donor-assisted development projects have played a key role in promoting animal traction, and they are likely to be important in the coming years. Not all have been very successful: some have been too short, some have been dominated by expatriates and some have resolutely promoted technologies that farmers did not consider appropriate.

Donor-assisted animal traction programmes must be prepared to operate for many years. They must be constantly responsive to farmer feedback, and continually reassess their plans of operation. They should be very careful to ensure that the smallholder farmers are the main beneficiaries of project funds, and not merely the nationals of the donor country. Expatriate "experts" should work closely with Zambian counterparts and provide on-the-job professional training. If a designated Zambian counterpart is sent for overseas training, another person should be assigned to work with the expatriate to maximise the value of the technical cooperation arrangement.

Training and publications

There is a shortage of suitable training materials relating to animal traction, and the development of these (as planned by Palabana) continues to be a priority.

An attractive animal traction documentation centre should be established. Important documents and reports should be reproduced and made available to key institutions, such as Magoye and Palabana.

Projects engaged in animal traction should try to improve the standard of their publications. All new animal traction reports and documents should include concise summaries. An annotated list of animal traction research studies and evaluation reports that have been carried out in the country should be prepared and circulated to all relevant organizations. Those containing particularly important lessons should be reproduced and circulated, and possibly summarized in international publications.