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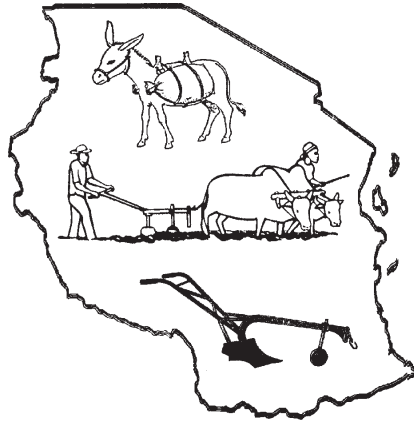
Animal traction in Tanzania: experience, trends and priorities



by

Paul Starkey and Wilson Mutagubya

United Republic of Tanzania
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Cover picture

*Women working with a team of oxen
and cows to make ridges in Tarime District.*

Photo: Paul Starkey ©

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Contents

Summary	3
Preface and acknowledgements	5
Abbreviations and acronyms	6
Background and context	7
Animal traction benefits	7
Regional trends	7
Institutional context	7
Animals employed	7
Gender issues	7
Draft animals in Tanzania.	8
Historical perspective	8
Present status of animal traction.	8
Numerical estimates: oxen and donkeys, 8; Horses and buffaloes, 9	
Distribution, 9; Relative importance, 11, Systems of use of animal power, 11	
Areas of widespread use, 11, Areas of introduction, 12, Areas of no use	
12	
Major tsetse zones, 12; Socio-economic constraints, 13; Topography, disease, rainfall, 13	
Benefits of animal power.	13
Area expansion and yield increase, 13; Timeliness and risk reduction, 13	
Drudgery reduction, 13; Transport, 14; Gender and age implications, 14	
Existing institutional framework	14
Introduction, 14; Ministry of Industry and Trade, 15	
NATSC, 15; ATNESA, 16	
Key issues	17
Low farm incomes	17
Animals.	17
Management and feeding, 17; Animal health, 18; Trypanosomiasis, 18	
Tick-borne diseases, 18; Other diseases, 18; Animal quality and quantity, 18	
Animal supply, 19; Use of cows, 19; Risk and theft, 19; Use of donkeys, 19	
Implements	20
Transport	20
Human and animal transport options, 20; Pack animals, 20; Sledges, 20, Carts, 21	
Shinyanga carts, 21; CAMARTEC carts, 21; Four-wheel carts, 21; Cart brakes, 21	
Institutions.	22
Research reports and literature, 22; Implement research and development, 22	
Development strategies	23
Some general issues	23
Rural development and market access, 23; Tractorization, 23	
Subsidies and realistic pricing, 23	
Extension and research	24
Prioritization and targeting, 24; Areas of animal traction use, 24	
Weeding technology, 24; Networking approach, 24	
Seeding and harrowing technology, 25; Rice cultivation, 25	
Conservation tillage, 25; Donkey harnesses, 25; Donkey implements, 26	
Further introduction of animal traction	26
Carts and transport	26
Implement manufacture and supply	27
Implement distribution	28
Implement testing and development	28
Professional training	29
Training institutions, 29; Upgrading extension staff, 29; Farmer training and the OTCs, 30	
Credit	30

Blacksmith support/training	31
National network and coordination	31
International network/coordination	32
Animal traction directory: Tanzania	33
Introduction	33
Ministry of Agriculture	33
Ministry of Industries and Trade	34
Ministry of Tourism, Wildlife and Forestry	35
Ministry of Education	35
Donor-assisted projects	36
Non-governmental organizations	38
Marketing and financial organizations	38
Private sector organizations	38
Aid agencies	39
References and bibliography	40
Persons contacted	45
Colour illustrations 1	49
Colour illustration 2	51

Summary

Animal traction is an appropriate, affordable and sustainable technology that is increasingly used throughout Eastern and Southern Africa. Although the technology tends to be dominated by men, the benefits extend to women and children. Women are increasingly becoming actively involved in the use and management of draft animals. Animal traction reduces human drudgery and allows increased production through area expansion and improved timeliness. The social, economic and production benefits of animal power are greatly increased if animals are used for transport.

About one million draft oxen from the national herd of 12 million East African Zebu cattle are employed in Tanzania. They are mainly used for plowing in the cultivation of maize, sorghum, rice and cotton. They plow about 20% of the cultivated land area. Animals are often worked in teams of four, but single pairs and teams of six animals are also common.

The main implements are single mouldboard plows. About 300,000 plows manufactured in local factories are in use, and annual demand is said to be about 35,000. The numbers of harrows, planters, ridgers and weeders in use are small, and have increased little in recent years. This is partly due to lack of availability of suitable designs.

Most of the 250,000 donkeys are employed as pack animals, but they are increasingly used to pull carts and cultivation implements. One project has been evaluating a few water buffaloes as draft animals, but these are unlikely to have an impact on smallholder agriculture in the foreseeable future. The 3000 horses are mainly retained for recreation and personal transport.

Animal traction is increasing in most parts of the country. It would increase faster if farm incomes and crop marketing systems were improved.

Animal power is complementary to tractor power. In most smallholder systems animal traction will prove the more appropriate option unless the situation is distorted by government/donor subsidies to tractors. Genuine free-market competition should be allowed between human power, tractor power and animal traction.

The main area of animal traction use is the cotton belt of Arusha, Mara, Mwanza, Shinyanga, Tabora and Singida which accounts for three quarters of Tanzania's work oxen. In some areas over 90% of farmers use work animals. The costs and benefits are

often shared through traditional systems of hire and reciprocal benefits. Other regions with important concentrations of work animals are Rukwa, Mbeya, Iringa and Dodoma. Animal traction is spreading in all these regions, due mainly to farmer migration and farmer-to-farmer contacts.

In several areas where animal traction is little used, it is being slowly but successfully introduced by the extension efforts of donor-assisted projects. Although the prospects for animal traction are limited in some areas by lack of cattle (due to trypanosomiasis), it is suggested that animal traction will slowly spread even in these areas, as this is the trend seen throughout the region.

Traditional sledges made from forked branches are widely employed and the use of animals for cart transport has been increasing. The animal-drawn transport sector in Tanzania is underdeveloped and has much scope for expansion. Animal-drawn carts have been shown to have several important agricultural, social and economic functions: they reduce drudgery, increase productive time, facilitate marketing, stimulate trade, enable storage of animal feeds and improve manure use and nutrient cycling. Existing animal-drawn carts range from impressive and innovative artisan-produced carts to institution-produced carts of inappropriate technology. Carts made with roller bearings seem most suitable. The spread of carts is limited by the supply and price of good axle units. Local artisanal manufacture would be stimulated by increasing the regional availability of appropriate axles and/or components. The provision of credit for carts would stimulate the market, and would be justified by the wide-ranging economic and social benefits.

An objective programme of on-station and on-farm testing of existing designs of carts and axles would prove valuable. The results should be published and circulated. A small project could be established to undertake this, under the professional guidance of the Animal Traction Network Tanzania (ATNET) and the national animal traction steering committee.

Animal traction in Tanzania is being influenced by organizations and parastatals from four government ministries, several donor-assisted projects, some non-governmental organizations and a few private sector companies. Unlike several other African countries, crop marketing organizations and financial institutions are not actively involved in supporting

animal traction. At the end of this report, information is provided on some 40 organizations working with animal traction in Tanzania. Bibliographic references are given for 140 relevant documents and publications.

Several different parastatal organizations are involved in designing, developing and manufacturing animal traction equipment. Deficiencies in these organizations have long been apparent, and the designs, quality, supply and distribution of animal-drawn implements remain poor. The opening up of the market to imports and competition should improve matters. It might be useful if the present manufacturers were privatized through partnership with other manufacturers in the region. All animal traction equipment should be sold at fair market prices.

In order to rapidly overcome the existing design problems, particularly of weeders, an intensive, programme of collaborative on-farm testing is proposed. A networking methodology is recommended, as this would combine the experiences of several different organizations within Tanzania with expertise and experience elsewhere in the region. It is proposed that Tanzania hosts a farmer-orientated, regional workshop on animal-drawn weeding technology to set the process in motion.

There are several areas where a modest investment in farming systems research, development and extension (mainly building on existing experience in neighbouring countries) should result in some clear technical messages and rapid adoption. These include weeding and ridging technology, donkey harnessing and rice field levelling.

All animal traction research, development and extension programmes need to be farmer-orientated, gender sensitive, self-critical, adaptive and long-term in nature.

At present, standard extension messages are only effective in zones of introduction, where basic knowledge of animal traction is still a limiting factor. In these areas, small, donor-assisted projects have been shown to have a comparative advantage in successfully promoting animal traction. In other areas, farmers generally know more than extension

workers, and there are not yet clear, proven extension messages. These should arise from the proposed farming systems work on weeding and tillage.

There is need to improve animal traction skills, knowledge and understanding within existing training establishments. In-service training of extension workers should be conducted within the animal traction priority areas to be targeted. Appropriate training materials and extension manuals are urgently required. New publications could be prepared in collaboration with programmes in other countries in the region, in association with the Animal Traction Network for Eastern and Southern Africa (ATNESA).

The present oxen training centres (OTCs) were established at a time when top-down, station-based training was considered appropriate. Such strategies have proved inappropriate, and future training of farmers should be village-based. Suggestions are put forward for ways in which the OTC facilities could be usefully employed, but district-specific local solutions are advised.

The existing local multipurpose cattle serve several functions, and are technically and socially suitable for draft work. Although there are animal health and nutritional constraints, solutions do exist, and their adoption depends more on economic than technical factors. The gradual trend towards the use of cows to assist in seasonal tillage is likely to increase herd productivity in the long term.

Donkeys are increasingly being employed in mixed farming systems. Their use for animal-powered transport and inter-row weeding may have particular benefits for women.

The recent formation of national (ATNET) and regional (ATNESA) animal traction networks is most encouraging. These should be supported by national organizations and donor agencies as they could prove highly cost-effective in facilitating the transfer of existing knowledge and experience. To assist and complement these networks, it is suggested that a national animal traction coordination project be initiated.

Preface and acknowledgements

This report was prepared as a result of a consultancy assignment in Tanzania from 23 September to 12 October 1992, funded by the British Overseas Development Administration (ODA) through its Natural Resources Institute (NRI). The need for the mission, and its terms of reference were determined by the ODA-funded Livestock Planning Adviser (Mr. Jim Crees) working within the Ministry of Agriculture in Dar es Salaam.

The external consultant, Paul Starkey, worked with his local counterpart Wilson Mutagubya, Economist in the Planning and Marketing Department of the Ministry of Agriculture. They first spent eight days in Dar es Salaam, meeting officials of the Ministry of Agriculture, the universities, equipment manufacturers, aid agencies and others involved with animal traction. Over 120 documents relating to animal traction in Tanzania were identified and reviewed.

The external consultant attended a meeting of the National Animal Traction Steering Committee, and during this facilitated a participatory planning session relating to national animal traction strategies.

The two authors, then undertook a punishing (but rewarding) 3000 km field visit with Mr. Michael Haymassey of the Mechanization Unit and Mr. René Fischer, Project Manager of the Tanga Draft Animal Project. This took them through 11 regions (Coast, Tanga, Kilimanjaro, Arusha, Mara, Mwanza, Shinyanga, Tabora, Singida, Dodoma and Morogoro) which together account for the great majority of work animals in Tanzania. Interviews were held with about

65 people, including farmers, Ministry of Agriculture officials, development project staff, implement traders, ox cart manufacturers and others involved in animal traction.

At the end of the mission, the major observations were verbally presented to the ministry and some key findings were discussed. An interim report was then rapidly prepared for consideration by the 1992 Agriculture Sector Review team. The interim report was given a limited circulation for comments before this final report was prepared.

The report is a joint one in the sense that the issues and observations were discussed by both parties during the mission. The external consultant was fully responsible for the actual writing of the report.

The authors would like to thank all who assisted the mission and the preparation of the report. Particular thanks go to Jim Crees for arranging the mission and to René Fischer and Michael Haymassey for their valuable contributions during the field visits.

Acknowledgement is also due to all members of the National Animal Traction Steering Committee, for their stimulating ideas and suggestions during a “brainstorming” planning session. The written comments of Jim Crees, Peter Graham, Ruben Mungroop and Saidi Mkomwa on the draft report were most helpful. Sincere gratitude is also due to all the farmers, project workers and government officials who gave up their time to answer questions and air their views.

Abbreviations and acronyms

AETC	Agricultural Engineering Training Centre, Harare, Zimbabwe
AGROTEC	Agricultural Operations Technology for Smallholders in East and Southern Africa, Harare, Zimbabwe
ATNESA	Animal Traction Network for Eastern and Southern Africa
ATOL	Aangepaste Technologie Ontwikkelingslanden, Leuven, Belgium
CAMARTEC	Centre for Agricultural Mechanization and Rural Technology
CIDA	Canadian International Development Agency
COOPIBO	Coopération au Développement Ibo, Belgium (NGO)
CTA	Technical Centre for Agriculture and Rural Cooperation, The Netherlands
EC	European Community
FAO	Food and Agriculture Organization of the United Nations
FIT	Farm Implements and Tools Project, The Netherlands
FSR	Farming Systems Research
GATE	German Appropriate Technology Exchange, GTZ, Germany
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit GmbH, Germany
HIMA	Iringa Soil and Water Conservation Project
ILCA	International Livestock Centre for Africa, Ethiopia
ILO	International Labour Organization, Geneva, Switzerland
IPI	Institute of Production Innovation, University of Dar es Salaam
IT	Intermediate Technology
Kilimo	Ministry of Agriculture (Swahili).
KIT	Koninklijk Instituut voor Tropen (Royal Tropical Institute), Amsterdam, The Netherlands
MATI	Ministry of Agriculture Training Institute
MEIDA	Metal Engineering and Industrial Development Association
MIFIPRO	Mixed Farming Improvement Project, Mwanga, Kilimanjaro
MOP	Mbeya Oxenization Project
MoA	Ministry of Agriculture
NALERP	National Agriculture and Livestock Extension and Rehabilitation Programme
NATSC	National Animal Traction Steering Committee
NGO	Non-governmental organization
NRI	Natural Resources Institute
ODA	Overseas Development Administration
OTC	Oxen training centre
RALDO	Regional Agriculture and Livestock Development Officer
RDP	Rural Development Project/Programme
RUDEP	Rukwa Development Project
SAFIM	Southern African Farming Implements Manufacturers, South Africa
SIDA	Swedish International Development Agency, Sweden
SIDO	Small Industries Development Organization
SUA	Sokoine University of Agriculture, Morogoro
TAMTU	Tanganyika/Tanzania Agricultural Machinery Testing Unit
TCRS	Tanganyika Christian Refugee Service
TEMDO	Tanzania Engineering and Manufacturing Design Organization, Dar es Salaam, Tanzania
TFNC	Tanzanian Food and Nutrition Centre, Dar es Salaam, Tanzania
TIRDEP	Tanga Integrated Rural Development Project
TOOL	Technologie Overdracht OntwikkelingsLand, The Netherlands
TIRDEP	Tanga Integrated Rural Development Programme, Tanga, Tanzania
UAC	Uyole Agricultural Centre, Mbeya
UDSM	University of Dar es Salaam, Tanzania
UFI	Ubungo Farm Implements (implement factory), Dar es Salaam
UK	United Kingdom (of Great Britain and Northern Ireland)
UNDP	United Nations Development Programme, New York, USA
USAID	United States Agency for International Development, Washington DC, USA
ZZK	Zana za Kilimo (implement factory), Mbeya

Background and context

Animal traction benefits

Animal traction is an appropriate, affordable and sustainable technology that is increasingly used in Tanzania and most countries in Sub-Saharan Africa. Draft animals, notably cattle and donkeys provide smallholder farmers with vital power for cultivation and transport. Working animals complement both hand labour and motor power. In southern and eastern Africa, draft animals are mainly used for plowing and transport, and in some countries they are regularly employed for ridging, weeding and planting. They can also be used for water-raising, milling, logging, land-levelling and road construction.

Regional trends

Draft animals are being used in Southern and Eastern Africa to increase cultivated area, improve timeliness, reduce drudgery and to intensify agricultural production. Animal-drawn carts can improve the efficiency of farm management and the utilization of manures and residues. They also improve crop marketing and stimulate trade and a range of social and economic benefits. Animal traction has been shown to raise the living standards throughout rural communities, benefiting men and women, young and old.

Animal traction is increasing quite rapidly in the region as a whole. In many areas the great majority of farmers use animal power, while only a minority did so one generation ago. There are some areas where animal traction is increasing from a very low level, having only recently been introduced. Elsewhere, animal traction has yet to be used at all for various social, economic, environmental or practical reasons.

There was a period when animal traction technology was neglected by governments and aid agencies. It is now recognized as a crucial element in many farming systems, and an important area of research and development in most countries in the region. Governments, research institutions, aid agencies and

development projects are committing significant resources to draft animal power.

Institutional context

In recent years, many animal traction programmes worked alone, unaware of other similar initiatives in the same country or in neighbouring countries. This led to repetition of mistakes and the repeated “reinvention of the wheel”. During the 1960s and 1970s progress was further slowed by emphasis on on-station research and development and “top-down” extension approaches. These problems are beginning to be resolved through national and international multidisciplinary networking initiatives with farming systems approaches.

Animals employed

In most of the region cattle are the main work animals. Cattle usually have several social, economic and productive functions, and they are seldom maintained exclusively for work. Oxen are the animals of choice in most countries, but cows (females) are increasingly being used as work animals, reflecting a worldwide trend in intensifying smallholder production systems.

Donkeys are increasingly being used in the region for both transport and tillage. Although lightweight, they are easily trained and reliable. They survive well in drought conditions, and may thrive more than cattle in tsetse infested zones.

Gender issues

Animal traction in the region tends to be a male dominated technology at farm level, and also in national research, extension and training systems. Although draft animals and equipment are generally owned and controlled by men, women increasingly have access to draft animals. Women generally benefit directly or indirectly from work animals, particularly if carts are used. Carts allow certain laborious and time-consuming tasks, such as water collection, to be delegated to children and youths.

Draft animals in Tanzania

Historical perspective

Work animals have been used on the islands of Zanzibar and Pemba for generations, and traditional wooden wheels of the Asian type continue to be manufactured by artisans. Similarly, on the mainland the use of pack donkeys by pastoralists goes back many generations. The development of animal traction in Tanzania has recently been reviewed by Sosovele (1991). The early colonialists used animal power for transport, and subsequently for cultivation. Steel ox plows manufactured in Europe were introduced to local farmers in the 1920s and 1930s to encourage the production of cotton, and later of rice. During the 1950s, the large-scale colonial farmers increasingly employed tractors, but smallholder animal traction spread mainly through the cotton belt, stimulated by cotton prices and new production potential. It also spread in Mbeya and Mbozi Districts. Most of the expansion was through farmer to farmer contact, and private financing (cattle exchanged for plows).

The early post independence years, in the 1960s, led to emphasis on villagization and tractorization, and animal traction tended to be neglected. Nevertheless even during this period animal traction was gradually spreading, and received some official support. The Tanganyika Agricultural Machinery Testing Unit (TAMTU) started work on "appropriate technology" implements and the government-sponsored Ubungo Farm Implements (UFI) factory was opened in 1970. UFI started manufacturing steel plows of a design similar to those used during the colonial period. It had a capacity of 20,000 plows a year.

By the early 1980s, it was clear that tractorization was not to be a panacea for smallholders in Tanzania. Donor-assisted projects started to actively promote the use of animal traction, for example in Tanga, Iringa and Mbeya. Oxen training centres (OTCs) were established in all regions to train farmers in animal traction technology. A second plow production factory, Zana Za Kilimo, was opened at Mbeya and produced several hundred plows of an unproven, prototype design. Engineers from the Centre for Agricultural Mechanization and Rural Technology (CAMARTEC an institution derived from TAMTU and other organizations) developed various cart and implement prototype designs, although these subsequently had little adoption.

In 1984, a donor-sponsored survey suggested that plow supply was a limiting factor: the resulting donor-financed importation of 100,000 plows led UFI to stop the local manufacture of plows for about four years.

Several seminars, sponsored by donor agencies, were held between 1985 and 1991, bringing together people (mainly agricultural engineers and agromechanization officers) from different organizations. On each occasion they identified the design, supply and distribution of implements as factors limiting the use of animal traction, but there was little or no follow up to correct the problems.

In 1991, a national animal traction network was launched, to improve liaison and information exchange and influence policies. In the meantime animal traction continued to spread during the 1980s and early 1990s, mainly through farmer to farmer contact in and around the areas of widespread use.

Present status of animal traction

Numerical estimates: oxen and donkeys

Animal traction is increasing in Tanzania, and is likely to continue to increase. These are the views of all people interviewed in the preparation of this report including farmers in seven regions, agricultural officers in six regions, and staff of the Ministry of Agriculture, the Universities, training institutions and agricultural development projects. All were unanimous that there has been a major increase in the number of draft animals in the past ten years, and that this trend is likely to continue during the next ten years.

The exact extent of the increase is not known. There are no reliable estimates of the number of working animals in Tanzania at present. Quoted figures vary greatly: some figures occur in the same document as "numbers of working animals" and "numbers of pairs of working animals", so that one of these figures must be out by a factor of two, relative to the other. The 1991 National Agricultural Mechanization Programme (MoA, 1991) puts the number of draft animals from selected regions as 1.5 million (788,000 pairs quoted on page 15) and yet also gives a recent estimate of the number of oxen and donkeys as 559,000 (page 163). Most estimates are based on compiled data from the districts and regions. While these look impressive when combined into a table,

Table 1: Working animals by region in Tanzania (1984).

Region	Work oxen	Donkeys
Shinyanga	247 078	11 281
Mara	107 949	5 519
Mwanza	103 729	6051
Singida	72 480	22 759
Tabora	71 032	8 166
Arusha	67 556	107 768
Iringa	53 322	3 847
Rukwa	45 481	3 825
Mbeya	44 045	4 695
Dodoma	18 182	30 268
Kilimanjaro	3 491	6 477
Kagera	863	96
Morogoro	651	1 827
Kigoma	201	2
Tanga	172	4 244
Ruvuma	93	40
Lindi	22	2
Coast	15	383
Mtwara	10	3
Dar es Salaam	0	23
Total	836 373	217 276

Sources: MoA, 1984 and Mgaya et al, 1992

the original figures may well be very unreliable. Some regional figures are unrealistically constant for several years and some fluctuate dramatically without explanation (Mgaya, Simalenga and Hatibu, 1992).

The 1984 livestock census is considered fairly accurate by some people, and inaccurate by others. The census figures for work oxen and donkeys are shown in Table 1. These probably represent a reasonable order of magnitude estimate of the draft animals used at that time. If these estimates were correct, then the increase noted by everyone might put the present number of working cattle at about one million (this would represent a 20% increase since 1984). Given the lack of reliable data, a round figure of one million working cattle is a reasonable

guideline. Similarly, all people interviewed said that the number of donkeys in use was increasing, and so the number of donkeys may now be about a quarter of a million.

Horses and buffaloes

The 1984 livestock census estimated there were 2000 horses in the country. Most of these were used for personal riding and recreation, and not for agricultural work or cart transport. Attempts have been made to import horses, for ranch management and personal transport, but the numbers remain low, due to disease constraints. It is anticipated horses will remain insignificant from the point of view of the smallholder farming sector in the coming years.

There is one inbreeding herd of Egyptian dairy buffaloes in the country. During the past few years, a small number of surplus males have been used for work at Nyegezi Agricultural Training Institute and Usangu Irrigation Project. Although they have been shown to be capable of draft work within the context of well-managed institutional farms, mortality has been quite high (they died out at MATI Nyegezi and were not replaced). It has yet to be proved that the buffaloes are able to thrive, reproduce and work at village level.

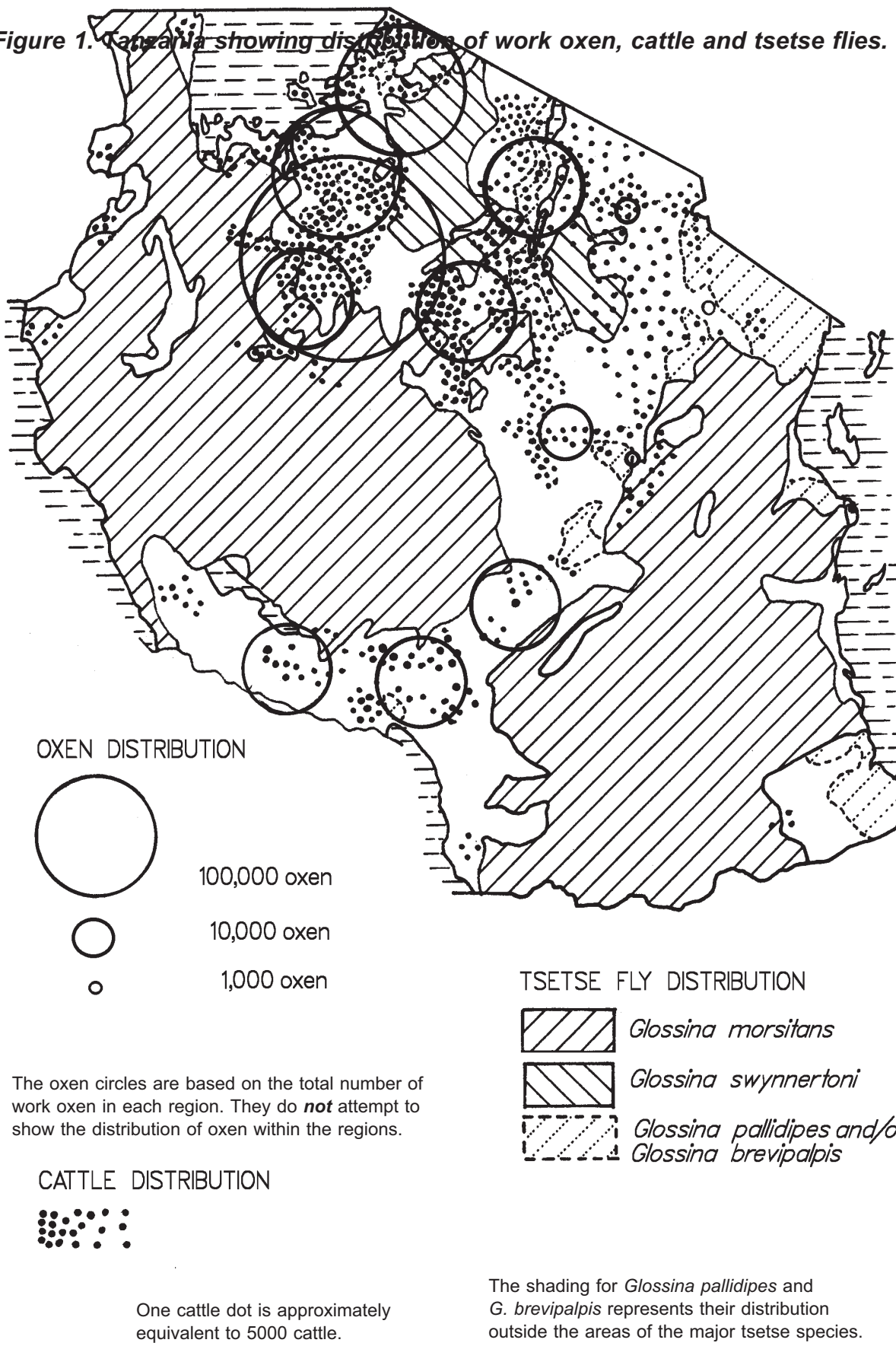
Since well-adapted local cattle can be used effectively for rice production in Tanzania, the value of promoting the exotic water buffaloes seems unclear. While buffaloes have a few advantages (large size, large feet and good tolerance of rice straw), they have also some important disadvantages (poor adaptation, high cost and high risk). National buffalo numbers are very small, and are likely to be so in the foreseeable future. Their potential for use in villages is, at best, highly questionable. While a few surplus males might be employed in a few special circumstances, such use is unlikely to be significant from the national perspective.

There have been various attempts to train zebra for work. It is technically possible, but has never proved sufficiently attractive for it to be adopted by farmers. Such minority-interest draft animals (horses, water buffaloes, zebra, etc.) are most unlikely to have any impact on smallholder farming systems in the coming decade (or more), and so will not be considered further in this report.

Distribution

An impression of the distribution of working cattle is given in Figure 1. The striking feature is the concentration of animals in the cotton belt of Mara, Mwanza and Shinyanga and the adjacent regions of Arusha, Singida, Tabora and Iringa. There is a

Figure 1. Tanzania showing distribution of work oxen, cattle and tsetse flies.



Sources: MoA, 1973 (cattle and tsetse) and MoA, 1984 (oxen numbers).

smaller concentration in the south west (Mbeya and Rukwa). The distribution reflects well the general cattle distribution, with the exception of the pastoral areas which have cattle but little crop cultivation and few work oxen. Most of the regions that have few work oxen are tsetse infested, and consequently have few cattle of any type. One region with both cattle and a favourable environment is Kilimanjaro, but here much tillage and transport is mechanized.

Relative importance

Estimates of the relative importance of hand cultivation, animal power and tractors vary greatly. Some examples are given in Table 2.

Table 2: Some estimates of proportion of cultivated land tilled by hand, animal and mechanical power in Tanzania.

Hand %	Animal %	Tractor %	Source/reference
55	28	17	Hassan (1987)
82.5	12	5.5	Lyimo (1987)
70	20	10	Urasa <i>et al</i> (1990)
80	14	6	Mrema and Hatibu (1990)
78	12.5	9.5	MoA (1991)
84	10	6	Graham (1992)
80-85	10-15	5	Mtenga (1992)

Few authors have cited their sources, or method of calculation. There are various ways of estimating the extent of animal draft power. One way is to multiply the number of teams of draft animals by the area cultivated each year per team (this is more than the area of one farm, for teams invariably cultivate for neighbours on a hire or reciprocal benefit basis). If the one million draft animals comprise about 350,000 teams and cultivate about 4 ha per team per year, the cultivated area would be about 1.4 million hectares.

According to the estimates published in the national mechanization programme, a total of 5.1 million hectares were under cereals, root crops and cash crops in 1988/89 (MoA, 1991: pp. 203-205). Combining these area estimates with the ox cultivation estimate, would give animal power cultivation about 27% of the cropped area.

Another rough estimate can be made by taking the cultivated areas of cereals and cotton grown in the main animal traction using areas (1.5 million ha in Shinyanga, Mwanza, Singida, Mara, Tabora and Mbeya). If one were to guess that 65% of this might

be cultivated by animals, the animal-cultivated area would then be about 1 million ha (the total omission of draft animals from other areas such as Iringa should compensate for some of the low utilization zones within the cited regions). This "guestimate" would lead to a figure of about 19% overall cultivation by oxen.

Unfortunately, almost none of the data and statistics on which these estimates are based are very reliable – figures for the total area under cultivation vary between documents. Furthermore, the estimates used here (eg, 4 ha per plow team per year) could be altered by 30% and still seem reasonable.

From the literature, discussions and field visits, it would seem that estimates in the order of 10% oxen cultivation probably underestimate the extent of animal draft power usage today. Estimates in excess of 15% seem much more likely, and the figure could easily now be 20%, given the increases in animal traction in the past few years. The preferred "guestimate" is therefore that of Urasa *et al* (1990): 70% hand, 20% oxen and 10% tractor. Although this almost certainly overestimates the importance of tractors, the lack of precision is clear from the round figures.

Systems of use of animal power

Areas of widespread use

Within the areas of widespread use (notably in the cotton belt of Mara, Mwanza and Shinyanga) animal traction has become a normal part of many farming systems. In some areas in Mara and Shinyanga, over 90% of farmers use draft animals for plowing. Those farmers who do not own oxen, hire or borrow them from neighbours. In one animal traction survey in Tarime (Mara), it proved impractical to compare ox users with non-users as there were too few non-users to obtain a suitable sample (Sosovele, 1991).

In areas of where animal traction is already widespread, farmers maintain that animal traction is still increasing - that more farmers use animal traction than ten years ago, and that the upward trend is likely to continue. The plowed area increases each year as more farmers adopt animal traction and new land is opened up. Not only is animal traction increasing within these existing ox user regions, the areas of use are themselves expanding, as farmers move to new areas, and the technology diffuses from farmer to farmer near the periphery of the zones. In parts of Arusha, Singida, Tabora, Iringa and Mbeya the area of dominant animal traction use is expanding each year.

Farmers generally only use one implement, a mouldboard plow, which may well be kept in service

for ten, twenty or even more years. Farmers may not know of other possible animal-drawn implements, which are anyway not generally available.

Farmers frequently use wooden sledges, for transport, and sometimes animal-drawn carts. Animal-drawn carts are increasing in some areas, but their adoption is limited primarily by problems of affordability and availability.

Some farmers show signs of technical innovation, for example using plows for making ridges and inter-row weeding. Most information and training relating to draft animals comes from parents, relatives and other farmers. The effect of Ministry of Agriculture staff in such areas seems minimal. The farmers generally know more about animal traction than do the extension workers. The extension workers do not have specific equipment packages and techniques that have been proven by farmer adoption. Their taught messages about the need to harrow, plant and weed with oxen has little relevance since the equipment is not readily available and that equipment that does exist has been shown to have serious shortcomings.

Areas of introduction

As noted, animal traction is spreading from the areas of widespread use into surrounding areas, due mainly to farm expansion, farmer migration and farmer-to-farmer technology transfer. It is also spreading into new areas, due to the influence of extension advice. In particular, it has spread through donor-assisted development projects such as those currently working in Tanga, Mbeya, Mbozi and Mwangi, and the previous rural development project in Iringa. These projects have motivated teams of staff with access to transport. They also publicize their achievements at national and international events. It could be that normal, unsupported, ministry extension staff in other areas have had similar success, but there seem no reports of this.

In these areas of introduction (be they completely new areas - such as Tanga or "infill" areas such as Mbeya), there is a clear need for extension. Farmers generally do not know how to train oxen and how to plow. Lack of knowledge and farmer unfamiliarity with animal traction technology may be crucial limiting factors. The existing basic extension messages of the Ministry have been shown to work: farmers can be taught how to train oxen, how to plow and how to use a cart.

The rate of spread within such areas may be very slow, depending on factors such as animal availability and survival, farm profitability, extension methodology and availability of credit. The Tanga animal draft project can only boast about 300 pairs of

oxen, and some donkeys, after almost a decade of effort. Smaller NGO projects have measured their success in terms of tens, rather than hundreds.

However, provided conditions are favourable, such small initiatives may provide the necessary impetus to allow subsequent rapid ("snowballing") expansion. Various indicators, including farmer enthusiasm and recent farmer-to-farmer technology transfer, suggest the numbers of work animals in Tanga could easily double within a few seasons, and subsequently double again — small increases numerically, but large in percentage terms.

The experience of extension projects has provided much information on preconditions for successful introduction. Animal traction seems to spread most quickly where suitable animals are already owned by farmers. In such cases providing some training and making plows and carts available may be enough to start farmers using animal traction. Credit may be important, particularly for the adoption of carts. If animals are not already owned, then making suitable animals available and providing the necessary training and/or medicaments to allow them to survive may be essential in the first instance. Private sector animal trading may well follow if demand is first proven, but traders are unlikely to venture into new areas themselves.

Areas of no use

There are large areas of Tanzania where there are no draft animals at all. There are several reasons for this situation. The most important is the lack of suitable draft animals, related mainly to the distribution of the tsetse fly and trypanosomiasis. Figure 1 illustrates the distribution of cattle, work oxen and tsetse fly. The areas where there are a few work animals generally correspond to the areas of tsetse infestation and few cattle. This broad situation is unlikely to change rapidly, but some more gradual changes are likely.

Major tsetse zones

The areas of high tsetse concentration, few cattle and few people (for example close to some of the national parks and game reserves) are unlikely to change for some time. However, the margins of the various zones with tsetse and few cattle are likely to be slowly but steadily changed by increasing agricultural activity and population pressure. In such areas, oxenization and "cattle-ization" may well proceed at the same time. Donkeys may also be used for transport and for cultivation (in neighbouring countries, donkeys are considered by farmers to survive better in tsetse zones than cattle).

The process of slow spread of draft animals into these areas will probably occur naturally, without any government intervention, but it may well be speeded

if trypanocidal drugs are readily available. It is also likely that area-specific projects (NGO or government-sponsored) will speed up the process in certain areas, by transporting animals from neighbouring areas and making available implements, trypanocidal drugs and training.

There are some areas where cattle presently exist, but there is little or no animal traction. The areas bordering the "Masai Steppe" (Arusha, Dodoma, west Tanga and north Morogoro) are examples. These areas tend to be quite arid, and agriculture is dominated by pastoralism. However, even in these areas, populations are rising, and settled crop farming is increasing (in the more wooded areas this is often preceded by bush clearance by charcoal burners). Again, the trend here is likely to be one of slow, but steady adoption of animal traction by the cropping farmers. The process will probably occur spontaneously as a result of farmer migration, but it may well be speeded up by area-specific projects.

Socio-economic constraints

In the areas of no animal traction use, there may well be major socio-economic constraints to animal traction adoption. They tend to be the poorer, remoter areas, where farm income is low, and so investment in animal traction is difficult. Lack of knowledge of how to use draft animals may be a limiting factor, and it takes time (or extension programmes) for such knowledge to be acquired. In a few cases, local traditions relating to animals do not encourage the use of animals for work. Such socio-economic constraints may be very real at present, but they are likely to change with time, particularly where crop farming is profitable and there are significant economic benefits in employing work animals.

Topography, disease, rainfall

In the mountainous, high rainfall areas of the northwest, cropping systems (with root and tree crops important) may presently be effective without animal-drawn plowing or ridging. In such areas, animals are likely to be first employed for transport purposes (pack transport or carts). Subsequently, working animals may be employed for limited tillage operations (for example in valley bottoms) and this may well spread to other areas.

There are some definite limits to animal traction spread, imposed by animal disease, mountainous topography and insufficient rain for effective crop farming. However, in most of the agricultural areas in Tanzania where draft animals are not currently used, animal traction is likely to become adopted in the medium to long term. The steady spread of animal traction into new areas is already clearly visible within Tanzania and in neighbouring countries.

Benefits of animal power

Area expansion and production increase

One of the main benefits of draft animals is that they allow farmers to cultivate a larger area, and so obtain greater overall production. The farmers interviewed on this mission all confirmed this, and this has also been well reported from many detailed surveys and studies within Tanzania and neighbouring countries (Tobisson, 1980; Kjaerby, 1983; Bantje, 1989; Sosovele, 1991; Vanderschaeghe, 1991; Graham, 1992). Yield increases per unit area do not necessarily take place with animal traction, and higher yields may actually be obtained from intensive hand hoe cultivation. However, total farm production and output per active person are almost invariably much higher when draft animals are used, as the technology allows the farmers to cultivate significantly larger areas.

Timeliness and risk reduction

Draft animal technology allows farmers to improve the timeliness of their operations (relative to hand labour), which may lead to risk reduction and yield increases. Timeliness of tillage is particularly important in the more arid areas, where a delay of even one day in cultivating and/or planting after rain has fallen can reduce yields. Rapid cultivation with draft animals in such circumstances is much more effective than manual labour (tractor power can achieve similar, or even better timeliness, but in most cases this is economically unrealistic).

Animal power allows more rapid and timely weeding, so allowing farmers to weed more often and/or over a wider area (Loewen-Rudgers *et al*, 1990; Kwiligwa, Shetto and Rees, 1992). This is particularly important, as weeding is often a major bottleneck that limits the harvested area.

Animal transport facilitates timely harvesting, by allowing all available labour to concentrate on harvesting rather than head-loading the produce.

Drudgery reduction

Social and economic benefits come from work animals. The power of the animals allows humans to move from power-intensive (exhausting and/or back-breaking) work to more control-intensive operations (physically easier and with greater social status and prestige). The status element may be particularly important in keeping young people in farming. The energy-saving benefits to men, women and children may be translated into alternative, additional production or higher quality of life.

Transport

The agricultural, social and economic importance of work animals in rural transport in Tanzania can hardly be stressed too much. Draft animals (cattle and donkeys) already fulfil an important role in many areas, and their importance is likely to increase still further in the coming years.

Animal transport (carts, sledges and pack animals) saves much time and reduces drudgery in the daily collection of water. Savings are also made in the transport of fuel wood, milling grain and building materials. In the event of problems, or simply to allow attendance at markets, old people, young people and the sick can be transported in carts.

Animal nutrition is assisted by animal-powered transport, as it is relatively easy to transport and store stover, crop residues and hay using carts, sledges or pack donkeys. Without animal powered transport, the storage of such residues is seldom practised. (An interesting exception is in the Kilimanjaro Region where motorized transport is widely used to transport animal feed for peri-urban dairy farmers).

The recycling of nutrients is assisted by animal transport, as the animals make it easy to carry manure to the field (by cart, sledge or pannier basket). It is rare for large quantities of manure to be used unless there is animal transport (head-loading manure is slow and unpleasant work).

Local economies are stimulated by animal transport, as people find it easier to trade. Markets are more accessible, and larger quantities of produce can be carried to, and from, market. As marketing prospects increase (maximum sales are no longer limited to one head-load of produce per market day) production is increased.

With animal-drawn transport, farmers are prepared to travel further to their fields, and so more land, or better quality land, becomes accessible for production. A recent survey in Burkina Faso suggested that draft animals increased the effective range of production by about 2 km around a village or household (Airey, 1992).

Animal-drawn transport makes it easier for farmers to travel further to market their produce, and so the circle of interaction for marketing increases. The larger circles of production and trade, stimulates the growth of support services, which in turn make it easier for people to adopt animal power transport.

In several parts of Tanzania, notably in Shinyanga, Tabora and Singida regions, several such mutually reinforcing systems (animal-drawn transport, trade, production and support services) have developed in

recent years, to the benefit of individuals and the whole local economies.

Gender and age implications

In most of Tanzania, the ownership of cattle and the control of animal traction technology is dominated by men. In most areas, women seldom handle the plow, although they may help to control the oxen. In Tarime District (Mara), the reverse is true, and it is now normal for women to plow, and if men assist, they control the animals.

There has been recent discussion within Tanzania on how animal traction affects women (Madundo, 1992; Marshall, 1992; Marshall and Sizya, 1992; Njiku, 1992; Makwanda, 1992; Sylwander, 1992; Wekwe and Marshall, 1992). The general impression (gained from these documents and from meetings and field visit discussions) is that animal traction does indeed benefit all family members: men, women and children. Naturally, one technology cannot by itself greatly change the overall position of women in male-dominated societies. In most cases, men have much easier access to cattle, plows, cash and credit than do women. There seems little evidence that animal traction increases the marginalization of women. In many cases there are specific benefits to women.

One of the main benefits to women is transport (Marshall, 1992; Doran, 1992; Sylwander, 1992). The head loading of fuel wood, water, crop harvests and goods for markets has traditionally been a major task for women, and this is often still so. However, the ox cart and donkey cart have allowed women to spend less time and less energy, while carrying more. Furthermore, with carts, the work of water collection can frequently be delegated to children, freeing the women for other tasks. The influence of animal power on village transport tasks is very clear in many parts of the country.

Children, particularly boys, often play an important role in looking after the animals, and supervising routine transport operations. They often benefit indirectly through increased family production and the time savings of their parents that the work animals permit. In some rural families, the education of children may suffer if their household or agricultural duties interfere with their schooling. This is a general social problem not specific to users of animal traction. Nevertheless, owners of draft animals often rely on family labour. Farmers sometimes cite child school attendance as a reason why they cannot adopt animal traction.

Existing institutional framework

Introduction

A large number of government departments, parastatal companies, publicly funded institutions, private sector workshops and donor-backed development organizations are directly or indirectly involved with animal traction. An annotated directory of the main institutions has been compiled as part of this report. This directory, which is found towards the end of this document, gives the addresses of the main organizations, together with notes on their involvement with animal traction and details of any relevant publications. The following sections will therefore merely contain some pertinent points relating to certain institutions.

Ministry of Agriculture

The Ministry of Agriculture is involved in research, extension and training relating to animal draft power. Some research is currently being carried out within the context of farming systems research teams. Although there has been some farming systems research in Sukumaland for many years (Bantje, 1989) there has been little attention to animal power issues. A farming systems research support project, with headquarters in Dar es Salaam, is currently being aided by the Netherlands. The present teams are interested in animal traction, but they have yet to define a clear work programme in this area. Some team members are relatively inexperienced, and most personnel have yet to produce good analytical publications in this field. The need for external stimulus, guidance and collaboration is generally recognized.

For several years, animal traction research has been undertaken at Uyole Agricultural Centre in Mbeya Region. In the early 1980s this took the form of on-station work with “top-down” orientation, and included the development of wooden wheeled toolcarriers that were tested using the exotic cattle breeds maintained on the station. This gradually evolved into some more relevant on-farm and on-station cultivation trials carried out in collaboration with the Mbeya Oxenization Project. This work has been quite well reported (eg, Shetto and Kwiligwa, 1992). Uyole has also collaborated with Mbeya Oxenization Project in studies on animal-drawn carts, and the preparation of extension manuals.

There are several institutions involved in the training of agricultural extension staff. These include Uyole

Agricultural Centre and the Ministry of Agriculture Training Institutes (MATI) at Mlingano, Nyegezi and Ukiriguru. During the 1960s, 1970s and 1980s these institutes tended to neglect the subject of animal traction. Most institutes had no relevant training materials and little scope for practical work. The lack of relevant books, training materials and practical facilities continues largely to this day. As a result of this, most agricultural extension workers in the country have little or no relevant training relating to animal traction. Their knowledge of the subject depends largely on what they learned from their own relatives and from the farmers in the areas where they have been posted.

The extension branch of the Ministry of Agriculture is responsible for a number of oxen training centres (OTCs). These were variously established in the 1960s, 1970s and 1980s to promote animal traction. They were developed at a time when “top-down” extension policies were popular. It was assumed that farmers would come to the centres and be trained in the use of draft animals and “improved” equipment packages. Although some useful work was carried out in some centres, they tended to suffer from lack of adequately trained staff, lack of suitable extension packages and poor locations. More recently they have suffered from chronic under-funding, and they are now rather of an embarrassment.

The Ministry of Agriculture has recently adopted the training and visit system, being promoted by the National Agriculture and Livestock Extension and Rehabilitation Programme (NALERP). World Bank funding is being used to assist this programme. There seems to be widespread appreciation of the enthusiasm with which this programme is being implemented and/or for the associated practical and logistical benefits. There seems much more caution in respect to the anticipated achievements. It is acknowledged that the effectiveness of the programme depends on well-trained, motivated extension staff with specific extension advice of immediate benefit to farmers. Unfortunately, it is also generally agreed that in the field of animal traction, at least, such a utopian situation does not presently exist.

Ministry of Science, Technology and Higher Education

The Sokoine University of Agriculture at Morogoro and the University of Dar es Salaam are both involved in aspects of animal traction research and training. These autonomous institutions fall under the overall supervision of the Ministry of Science, Technology and Higher Education.

There was a time when animal traction was seriously neglected in the undergraduate curriculum of Sokoine University of Agriculture. This has gradually been changing and the Agricultural Engineering Department has been trying to increase practical and theoretical coverage of animal power issues. Recent research has included some student studies on animal traction (Mgaya, Simalenga and Hatibu, 1992; Luziga, Nyakalo and Simalenga, 1992). Lack of resources and heavy teaching commitments of staff have been cited as reasons for the lack of an animal power research programme of international standard. Staff of the Department of Agricultural Engineering are closely involved in the development of the national and regional animal traction networks.

Involvement of the University of Dar es Salaam with animal power has tended to be associated more with the interests of individuals than the commitment of departmental teams. In the late 1980s, the Department of Mechanical Engineering (supported by GTZ) became interested in the design and development of animal-drawn implements. It held a professional course on the subject (Hartmann *et al*, 1989). The Institute of Production Innovation (IPI), also supported by GTZ, was involved in the development of carts, wheels and animal-drawn scoops (Wirth, 1992). A member of staff of the Institute of Resource Assessment has recently completed his PhD on the topic of animal traction in Tanzania (Sosovele, 1991). Continued interest in socio-economic research in this area appears likely.

Ministry of Industry and Trade

The Ministry of Industry has responsibility for most organizations concerned with animal traction implements. These include the large and well-equipped parastatal implement factory, Ubungo Farm Implements (UFI). UFI makes animal-drawn plows and hand-hoes. It is also the main importer of other animal traction implements (weeders, ridgers, harrows and planters). UFI claims it is more profitable to import and retail such implements than to manufacture them locally.

For many years there has been criticism from agricultural officers and from farmers that UFI equipment (manufactured and imported) is not

particularly good or suitable; also that distribution is poor, and that UFI is unresponsive to feedback. Such opinions are still widely held within the Ministry of Agriculture.

The country's second agricultural implement factory, Zana za Kilimo (ZZK) at Mbeya is also well-equipped. It has hardly produced any animal traction implements since its inception. This is for a variety of reasons related to workshop management, poor designs of animal-drawn implements and financial and infrastructural constraints.

The country's main agricultural engineering research and testing establishment is also under the Ministry of Industries. The Centre for Agricultural Machinery and Rural Technology (CAMARTEC), based near Arusha, was established in 1981, by merging the Tanzania Agricultural Machinery Testing Unit (TAMTU) that had been operating since the 1950s with the Arusha Appropriate Technology Project established by SIDO.

CAMARTEC has an impressive mandate relating to the design, development, testing and production of agricultural implements and to ensuring national liaison in this field. Although much time and effort has been expended on developing prototype animal traction equipment and ox carts, there is little evidence of subsequent, sustained adoption. Detailed, objective test results of the various animal traction implements and carts available in Tanzania are not published or readily available. National liaison and consensus on appropriate animal traction implements for Tanzania have still not been achieved.

Ministry of Agriculture staff consider that the position would be greatly improved if CAMARTEC were back under the Ministry of Agriculture. While this might indeed be the case, the very reason why CAMARTEC had been removed from the Ministry of Agriculture was its previous lack of achievement and influence on local manufacturers.

The Small Industries Development Organization (SIDO) is a parastatal organization, charged (among other activities) with assisting small workshops and village artisans to produce agricultural implements and spare parts. Some of the designs of animal traction implements made by ZZK and Themis Farm Implements, that proved unpopular with farmers, were said to have originated from SIDO. SIDO has also helped establish some ox cart workshops, using an "appropriate technology" design.

Ministry of Wildlife, Tourism and Forestry

The Department of Forestry has expressed interest in developing the use of oxen for logging. It has received advice on this topic from FAO and the Commonwealth Development Corporation (Humar, 1984; Starkey, 1990). Other countries in the region, including Malawi, Swaziland and Zambia have found timber extraction with draft animals to be efficient and economically viable. With the sustained interest of the Department of Forestry, animal-powered logging could become well-established in the forestry areas of Tanzania.

Donor-assisted projects

Donor-assisted agricultural development projects often have major advantages in Tanzania and neighbouring countries. They generally have much higher levels of transport and communications than do Ministry of Agriculture extension programmes. They have assured operating budgets and, once established, they are generally able to operate without excessive bureaucracy. The presence of expatriate teams intent on achieving measurable attainments within a short period of time tends to encourage goal-orientated motivation.

In recent years, several donor-assisted projects have been directly involved with the promotion of animal traction in Tanzania.

The Tanga Integrated Rural Development Project (TIRDEP), supported by GTZ, started an animal draft power component in 1981. This is due to close in 1993. The Tanga project has been attempting to introduce animal power into an area with few cattle and no tradition of using work animals. In numerical terms, its results have not been spectacular, but it appears that animal power has become firmly established in the area, and is likely to take off. Its activities have included the introduction of donkey carts, the use of animal-drawn animal carts for rural road construction and the development of a prototype, heavy weeder-roller for clearing fields.

In the early 1980s, the Iringa Integrated Rural Development Project, supported by the European Community, operated in the Iringa Region where a certain amount of animal traction already existed. The project therefore tried to expand the use of animal power, through the promotion of ox carts and a range of other implements. The project is reputed to have had a "top-down" approach, and actively promoted technologies before testing them with farmers. The results were rather disappointing. Farmers did not like the CAMARTEC-type carts with wooden-bush bearings that were promoted. There

was not a well-tested weeding package, and the heavy ridgers and adjustable weeders being advocated had little acceptance. The project ended, without ever adopting a farming systems approach to development.

In 1987, the Mbeya Oxenization Project (MOP) was established, with support from the Canadian International Development Agency (CIDA). This started with farming systems problem-identification studies and a farmer-orientated approach. The project, which has a long-term vision, has given priority to the development and promotion of animal-powered systems of weeding and transport. It has worked in close cooperation with farmers, government institutions and local entrepreneurs. Its approach and methodology has earned MOP a good reputation both within Tanzania and in neighbouring countries. It has supported national and international networking and has recently hosted a workshop on gender issues in animal traction. There has been some doubt expressed concerning long-term funding prospects for MOP, but it is hoped that if CIDA cannot maintain a funding commitment, then another donor will be able to support continuation of the project.

Mbulu and Maswa rural development projects have recently been established, with assistance from The Netherlands. These both have animal traction components, and the Maswa project has recruited a full-time animal traction specialist. Both projects placed initial emphasis on equipment provision (carts and implements) but both intend to take a farming systems approach to animal traction development.

Non-governmental organizations

Non-governmental organization (NGO) development programmes in Tanzania are generally supported by external aid agencies. Although the programmes are generally much smaller than government-sponsored development projects they have several similarities. NGO programmes have similar advantages in terms of access to resources, limited operational bureaucracy and the support of motivated, achievement-orientated expatriates. Non-governmental organizations often operate in small areas, working closely with farmers. This makes it easier for them to identify constraints and appropriate solutions. Thus NGOs, with close farmer connections and small budgets are less likely to make expensive mistakes in the promotion of technologies. On the other hand their geographical concentration makes it difficult for NGOs to have a noticeable impact over a wide area.

Several NGOs have been working with animal traction in Tanzania. They include Tanganyika Christian Refugee Service (TCRS), Mbozi Agricultural Development Project and the Mixed Farming Project in Mwanga, Kilimanjaro. These projects have been able to introduce basic draft animal power and they are in a good position to work with farmers to evaluate new technologies.

Financial institutions

In some countries commercial banks have been involved in providing loans for animal traction. In other countries, formal rural savings schemes have been established to provide credit for animal traction. There appears to be no comparable information available on the role (if any) of financial institutions on the development of animal traction in Tanzania.

Marketing organizations

Marketing organizations do not appear to have had any role in the development of animal traction in Tanzania. In other countries, notably in West Africa, companies involved in the marketing of cotton and groundnuts have been instrumental in promoting animal traction. In normal circumstances, the profits of marketing organizations depend on them being able to obtain large quantities of produce from the small farmers. Thus some efficient organizations have become involved in the provision of services that assist such production. They have ensured implements, spare parts and other agricultural inputs have been available, and in many cases they have provided credit. In countries such as Mali and Côte d'Ivoire, the cotton development companies have had considerable success in introducing animal power for plowing, weeding and transport.

Such involvement with animal traction has not occurred in Tanzania, and the present situation of the parastatal marketing organizations does not give any cause for optimism in this area.

Private sector

In many African countries the private sector is heavily involved in the manufacture, distribution and repair of animal traction implements and carts. In Tanzania, the formal private sector has only limited involvement. This seems largely attributable to the influential role of the main parastatal factory (UFI) and the implement distribution system. With UFI prices low by international standards, there has been little incentive to compete in manufacturing. With intermittent supplies to rural areas at low prices, formal private sector supply systems have not developed.

Thembi Farm Implements at Arusha was established as a private sector workshop, with assistance from USAID. In return for capital assistance and loans, Thembi entered into a ten-year commitment to manufacture agricultural implements. It has made some plows, using a design supplied by SIDO. It has also manufactured some carts, using CAMARTEC designs and undertaken some supply contracts. In the long term, Thembi is likely to find that it can maximise its profits if it concentrates on contract work and manufacturing for the non-agricultural sector.

Mbeya Oxenization Project assisted the establishment of the private sector firm SEAZ Agricultural Equipment. This manufactures animal-drawn implements and carts. It considers its biggest problem is likely to be "unfair competition" in the form of parastatal producers and donor project importers.

The informal private sector dominates the manufacture and maintenance of animal-drawn carts. In most towns, there are artisans capable of making carts from vehicle axles for use with human or animal power. The most highly developed artisanal manufacture and distribution system is found in and around Shinyanga.

In many areas village blacksmiths play an important role in maintaining animal-drawn implements. In some cases they manufacture spares and undertake repairs, but there are also instances where they modify the original design. There are few examples of blacksmiths manufacturing whole implements. In some areas farmers (and projects) complain of the scarcity of blacksmiths to help maintain implements.

Donor agencies

Many bilateral and multilateral donor agencies have been supporting animal draft power introduction and development in Tanzania. Unfortunately few donors have shown the long-term commitment, persistence and consistency needed for successful animal traction programmes. Thus external project assistance has tended to follow donor funding cycles rather than the needs of farmers. Few donors have had the courage to give long-term assistance and critically assess the resulting achievements. Many of the institutions, departments and projects mentioned in previous sections have been strengthened temporarily with funding and technical assistance. Unfortunately several have had their morale and effectiveness undermined by withdrawal after one funding cycle.

The German aid agency GTZ has demonstrated a long-term commitment to animal power in Tanga region. This has allowed the Tanga animal draft

power project to introduce animal traction as a sustainable technology within local farming systems. GTZ has also supported animal power in the context of its assistance to the University of Dar es Salaam (IPI and Department of Mechanical Engineering) and CAMARTEC, although this support was less targeted and less persistent. On the negative side, the support of GTZ to MATI Nyegezi in the 1980s neglected the training needs of animal power, concentrating on the importation of German tractors and other equipment.

For many years FAO has been supporting a mechanization project in the Usangu plains that has had a small animal traction component. In general, FAO's support for animal traction in Tanzania has been small compared to the FAO-administered assistance given to various tractorization initiatives. In the 1980s, ILO and FAO, with support from Finland, started initiatives to share regional experiences relating to animal traction and labour-intensive agriculture (ILO, 1982; ILO, 1987). Although some meetings were held, and needs identified, the initiative was not followed through.

The Netherlands has recently taking a leading role in support for animal traction. Not only is it funding the Maswa and Mbulu projects, it is also providing technical assistance and support for the farming systems research programmes. Furthermore the volunteer service of the Netherlands (SNV) is assisting some agricultural development programmes with animal traction components.

For the past few years, Canada has been supporting the Mbeya Oxenization Project. From its inception, this project developed a long-term, farmer-orientated perspective. Its work and methodologies have been acknowledged locally and internationally, and it has received positive external evaluations. It therefore seems sadly incongruous that this animal traction project too may suffer from lack of long-term donor commitment.

Donor assistance to animal traction has not been entirely beneficial. There was one major fiasco in the mid 1980s, attributable to Scandinavian donors. A consultancy report financed by SIDA and subsequently published suggested there was an accumulated demand for 75,000 plows in addition to an annual demand for 50,000 plows (Mothander, Kjaerby and Havnevik, undated and 1989). As a result, donors financed the importation of 100,000 ox plows from Zambia, Zimbabwe and India. The national plow factory, UFI, had enormous problems in stocking and distributing these imported plows, which took several years to clear. The UFI factory, that up to this time had been making about 20,000 plows a year (a realistic production level) ceased

plow production altogether for four years. Thus the well-meaning donor, by importing so many plows, caused the medium-term closure of the national plow production facility. Luckily for the staff concerned, UFI is a parastatal organization and the debacle of reduced production did not cause workers to lose their jobs.

Animal Traction Network Tanzania

For a long time, there has been a clear need for improved liaison, coordination and collaboration in relation to animal traction in Tanzania. Some national meetings concerned with animal traction issues were held during the 1980s (ILO, 1987; Hartmann *et al*, 1989), but although these were welcome and valuable, they tended to be donor-initiated or led. They also put emphasis on agricultural engineering technology, rather than farmer needs, and were characterised by almost total lack of local follow-up initiatives.

The recent creation of the multidisciplinary Animal Traction Network Tanzania (ATNET) and the National Animal Traction Steering Committee is therefore to be greatly welcomed. This could prove most valuable and cost effective. A recent study of animal traction networks in Africa has highlighted the benefits of such structures (Starkey, 1992). Networks effectively link people who would not otherwise interact. Many benefits arise from exchange of experiences, skills and materials through meetings, publications and cooperative programmes. These increase the competence of network members. Networks reduce duplication of effort and increase overall progress. Networks provide peer support, encouragement, motivation and professional recognition. They can create critical mass for action and policy change.

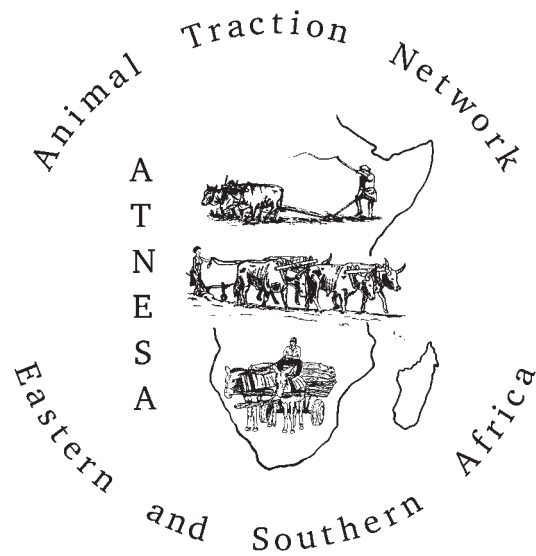
The national network and steering committee were launched at a national workshop on animal traction held 8-10 April 1991 in Morogoro. The proceedings of this meeting, containing 15 papers on animal traction in Tanzania have recently been published (Simalenga and Hatibu, 1992). Since then there have been two, well-attended steering committee meetings, the last of which included a wide-ranging discussion as an input into this present report. The committee has stimulated the production of a directory of local experts and organizations (Simalenga and Hatibu, 1992) and animal traction training syllabus for extension workers (Massunga, 1992). It has participated in a joint ATNESA/MOP workshop on gender issues in animal traction and exhibited at the Arusha show. Among its planned activities is a national workshop involving implement manufacturers, which it may hold in collaboration

with AGROTEC (a regional project based in Zimbabwe).

ATNESA

The formation in 1990 of the Animal Traction Network for Eastern and Southern Africa (ATNESA) has provided Tanzania with a valuable framework for information exchange, cooperation and collaboration with animal traction organizations elsewhere in Africa and the world. The first open ATNESA workshop, held in January 1992 in Lusaka, was attended by 12 people from Tanzania. The first ATNESA specialized workshop, on gender issues and animal traction, was hosted by the Mbeya Oxenization Project in June 1992. The present ATNESA Chairman is Tanzanian (Dr. T. Simalenga of Sokoine University of Agriculture).

There is much evidence that farmer-orientated, animal traction networking can be highly cost-effective. Specific examples have been cited of donor-supported projects and national institutions saving both time and money by building on the experiences in neighbouring countries (Starkey,



1992). Given the slow progress of Tanzania in some fields (eg. cart and weeder design), despite significant numbers of institution-, project- and person-years, the potential for cost and effort savings within Tanzania is very high.

Key issues

Low farm incomes

One of the biggest constraints to the more rapid spread of animal traction is the lack of money within remote rural communities. This is associated with the relatively low incomes that can be achieved from crop farming and the difficulty of marketing farm products. The adoption of animal traction technology is particularly difficult for farmers who do not own cattle, for they have to invest considerable sums (relative to local incomes) in expensive animals. Cattle owners may have significant wealth tied up in cattle, but they are often reluctant (for social reasons and risk avoidance) to reduce their stock, in order to purchase a plow or a cart.

The fact that animal traction is spreading, suggests that farmers believe the investment is justified. Economic models have been produced to give the cropped area required to justify the investment. These are fraught with problems as many of the costs and benefits of using animal traction within the villages are not normally measured in cash terms. Access to animals and remuneration for family labour often involve complicated reciprocal benefits rather than monetary payments.

The rate of animal traction adoption has been accelerated when credit has been made available for the purchase of implements and animals. Credit schemes seem to have been successful, in that the injection of capital, in the form of credit, has led to more rapid investment in animal traction technology.

Draft animals

Animal nutrition

In Tanzania, and throughout the region, work animals suffer from the fact that they are required to plow at the beginning of the rains, at the time of year that they are in poorest body condition (Crees, 1992). The severity of this problem varies with both the region and the year. During the field visits for this mission, animals (cattle and donkeys) were seen to be in quite good condition, with none of the signs of severe emaciation seen in neighbouring countries in the past year. Farmers contacted on this mission did not stress the problem of animal feeding, although it is accepted that it is a real problem in some districts and in some years.

Experience from Tanzania and other countries suggests that the nutrition of draft animals may be more a problem of economics than knowledge or

technology. In Kilimanjaro Region, a private sector market for fodder has developed spontaneously, in response to the economic demand of local dairy farmers (see illustrations 1-D and 2-H). In this area, farmers sell and purchase grass, hay and maize stover — the market has developed because dairy farmers can get a regular and immediate income from the sale of milk.

Similar private-sector forage markets have developed in West Africa and Madagascar and elsewhere for transport animals (oxen, donkeys and horses). Farmers sell much of their stover to the transporters, rather than feeding it to their own animals. An immediate return and regular income can be obtained from animal-drawn transport, while feeding plowing animals well is only really economically justified if they have to work a great deal, and their condition is very weak.

Farmer experience, backed up by research in Ethiopia and Mali, indicates that animals in poor condition can actually plow quite effectively (Abiye Astatke, Reed and Butterworth, 1986; ILCA, 1989; ILCA, 1990). Provided the animals are not at risk, and provided that they will be able to gain weight when the grass starts growing, it may be a reasonable strategy to allow them to lose weight before and during the plowing season.

That being said, there are ways of improving draft animal nutrition, and some of these are being adopted (particularly by farmers who also use their animals for transport). The most obvious one is the stocking of maize stover, groundnut hay and other crop residues. If stocked, they are preserved from wastage and trampling, and can be fed during the dry season or immediately before the plowing season. Stocking residues generally only starts when farmers start using carts, as collecting and storing stover is difficult without transport (although maize stover can be transported by sledge). In a recent survey in Maswa and Meatu Districts, farmers reported that they did not stock and store stover because they lacked appropriate transport (Ngedelo, 1991). Experience from West Africa and elsewhere makes it clear that animal-drawn carts are one of the best means to improve the nutrition of work animals.

In some areas of Tanzania, groups of farmers reserve certain grazing areas for the late dry season (Ngedelo, 1991). This can be effective, but it is risky, as the reserved grazing can be diminished by

fire, wild animals and other people's cattle. Thus farmers often adopt the strategy of letting their animals graze all areas, on the basis that food reserves are best stocked within the animals themselves. In the cotton zone, some farmers have started to feed their animals cotton seed, which makes a valuable supplement for transport or working animals.

Animal health

The distribution of cattle and donkeys in Tanzania is not uniform, and is highly influenced by animal disease (notably trypanosomiasis carried by the tsetse fly). Thus animal disease is one of the main factors determining the present distribution and future potential of draft animals in Tanzania.

Working oxen and donkeys are susceptible to the major diseases of bovines and equines, but few diseases and conditions are specific to draft animals. The major diseases are important in determining the size and productivity of the animal populations in each region, 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.

The main plowing season corresponds to a period of high challenge from ticks and diseases (Ngendelo, 1991; Crees, 1992). It is possible that the stress of work makes draft animals more susceptible to disease, and that the challenges of diseases and parasites reduce work performance. However, there do not appear to be either scientific or anecdotal reports of such interactions being especially important in Tanzanian farming systems. The rate of survival of work animals appears to be quite good, relative to other animals (animals that are used for work have already survived the vulnerable early years). Those conditions associated with work, such as yoke galls and harness sores, do not appear to be of major importance to cattle in Tanzania, although donkeys do suffer from skin abrasions caused by yokes.

Trypanosomiasis

Trypanosomiasis is still a major disease that restricts cattle keeping in many areas. Chemoprophylaxis is considered cost-effective in some areas, and drugs for this are generally available (although there may be local shortages). Whether or not it is a direct result of reduced tsetse infestation, the cattle areas do seem to be spreading. Animal traction may play a role in this in some areas, as it provides a strong incentive for people to adopt cattle husbandry. 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, as noted above, animal traction will tend to expand numerically and geographically.

Tick-borne diseases

Tick-borne diseases, such as East Coast Fever (*Theileriosis*), are enzootic in parts of Tanzania. Although such diseases can be fatal, local animals tend to be fairly resistant. The diseases can be controlled by regular dipping or spraying, but if the challenge is not too serious, some authorities prefer 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.

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 has been cited as a possible constraint to farmers using animal traction (Kapinga, 1979). Other diseases such as contagious bovine pleuropneumonia, black quarter, haemorrhagic septicaemia and anthrax offer no special threat to work animals. Cattle owners may well obtain the necessary vaccinations from the veterinary department.

Animal quality and quantity

The great majority of cattle in Tanzania are of East African Zebu type. In Kigoma and Ziwa Magharibi regions (and neighbouring Burundi, Rwanda and Uganda) some Ankole cattle are maintained. In the northern cotton zone, there is some influence of the Boran breed (originating in southern Ethiopia and northern Kenya), both among smallholders and in the estate sector. Around Kilimanjaro, some genetic influence from the exotic dairy cattle is apparent.

Most cattle used for work in Tanzania are Zebu type. There is considerable variation in size, with many work animals being 200-400 kg. Although, by international standards the Zebu breed is quite small, the animals seem quite capable of performing draft work well. There is no suggestion that animal quality is a limiting factor.

Individual animals differ in both size and temperament, and some will be better than others. Such differences between individuals are likely to be more important than any differences between the available breeds. The present system by which farmers choose the animals that are most readily available, and then select individual animals on merit, seems to be working well.

Some people from SUA and MoA, 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, it is argued, there is more power and more farmers would be able to use two rather than four animals.

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 who owns two large animals than one who owns 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). In most cases, small farmers will be better off with the available indigenous breeds, selecting individual animals that suit their needs and budgets.

No recommendations are made here for special breeding or upgrading programmes. If such programmes were to be established for other reasons (meat, milk), it would be sensible to consider whether the animals so produced would be capable of being used for draft.

Use of donkeys

It seems generally agreed that donkeys are increasingly being used for work. It is also agreed that this trend will continue. They are mainly used for transport, but some farmers are using them to plow. In Singida, Shinyanga and Tabora Regions it is not uncommon for pairs of donkeys and pairs of oxen to be attached to the same cart or plow (see illustration 1-C). Donkeys are often placed in front of oxen, to maintain walking pace on flat roads and decrease pace on descents (oxen are more likely to start trotting on a downward slope, which risks carts overturning).

Donkeys are generally harnessed with the same type of yoke used for cattle, and neck sores are frequent. Elsewhere in the world, donkeys are normally harnessed with breast bands or simple collars, with a back saddle to take any vertical load (as with a cart). The Tanga Animal Draft Project has started to introduce breast bands and saddles, but the technology has yet to spread to other areas. The introduction of donkey harnesses (of the type widely used elsewhere in Africa) is therefore a specific recommendation. The introduction of a range of lightweight cultivation implements suited for use with donkeys is also recommended.

It has been suggested that donkeys may be particularly suited for increased ownership and use by women and children. Not only are donkeys particularly easy to manage, they also have fewer traditional associations with male ownership and domination.

Little is known about the type and breed of donkeys in Tanzania, although they do seem to be well-adapted and have strong survival characteristics. There seems no suggestion that the size or breed of donkey is currently a problem in Tanzania, and no breeding initiatives seem justified at present. Although it is by no means a priority, it would certainly be interesting to obtain more information on the characteristics and qualities of Tanzanian donkeys.

Animal supply

The shortage of available animals is a major constraint to the adoption of animal traction in certain regions and districts. There is no shortage of potential draft animals in the country as a whole: the problem is one of distribution. Moving cattle or donkeys 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.

It is clearly desirable for all districts to have sufficient locally-raised steers and/or donkeys to meet the local demand for work animals. In areas with few cattle, the long-term sustainability of "oxen-ization" will depend on "cattle-ization", and the establishment of small privately-owned breeding herds. The same is true for donkeys.

There have been suggestions from MoA staff that government breeding ranches should be established to provide donkeys and/or oxen in deficit areas. Comparable public-sector initiatives have been tried in several countries, but they have tended to prove costly and inefficient (Starkey *et al*, 1991). Public-sector breeding programmes to supply donkeys and oxen therefore cannot be recommended. It is likely that encouraging small private sector breeding herds and/or trading systems would prove more sustainable.

Risk and theft

Animal ownership is risky, as animals may be lost through disease (as discussed above), accident or theft. Cattle theft can be a major worry and constraint in some areas (Sosofole, 1991). One cited advantage of donkeys is that they are less likely to be stolen (although donkey thefts do occur).

Animal gender

Most work animals in Tanzania are oxen, that is castrated male animals. Oxen are the preferred draft animals in many countries, particularly where large numbers of cattle are maintained on an extensive basis. In some countries, including northern Nigeria, young work bulls are preferred. Bulls can be effectively used for work, but they tend to be less docile than oxen, particularly if a nearby cow is on heat. In most countries, surplus bulls are castrated when they are between one third and two thirds the normal adult body weight. It is widely believed that the later the castration, the more masculine the conformation, and the greater the adult strength. People concerned with animal welfare prefer earlier castration, arguing that it is less traumatic at a younger age, and that it actually makes little difference to the final conformation.

In many countries in the region, there is an increasing use of cows (female animals) for plowing within mixed farming systems. In many other parts of the world, cows are used for work (in Indonesia, 80% of draft animals are females). It has been found that, with modest work, the fertility and milk production of working cows can be acceptable (and it will always be greater than the reproductive performance of oxen!). Where animals are to be used very regularly for work (contract plowing or transport) or for specialist applications (road building or forestry) male animals are normally preferred.

During the field visits several cows were seen plowing, as part of mixed teams in Mara region. Farmers said that it was normal to put cows that have not calved to work, as this was found to stimulate reproductive activity. The use of females for occasional plowing is likely to increase spontaneously, and should not be discouraged. In the long term it is likely to lead to fewer old oxen being retained. This will lead to a higher proportion of cows in the herds. As cows replace oxen, overall herd output will increase.

Female and male donkeys are employed equally for work. Donkey jacks are generally castrated unless they are needed for breeding. Entire males are difficult to control when a nearby female is on heat, and castrated males are generally preferred for year-round work. It is normal for female donkeys to be rested immediately before and after parturition, but reproduction has little disruptive effect on donkeys engaged in routine light work.

Animal-drawn implements

Plows

The basic UFI plow design is broadly similar to the "SAFIM", "Victory" or "Zimplot" design used in neighbouring countries. It is generally acceptable, but has some points that could quite easily be improved, and these have been known and discussed for many years. These include the wheel (size and position), the mouldboard shape and the angle of the frog piece. A responsive, market-orientated manufacturer would have experimented with such changes long ago, and test-marketed different options. UFI has made few design changes in twenty years. By contrast, some village blacksmiths have themselves attempted to modify the UFI plows, responding to local farmer criticism.

The Mbeya Oxenization Project (MOP) seeing the problems of the UFI plow, tested plows designed by Project Equipment Ltd, of UK. They, and the farmers, found these of good design and high quality. It was hoped that Zana za Kilimo (ZZK) would start to fabricate these. Unfortunately, for various reasons, ZZK was not enthusiastic about this, and so the firm of SEAZ was set up to make these under the brand name "Mkombozi". These plows appear quite popular, but the question of the economic viability of their production in Mbeya has yet to be answered.

Plows manufactured by the Dutch firm Rumpstads, and its associate in Zambia, Lenco, have recently been imported into Tanzania for evaluation and possible local assembly (Helsloot, 1992). It is too early to assess whether such implements will be both technically and economically appropriate to conditions in Tanzania.

Weeders and cultivators

The UFI-imported adjustable cultivator is based on a SAFIM-type design, which has been used successfully in Zimbabwe. Unfortunately the imported models, believed to be made in India, have several problems. These have been known about and reported for many years, without any remedial action being taken. These include cast iron parts that break and lack of alternative share types. MOP imported similar weeders direct from India, but they also found technical problems. It appears the models manufactured in Zimbabwe and/or Mozambique are of better quality, and MOP anticipates importing some of these for sale to local farmers.

MOP imported several other types of weeder for evaluation. The *Houe Sine* widely used in the semi-arid, sandy soils of West Africa was apparently not considered suitable, due mainly to reasons of cost. The *Houe Occidental* had insufficient clearance for

weed conditions in the southern highlands of Tanzania. A weeder designed by Project Equipment, and subsequently produced as part of the Mkombozi toolbar, was found effective but heavy and expensive. MOP designed and developed an over-the-row weeder, pulled by a long draw pole. This was found to be technically effective for early weeding, but not suitable for later cultivation. It was also considered difficult to manoeuvre.

MOP is continuing to work on weeding technology, although for its extension programme it has presently opted for the Zimbabwe weeder. MOP has summarized some of its findings (eg, Mkomwa, 1992) but has not yet produced detailed test reports on the equipment it has assessed. Such information could be of great assistance to other programmes wishing to evaluate weeders elsewhere in the country.

There remain several unanswered questions relating to weeders. The UFI weeder is only supplied with cultivating points, but in West Africa ducks-foot shares are preferred for weeding, particularly in sandy soils. These do not seem to have been adequately evaluated in Tanzania. In Zimbabwe, considerable use is made of hiller shares which help to cover weeds in the rows. These have been advocated for Tanzania (Kayumbo, 1992) but there seem to be few, if any, test reports on this technology, and hiller sweeps are not widely available. In several countries, ridgers have been found very effective for weeding. The ridgers available in Tanzania seem heavy, and are not designed specifically for weeding. There seems much scope for further objective investigation in this area.

Other implements

Apart from plows, and small numbers of cultivators, there are relatively few other animal-drawn cultivation implements in use in Tanzania. UFI ridgers are available, but they are considered to be heavy. Several designs of harrow have been made available in Tanzania, but few have proved popular. Metal zig-zag harrows seem to be preferred—they can be weighted down with logs if necessary. Some wooden harrows produced by CAMARTEC proved to be extremely heavy, and impracticable for use by farmers.

Very few seeders are owned in Tanzania, and planting following plowing is common. SAFIM-type seeders, with Pitman drives, appear to be both complicated and expensive, particularly in the higher rainfall areas where planting date is not very critical. One important advantage of animal-drawn seeders is that row planting facilitates animal-drawn weeding.

Although rice production is important in some areas, there do not appear to be scoops and levellers

available to allow animal power to assist in the creation of level rice fields. This seems to be an area requiring investigation.

Manufacture and supply

The parastatal factory Ubungo Farm Implements (UFI) is the major supplier of implements in the country. It has the workshop capacity to manufacture all national requirements for animal-drawn equipment. In practice, many items have been imported in recent years. In the mid-1980s, donors funded the importation of 100,000 plows, equivalent to four year's national supply. UFI administered the importation, stocking and sale of these implements. UFI therefore closed down its plow production facilities until the stocks were reduced. UFI has argued that it finds it more profitable to import implements and sell them, than to import steel and manufacture them. Importation also requires less effort.

For some implements, such as weeders, UFI has never invested in the necessary jigs for local production. This strengthens its arguments in favour of importation. UFI suggests sales are too low to justify local manufacture, but Ministry of Agriculture staff consider sales are only low because the imported equipment is not suitable.

During the past decade, staff of the Ministry of Agriculture have publicly and privately criticised the designs and quality of the implements manufactured and/or supplied by UFI. They have also criticised the poor distribution system. Although UFI has acknowledged such criticism during meetings and seminars, there appears little evidence that UFI has actually responded to the complaints. Ministry of Agriculture staff continue to maintain that there is urgent need to address the long-standing shortcomings of animal-drawn implement design, quality and supply in Tanzania.

The second implement factory, Zana za Kilimo at Mbeya, never had any impact on animal-drawn implements. Initially the factory, with external technical assistance, started to manufacture large numbers of plows of a prototype design that had never been tested. The farmers did not like the plows and did not buy them. The factory did not adapt its manufacturing or marketing policy to the needs of the farmers, and for many years it simply stocked the unpopular design. It also acted as a marketing outlet for UFI plows. The Mbeya Oxenization Project tried to assist ZZK to manufacture the Mkombozi plow. Steel and specialized components were imported from Europe. However ZZK showed little enthusiasm for this venture, and the jigs and

manufacturing responsibility was transferred to a small private firm, SEAZ Agricultural Equipment.

Although MOP/SEAZ has established a small market for the Mkombozi plow (and has sold several hundred), this manufacturing capability appears very vulnerable. The plow requires the importation of special steels and their transport to Mbeya, which may well prove a financial and administrative burden for a small private company. Furthermore, it is trying to establish a market in competition with a parastatal company that has very different criteria for pricing decisions and valuing its own capital and professional time.

Themis Farm Implements in Arusha has faced similar commercial problems. These were made much worse by the fact that the initial plows it manufactured were of an inappropriate SIDO design.

Repair and maintenance

Many animal-drawn implements in Tanzania are in need of repair. Some plows have been kept going for more than thirty years by farmers, local workshops and village blacksmiths. Others have been abandoned because of lack of spare parts. Farmers generally find it difficult to obtain spares. In a few areas, including parts of Mwanza Region, UFI-supplied factory-manufactured spares are available, at relatively low cost.

Artisanal manufacture of spares is not well-developed in Tanzania. In some areas there are reputed to be few blacksmiths. Where blacksmiths are found, they generally find it difficult to obtain raw materials. The low cost of UFI spares, while good for the farmers, may be inhibiting the development of artisan-produced spares.

Transport

Human and animal transport options

There are three main types of animal-powered transport in use in Tanzania: pack donkeys, animal-dragged sledges and animal-drawn carts. It should also be noted that, in rural areas, there is still much head-loading of water, fuel wood and market produce. This is hard work and time consuming (mainly for women), and imposes limits to consumption, marketing, trade and production. There is therefore much scope for improved rural transport.

It is also relevant to observe that bicycles are increasingly used in Tanzania, for personal transport and for carrying loads in urban and rural areas (illustration 2-E). They are generally used by men. The growth of bicycle use has not been at all uniform. Certain towns and villages have quite

rapidly developed high concentrations of bicycles. In areas where bicycles have become common, repair and maintenance services have developed rapidly, so that puncture repairs have become relatively straightforward. The impression gained is that in recent years bicycle adoption seems to have started with an initial source, a local concentration of interest leading to a critical mass of adoption that has justified the support services whose existence has encouraged more adoption. It will be argued that a similar general pattern of adoption has been seen in the development of animal-drawn carts.

It is also noteworthy that human-powered carts are common in most towns (illustration 2-E), and even in some large villages. Again, where several such carts are in use, support services have arisen for their repair, maintenance and construction. Human-powered carts are almost invariably designed and made by local artisans using the tapered roller bearings from old car axles. It is probably significant that TAMTU and CAMARTEC carts (using wooden bushes or bearings) have not been adopted for use by people, even around Arusha, where they have been produced for many years.

Pack animals

Donkeys are quite widely used as pack animals (illustration 2-I). There is one early report of the use of cattle as pack animals, but this idea does not appear to have spread (King, 1940). In most cases, no special pack saddles are used, and the technology employed is extremely simple and effective. When grain is to be transported, sacks are usually slung over the back of the donkey. Where other loads, such as water cans, are to be carried, simple pannier baskets or frames may be used. The Masai have traditional designs of panniers.

Donkey packing is particularly suited to hilly regions or areas with few roads. A donkey can carry 70 kg or more, which is much more than one person can comfortably carry. A single pack donkey is very well suited to allow a woman to carry grain to a grinding mill. Pack donkeys have their limits, as individually they cannot carry as much produce as one could place on a cart or sledge, moving on flat terrain.

Sledges

Traditional, simple wooden sledges, made from a forked branch are widely used in many areas for transporting water (illustration 2-F), fuel wood (illustration 2-G), sacks of grain, manure and plows. Their main advantage is that they are extremely cheap and simple, and allow the animals to pull loads that would be too great for humans. They do not have the same large load-carrying capacity as carts.

Attempts in Zambia to design “improved” sledges were not successful.

Sledges are said to stimulate erosion in certain areas. The paths worn by the sledges can become water courses, which can be very serious in hilly areas. For this reason, sledges are banned in some countries in the region (Zimbabwe and Lesotho). However, in flat, sandy areas, the risk to the environment seems minimal. In deep, loose sand, sledges can ride over the sand, while carts with small and narrow wheels tend to sink or create excessive drag.

Sledges perform a most valuable social and agricultural role, and it would seem unreasonable to actively discourage their use. A more positive approach would be to actively encourage and facilitate the use of animal-drawn carts. Farmers know that carts are better in most conditions, and it is generally only cost that prevents them from upgrading from a sledge to a cart. In the long term, carts are likely to replace sledges in rural Tanzania.

Carts

In Zanzibar and Pemba, as well as in Madagascar, carts with wooden spoked wheels have been made and used for generations. This technology does not seem to have been transferred to the mainland (indeed, wooden spoked wheels do not appear to have been adopted in any country in sub-Saharan Africa, even though they were often used by colonialists).

In some parts of the country, farmers have invented their own carts, using simple wooden wheels sliced from tree trunks (Shetto and Kwiligwa, 1988). Some of these have been made by raising sledges onto simple wooden axles. Such carts may not be efficient or durable, but they are locally made and very cheap. The fact that they have evolved illustrates the clear need, and demand, for animal-drawn carts.

Elsewhere, in towns and large villages local artisans have made carts from old car axles, for human power or for animal power. In some cases, complete Landrover-type axles are used, and a wooden platform or body has been built on. In some cases the backs of pickup trucks have been used as carts, largely unaltered. More recently, artisans have started making carts by welding vehicle stub axles onto axles made from large water pipes or railway line.

Shinyanga carts

One of the best centres of artisanal cart production is in Shinyanga market. Some traders specialize in selling locally fabricated cart axles, bearings, rims, tyres and tubes (illustration 2-A). Others specialize in making complete cart bodies (illustration 2-A). One point of interest is the fact that the carts have been

decoratively painted. Such painting has become a characteristic of well-developed indigenous cart industries in several countries (eg, Madagascar, Costa Rica, Portugal). Painting their carts distinctively has helped the manufacturers develop a recognized and known brand image. Farmers are said to request the carts by the well-known name (*Masale carts*) and other manufacturers have started to copy and imitate the successful carts.

Further evidence of entrepreneurial skills has been exhibited in the cart marketing system that has developed. Traders travel out to villages with ox carts, and exchange them for cattle (normally four animals). These are then sold in Shinyanga, and a proportion of the proceeds is reinvested in more cart components.

CAMARTEC carts

TAMTU and CAMARTEC have designed several carts during the past thirty years. Initial emphasis was placed on “appropriate technology” carts. These had steel wheels (to overcome puncture problems) and wooden bushes or wooden block bearings. Numbers of these were promoted by projects, notably the Iringa Project. On the whole these proved unpopular, because of rapid wear of wooden bushes, and high friction of wooden blocks. Farmers preferred artisanal carts, made from axles, but these were difficult to get, and the CAMARTEC carts were often available through credit.

When it became apparent that farmers preferred pneumatic tyres, and could cope with punctures, CAMARTEC (with technical assistance) manufactured rims that could be used with old Landrover tyres. They also designed a cart using two roller bearings on each side. This seemed better much better than the older designs, but was not based on the designs of carts widely used in West Africa and elsewhere that make use of tapered roller bearings.

There are no reports of objective on-farm tests of the various CAMARTEC carts, nor of comparisons with alternative models. This contrasts with the situation in Zambia where there has recently been a comprehensive programme of on-station and on-farm cart testing (Dogger, 1990). CAMARTEC staff claim that their designs are now good, and that they have passed their own testing procedures satisfactorily. Unfortunately, the lack of objective test reports, combined with CAMARTEC's poor track record spanning some thirty years, gives more scope for scepticism than optimism.

Four-wheel carts

Most carts in the country have just two wheels. Two-wheel carts are easy to make and to manoeuvre, and

most carts in Africa have just two wheels. Four-wheel carts can carry larger loads. They are much easier on the animals, since the animals do not have to take the balancing load of the cart. Historically, in both Europe and North America, four-wheel carts largely replaced two-wheel carts for carrying goods on farm and on roads. In Asia, four-wheel carts are used in and around towns, but carts with two (large) wheels are widely used in rural areas.

The most expensive components of a cart are the axles and wheels: on a two-wheel cart, the cost of the axle and wheels may well account for 70-80% of the final price. A four-wheel cart has two axles and four wheels and thus a 4-wheel cart is significantly more expensive than a 2-wheel one. Furthermore, efficient systems for allowing the front wheels to steer can be difficult (and expensive) to make.

Several organizations, including CAMARTEC and Malya ox cart workshop, Mwanza Region have designed four-wheel carts, but sales have been very few. One four-wheel cart was imported from Germany for MATI Nyegezi, but it is not in current use. Some local artisans have succeeded in making and selling 4-wheel carts, and these are generally used for trading and hire (a locally designed 4-wheel cart, pulled by a team of six animals is seen in illustration 2-C). Although such carts may prove to be valuable, it is likely the major demand will be for two-wheel carts.

Cart brakes

Few carts in Tanzania have brakes. Brakes are important not only in hilly regions. In seemingly flat areas there are often steep slopes down to river beds or up road embankments. Without brakes, animals can be hurt as a moving cart pushes the yoke forward, onto the animals' heads.

When carts are made from car axles, it is sometimes possible to make use of the car braking system, particularly if a cable brake is installed. CAMARTEC developed a braking system in which a bar is pulled into contact with the wheels. Only one of these carts was seen on during the field visit, and its brake was broken (illustration 2-H). CAMARTEC has also developed another braking system, in which the rubber-covered bar applies friction to the inside of a drum attached to the wheel. CAMARTEC claims this is more effective, particularly in wet conditions, but it is not yet widely used.

Animals themselves can act as cart brakes, provided they have a suitable harness. This is seldom the case in Tanzania. With the normal withers yoke (commonly used with donkeys as well as oxen), a cart rolling forward under its own momentum pushes the yoke onto the animals' heads. This can be

prevented by using a breeching strap around the rear of the animals, using head/horn yokes or by fixing a bar to the cart that will touch the rear of the animals before the yoke is pushed onto the heads.

Further work on the design, testing and promotion of cart brakes seems indicated. In the meantime, there are a few simple options. A short rope behind the cart can be used by people to hold a cart back in many situations, and sticks can be wedged against wheels where greater braking is needed.

Research and development

Research reports and literature

A quite remarkable number of papers relating to animal traction have been prepared in Tanzania in the past twenty years. Over 120 references are cited in the bibliography, a figure that is much higher than comparable document collections prepared in neighbouring countries.

Many of the papers cited in the bibliography are descriptive (some at a national level, others at a regional level), and while some identify problems and constraints, few are analytical or critical.

From these papers, and from discussions, it appears that there has been little rigorous research relating to animal traction in Tanzania. The research that has been undertaken can be divided broadly into on-farm surveys, concentrating on socio-economic issues, and on-station trials, concentrating on implements. There appears to have been very little follow-up to any research.

Implement research and development

As long ago as 1984, Kinsey in his analysis of agricultural implement development in Tanzania, wrote:

“It is remarkable that in Tanzania, where strong policy statements are regularly made favouring simple, low-cost farm equipment, that so little research has been done at the farm or village level, despite the fact that the need for such research was identified almost 15 years ago. Indeed it is probably valid to state that more has been said in Tanzania about equipment for small farmers and less done about it than in any other country in the region.”

In some ways, little has changed since 1984, but even more has been said (and written) about the problems of implement design and quality in Tanzania. In many of the references cited in this report, authors from the Ministry of Agriculture, development projects and universities have continued to highlight the inadequacies of animal-drawn equipment in Tanzania.

The Mbeya Oxenization Project, in collaboration with farmers and Uyole Agricultural Centre, has carried out some evaluation of plows and cultivators. The project developed its own prototype over-the-row cultivator. Although this was lent to farmers for assessment, the project maintained an admirable degree of objectivity. The farmers indicated the limitations of the design, and their preference for within-row cultivators. Equipment evaluation work is still being undertaken by the Mbeya project, and definitive conclusions have yet to be reached. It is to be hoped that the project will publish detailed reports of its research, development and testing programme, for the benefit of other organizations in Tanzania.

Hobbyism

Some organizations and individuals within Tanzania have shown a tendency towards “hobbyism”—that is

uncritically pursuing and promoting their own ideas and inventions (viewing them “through rose-coloured spectacles”). This was particularly true for some of the “appropriate technology” implements and cart designs developed at CAMARTEC during the 1970s and early 1980s.

It is quite natural for implement designers and those promoting technologies to be optimistic and enthusiastic about their ideas at the outset. Nevertheless, all mature innovators need to monitor their equipment designs in response to local needs, constraints and market forces. In particular, they need to obtain reliable feedback from farmers. This requires a humble, questioning and self-critical approach—and this appears to have been lacking in many organizations and projects.

Development strategies

Some general issues

Rural development and market access

A major constraint to further investment in animal traction is low farm income. The vicious circle of low investment and low income is made worse by the problems farmers experience in marketing produce. With improved marketing arrangements and greater farm income, farmers would be able to invest more in labour-saving and productive technologies, such as animal traction. Much animal traction in the country has spread as a result of “private sector” initiative, with farmer-to-farmer contact and the ability of private traders to supply implements and spares. It has been reported that in earlier years, rising prices of cotton and rice stimulated farmers to invest in plows and draft animals.

Government policies that stimulate efficient marketing systems and the development of rural infrastructure (notably roads and transport) will indirectly boost animal traction. If farmers can sell their crops easily, for an acceptable price, they will invest more in agricultural technology. Traders will try to meet farmers' needs for inputs, including those relating to animal traction. Although some specific strategies to develop animal traction are proposed, they will have limited effect if rural markets are not improved and farmers remain poor.

Gender issues

For cultural, social and historical reasons, animal traction tends to be a male-dominated technology, although it can benefit all household members. Women generally have less access to animal traction than men. Most extension programmes and credit schemes have intentionally or unintentionally been directed towards male farmers.

Two of the draft animal technologies that are underdeveloped in Tanzania have particular benefits for women. These are animal-powered transport and inter-row weeding. Promotion of these technologies in rural households is likely ease the burden of women, particularly in relation to on-farm and domestic transport. Women may benefit particularly from the use of donkeys for transport, and possibly for weeding as well.

Gender sensitivity is required in all animal-traction programmes. It may be that intrinsically gender-neutral initiatives are not sufficient to reach the women who could benefit from the programmes. It

may be that special attention is needed to target women beneficiaries, particularly in credit programmes.

Project approach and time horizons

Initiatives designed to improve and enhance animal traction require close contact with farmers and a self-critical approach. They also require time.

Programmes that have been effective have been farmer-orientated, adaptive and persistent. Some programmes that have been disappointing have started with answers rather than questions. Some have failed to rigorously evaluate their progress in relation to farmer's needs and the prevailing limiting factors. Some have simply been given inadequate time to respond to the identified needs.

Future research, development and extension programmes should learn from these previous experiences. This applies equally to projects concerned with introducing animal traction into new areas and to those improving utilization in existing areas. Programme staff need to work very closely with farmers, with critical monitoring and evaluation of their progress, and willingness to adapt and change their programmes as they progress. They also need long-term commitment.

Tractorization

In this paper no position has been taken on tractorization: it is assumed that, in the medium and long-term, tractor use will develop where it is profitable. However, in most cases, tractorization will **not** affect the smallholder farmers. These will be unable to afford tractors, and subsidized tractor-hire schemes have proven unsustainable and ineffective in Tanzania, and many other countries. Tractor schemes mainly benefit the tractor manufacturers, the donor countries and local officials. Unfortunately, it is in the vested interests of all these people to encourage further schemes, and they will probably propose further schemes for bringing tractors to farmers and, increasingly, to “entrepreneurs” in the private sector. Provided there are no direct or indirect subsidies, this is quite reasonable. Hidden subsidies should be avoided: for example subsidized credit provision allows local officials (farmers/entrepreneurs) to make rapid – but unsustainable – windfall profits through the hire of tractors.

If farmers are given the choice between subsidized tractor use (public or private sector) and animal

traction, they will probably opt for tractor power. While this may seem beneficial for the farmers in the short term, it will disrupt the supply and support systems for animal power. This will make it more difficult to restart animal traction when the tractors break down. Thus subsidized tractors should be avoided and animal traction should be allowed to compete on a free-market basis with both human labour and realistically priced commercial tractors.

Subsidies and realistic pricing

Animal traction technology, like other agricultural inputs, is affected by normal market forces and by pricing distortions and subsidies. Generally, subsidies on farm outputs allow farmers to choose their own ways to maximise production, which leads to innovations (European Community model). In a free market, or if output alone is subsidized, farmers can choose themselves whether they can profit most from use of commercial tractors, oxen (with UFI plow or Zimbabwe plow), donkeys or hired manual labour. On the other hand, subsidies on farm inputs tend to distort the free choice of optimal technology and this discourages innovation (central planning and donor-supported development project model). In the past, Tanzania's system of subsidies has encouraged the use of tractors where they were unsustainable. Innovative use of draft animals (at full market cost) was discouraged by the availability of low-cost tractor power.

The provision of cheap (subsidized) UFI animal-drawn plows, and spare parts, has discouraged people from manufacturing alternative designs within Tanzania or from importing [superior] implements from Zimbabwe. The availability of low-cost, factory manufactured shares has discouraged blacksmiths from developing local supplies of spares. Development projects (eg, those at Mbeya, Tanga, Mbulu) that have wished to introduce alternative implements have found it impractical to charge realistic prices for their products. The basic local market price for implements has been determined by UFI, without regard to the full costs of capital, foreign exchange, labour and management. As other organizations could not realistically price their products close to those of UFI, competition in plow and implement design has been restricted, and technological evolution delayed.

To prevent the recurrence of such situations, it is recommended that, wherever practicable, free-market pricing should apply to all animal-traction and agricultural inputs. If input subsidies are to be applied, for reasons of social assistance to isolated or impoverished areas, or as part of rural development and animal health programmes, the subsidies should

apply to a range of competing products, whether locally made or imported.

Extension and research

Prioritization and targeting

In the past, extension strategies and advice relating to animal traction have tended to be rather homogeneous for the whole country. Oxen training centres were established in relation to administrative boundaries rather than agricultural needs. In future, there should be more attempt to determine geographical and technological priorities. Particular areas should be targeted, with advice or inputs that are directly applicable to the local social, economic and environmental conditions. Such targeting should not just be based on administrative regions and districts, but upon particular soil types and farming systems within these areas.

From the animal traction viewpoint, the country can be broadly divided into areas of widespread use, areas of potential adoption, and areas where adoption seems unlikely. The broad strategy should be to improve the effectiveness in the areas of use, facilitate introduction in the areas of potential adoption and to do little (simply assess and monitor the situation) in areas where there seems little prospect of successful animal traction use.

These areas should not be considered homogeneous, and within each zone, activities should be targeted on those cropping systems, soils and societies, where changes are likely to be most effective.

Experience from within Tanzania and elsewhere suggests that animal traction technology (including the use of plows, sledges, carts, pack animals and weeders) can spread rapidly and spontaneously, once a critical mass of people has adopted the technology. Training five farmers in one village, or even placing five carts or weeders in one village, may well be more successful and sustainable than attempting to introduce technology into five different villages. Once one village has a firm use of the animal traction technology and developed the necessary supporting infrastructure the spread of the technology to neighbouring villages may be spontaneous. Thus within targeted areas and farming systems, resources should be further concentrated to achieve a critical mass of adopters to allow the technology to spread and be self-sustaining in future.

Areas of animal traction use

Within the main animal traction using areas, animal power could be more effective if animals were employed for more farm operations, notably for weeding. The increased use of work animals for cart

transport would also benefit the farmers, farming families, animals, crops and the local economies. The important issue of transport is discussed below, but it directly effects other operations. Animals used regularly for cart transport inevitably become well-trained, and one obstacle to the introduction of weeding technology is the poor standard of training of animals that are only used for plowing.

Weeding technology

Although for many years, the Ministry of Agriculture has advocated the use of work animals for weeding, there exist no comprehensive extension messages and technology packages that have been proven as transferable to farmers. The main OTC extension package (harrow, possibly seeder, UFI-Cossul weeder and heavy “Emcot”-type ridger) seems to have had almost no adoption, despite years of extension advice.

Farmers in the main animal traction zones appear ready for a suitable weeding package, and one sign of this is the fact that some innovative farmers are already, without extension advice, using plows as inter-row weeders. An intensive, coordinated, farming systems research-extension programme is required to prepare a clear and proven animal-drawn weeding extension package. The Lake Zone Farming Systems Research Team, in collaboration with Maswa Rural Development Programme, is planning to undertake an adaptive research programme in this field. This will not be a simple matter, as the Mbeya Oxenization Project animal-drawn weeder programme has been finding over the past four years in the Southern Highlands.

Networking approach

There are many people in Tanzania who have been, or who are, involved in animal-drawn weeding technology (MOP, Lake Zone FSR, Maswa RDP, Mbulu RDP, Uyole AC, SUA, MoA, CAMARTEC, UFI). There are also teams in neighbouring countries working on similar issues (Zambia, Zimbabwe, Malawi and Kenya). To ensure results are achieved within a few years, the various programmes involved should cooperate closely and establish a framework for information exchange and coordination.

At the national level, the Animal Traction Network for Tanzania (ATNET) provides such a framework, complemented at the regional level by the Animal Traction Network for Eastern and Southern Africa (ATNESA). At the earliest opportunity, these two networks should try to jointly convene an information exchange and planning workshop on animal-drawn weeding technology. This should provide a multidisciplinary forum to critically assess past experience, proven technologies and methods, and

present options. One objective of such a gathering should be to encourage research methods that are more farmer-orientated, questioning, self-critical and analytical than in the past.

In this way, it may well be possible to establish a coordinated adaptive research programme involving farmer-based testing of weeding technologies in several districts and possibly several countries. Such a programme, combined with good exchange of experiences, impact assessment and critical analysis should lead to the development of farmer-proven extension packages within a few years.

Without such a new and dynamic approach to achieve the required momentum and critical mass, there may well be a continuation of the well-meaning but ineffective small initiatives that have characterized much animal traction research in Tanzania during the past twenty years.

Seeding and harrowing technology

Animal-drawn seeders are not widely used in Tanzania. There is a desire for seeders, reported by both farmers and extensionists, and seeders would facilitate line planting and therefore weeding. Unfortunately, seeding technology is not as optimistic as that of weeding. Seeders are generally significantly more expensive than weeders and their mechanisms are prone to breakage, clogging and seed damage. While weeders have been adopted in many countries, seeders are only common in a few. While adaptive research would be desirable, it should not receive the same priority as weeding.

The research should be targeted in areas where adoption is most likely, which might be in cotton-growing areas with good marketing opportunities and critical planting times. Harrows are not generally used in Tanzania, but they may be needed if seedbeds are to be sufficiently smooth for seeder use. Again, a networking approach would be desirable, to benefit from the experiences in several districts and countries.

Rice cultivation

Work oxen are profitably used for plowing rice fields in several parts of Tanzania. They are seldom used for levelling fields, and animal-drawn levelling technology does not seem to be known by farmers or extensionists. Such technology, in the form of scoops, levelling boards and comb harrows, is widely used in other African and Asian countries. It is inexpensive and easy to manufacture and maintain. There would seem great potential for testing and introducing such technology, through a programme of farming systems research-extension. This should receive high priority, as the outlook looks favourable

from the technological and economic viewpoints. Again, a networking methodology should be used to maximise the returns to research-extension.

Conservation tillage

Considerable work has taken place in other African countries on conservation tillage practices, including tine tillage in low-rainfall areas and contour ridging in other areas. In some soils and areas of the Sahel, tine tillage has taken over from plowing as the preferred means of soil preparation by farmers. There does not seem to be an immediate farmer-led demand for such systems in Tanzania, but farming systems researchers would do well to discuss the options with farmers and with colleagues in other countries (through the various networks), to see whether Tanzanian farmers, and soils, might benefit from such practices.

Donkey harnesses

Donkeys are increasingly being used for packing, cart pulling and even cultivation. This trend is likely to continue. For packing, simple systems of using sacks slung over the back are cheap and effective (animal comfort can be increased by a simple pad on the back of the animal). Locally made panniers are also effective (again back padding is desirable). However existing systems of using ox yokes on donkeys are undesirable, being inefficient and unnecessarily painful. While yokes are appropriate to the anatomy of oxen, simple breast bands are more appropriate to donkeys. Such breast bands are widely used in other African countries, and donkey yokes are generally only found in transitional areas where farmers familiar with ox yokes have started to use donkeys. For cart pulling, the breast band should be combined with a simple saddle (or padded back band) to take the vertical load of the cart.

Simple donkey harnesses and carting saddles, based on designs used by farmers in other countries in the region, should be introduced to farmers. This may require some artisan training and sourcing of suitable materials. The Tanga Animal Draft Power Project has started to work on donkey harnessing and is intending to take further initiatives in this area. Other projects and NGOs may be able to build on their experiences.

Donkey implements

As noted, donkeys are increasingly being used for transport and for tillage. While draft oxen are likely to remain the dominant draft animals in the foreseeable future, donkeys may well become the animals of choice in certain areas, and for certain groups of people. Donkeys may well prove of particular value to women, as (unlike cattle) donkeys

are not considered a male-dominated resource. Their ease of handling may also make them more socially acceptable for women (in some areas cattle are perceived as troublesome and requiring the attention of men). It would therefore be helpful if implements, notably cultivators and plows, could be made available that are well-suited to donkeys.

Some designs have been evaluated by Mbeya Oxenization Project and Tanga Draft Animal Project. The local fabrication of favoured designs would facilitate the further use of donkeys. Present manufacturers and workshops are unlikely to make such equipment, unless they receive an initial order, or practical assistance, from a development project or similar organization.

Introduction of animal traction

From local and regional experience, it is clear that animal traction will gradually spread, bringing benefits to new areas. This may be a slow process, which may be usefully speeded up by strategic interventions and training (recent experience in Tanga, Mwanga, Mbozi and Mbeya is relevant here). In many cases, the farming systems have developed to the level where animal traction is viable, and the limiting factor for the spread of animal traction is lack of knowledge. The existing and proven extension messages relating to the use of work animals for plowing and transport may well be appropriate. However, the fact that animal traction has not spread into such areas already, may imply there are significant social, economic or environmental constraints which should be carefully considered.

The animal traction development strategy in areas where draft animals are seldom used should be to identify specific areas of priority for extension targeting. Areas should be prioritized according to the availability of suitable animals and environmental factors such as soil type, land use potential, climate and ecology. Not only should there be suitable cropping systems in existence in the priority targeted areas, but also there should be sufficient marketing infrastructure to allow farmers to justify monetary investment. Proximity to areas already using animal traction should be considered a positive factor. Lack of animal handling tradition may not be a crucial constraint, provided profitable farming and marketing systems are available.

The existence of a motivated NGO development organization, donor assisted project or enthusiastic MoA extension team should also be considered when targeting areas of introduction. (In general, small projects and NGOs seem to have a comparative

advantage over larger organizations in effective animal draft power introduction programmes).

In all cases, area-specific studies should be made of the social, economic and environmental implications, before the areas are targeted. With high-potential areas, emphasis should be on developing within specific localities the critical mass of users that will allow local sustainability and subsequent farmer-to-farmer transfer of knowledge to wider areas. From the outset, all training of animals and farmers should be village based, and gender sensitive.

Carts and transport

There is much evidence from Tanzania and neighbouring countries that animal-drawn transport has major benefits for farmers, farming families, agronomic practices, animal nutrition and local trade. Most areas of Tanzania are very underdeveloped in cart use, and this could be changed if good, affordable carts were more readily available.

Wheel and axle design

The main technological requirement for a cart is a good axle, complete with bearings and wheels. If such axles are available it is easy for local artisans to build cart bodies onto them. The provision of an effective braking system is highly desirable, but this has proved quite difficult to achieve. The experiences of several projects in Tanzania and neighbouring countries suggest that carts should have tapered roller bearings and pneumatic tyres. Most human powered carts in use in Tanzanian towns have these (derived from old car axles) as do the animal-drawn carts being successfully marketed by private artisans in Shinyanga and elsewhere. Even in Zanzibar and Pemba (areas where artisan-constructed carts have been used for a long time) there is a move towards such carts.

The “appropriate technology” approach to carts, using wooden or steel wheels and wooden bushes or bearings, as developed by TAMTU and CAMARTEC and other organizations has had little impact, and areas where such carts were promoted (such as Iringa) still have underdeveloped cart systems. Experience from other African countries suggests that animal-drawn transport really takes off if affordable, good quality axles are purchased in sufficient quantities to allow a critical mass to develop. Some doubts have been expressed as to whether the latest (roller-bearing) axles from CAMARTEC, IPI and Themis (and the proposed one of UFI) really meet the requirements for quality and reliability. Sales of such axles appear slow and lower than the artisan-produced ones.

Locally-produced carts, based on scrap vehicles, will continue to be important, but these are unlikely to be sufficiently numerous to meet the potential demand. There is likely to be scope for one or more manufacturer and/or importer to sell reasonable numbers of axles (several hundred a year at least), provided they are of good quality and affordable.

Standardization

There would be great advantages in terms of spare part marketing and distribution if bearings and wheels were to be of standard sizes. (In the Mbeya Region, the farmers have tended to adopt the “Landrover” standard of wheel size, and have been cautious about non-standard wheels and axles imported from Canada). However, innovation and farmer choice should not be precluded merely for the sake of standardization.

Entrepreneurial support

Project initiatives to assist the production and distribution of axles should attempt to build on, and not undermine, the genuine private sector initiatives that have built up in some areas (notably Shinyanga).

Credit

While cart ownership is generally profitable and affordable, farmers are often constrained by the initial high cost. Local traders have helped to overcome this problem among cattle-owners by taking carts to the villages, and exchanging them for cattle (eg, four small/medium animals). Experiences from other countries suggest loans for carts can be repaid from hire income and increased production and trade. The provision of credit for carts seems desirable and justified and creative ways to develop effective medium term credit should be investigated.

Objective testing programme

There would be benefits from an objective cart testing programme. This should be based on the experiences of Magoye animal draft power programme in Zambia (Dogger, 1990). There should be both on-station tests, and on-farm assessment by farmers in several areas. The system whereby carts are moved between testing farmers every few weeks has particular value, as farmers can compare the relative advantages and disadvantages of different designs. Such objective tests, if well recorded and reported, would help to finally resolve the claims and counter-claims for the various carts in the country, particularly those designed and/or produced by CAMARTEC.

Although it has a mandate to test equipment, CAMARTEC would not be a suitable organization to undertake such testing. There would be clear conflicts of interest if CAMARTEC were to try to

carry out objective tests on carts it had itself designed and built. An independent project based at CAMARTEC might be able to do the testing, although this might create friction (for example there could be a donor-assisted, volunteer project requested by the National Animal Traction Steering Committee). The testing could be carried out as a university project or it could be carried out in the context of a donor-assisted project, such as that at Maswa. It is suggested that tests be carried out on all carts manufactured in quantities of more than 100 per year. This would include the largest artisanal producers. Some tests could be carried out on other representative artisanal designs.

The costs of such testing would be justified by the potential savings to future government-sponsored and donor-assisted projects. These often order carts in large numbers, with little knowledge of their qualities. For example the Iringa rural development project ordered several hundred carts of a design that proved unpopular, and Maswa has recently purchased 50 Them/CAMARTEC cart kits.

The tests should be rigorously and fairly undertaken, and the results openly published. As with other consumer-orientated tests, assessments should be made on the basis of value for money for the farmer, and not simply on engineering perfection. Without the consideration of cost to the consumer, the test results would naturally tend to be interpreted in favour of the strongest and most durable carts. Farmers may well find low-cost carts of intermediate durability more appropriate.

Animal-drawn implements

Manufacture and supply

The designs of the implements manufactured and imported by UFI have major problems that have been known for a long time. A market-orientated manufacturer and importer, would have taken steps to rectify the problems long ago. UFI has consulted with the parastatal suppliers of technical information at both CAMARTEC and SIDO. Unfortunately, the indigenous and expatriate specialists working within these organizations do not seem to have been closely in touch with farmers. A large range of plows, harrows, seeders and other prototype implements has been developed by these organizations. Their lack of widespread adoption illustrates the basic problem of an engineering-orientated, top-down approach to animal traction technology. The designers have tried to [re-]invent rather than take established designs, and fine tune them in accordance with farmer wishes. A market-orientated manufacturer and importer

would long ago have started to seek advice from other sources.

The present situation reflects badly on UFI, which for many years seems to have largely ignored feedback supplied by agriculturalists and projects during visits, meetings, seminars and workshops. Change is likely to come if UFI adopts a new receptive and market-orientated management approach.

Privatization and/or partnership

Change at UFI might well be achieved from some form of privatization. The terms of reference of the present mission did not stretch to consideration of such details, but the impression gained from the people contacted was that UFI would benefit greatly from being managed by one of the private sector implement factories already existing in the region (for example in Zimbabwe). If such a firm were to purchase UFI, or enter into a creative partnership, the new UFI should have the necessary management expertise and animal traction technology designs to respond to the needs of the farmers in Tanzania. Similar conclusions apply to ZZK, and market forces might be improved if ZZK were to be managed in partnership with a different implement-manufacturing company from that of UFI.

Donor-assisted projects to improve UFI and ZZK are not considered appropriate, unless the implementing company (and/or technical assistance personnel) invests and risks its own capital in the venture. Both factories have received well-meaning technical assistance in the past, but the expatriates have been able to leave without living with the consequences of their advice (wooden-beamed plows at ZZK, large importation of plows by UFI). Elsewhere in the region, north-based companies have helped establish or revitalize implement factories (for example in Zambia). However, their profits have come exclusively from the donor-financed aid contracts supplying equipment, materials and expertise and not from the subsequent sales of implements. This has meant that they have not always been rigorous in identifying market (farmer) preferences or using local sources of material (Starkey *et al*, 1991).

Complete privatization of the factories runs the risk that the owners will stop making plows, as they may well be able to obtain a better return on their investment by manufacturing other goods (such as metal window frames, burglar bars, grills and gates). The risk would be less, if the factories were run in partnership with external companies already involved in manufacturing plows. In such cases it would be important that the partner companies (whether private capital or donor-assisted) should undertake some entrepreneurial risk and have a direct financial

interest in the successful marketing of plows within Tanzania (not merely a technical assistance contract).

With the opening up of the Tanzanian market, the factories will have to compete, on a free-market basis, with imported products from the region. This is likely to be healthy, but aid donors should be discouraged from dumping subsidized products on the local market. (This is not unusual, for two European donors recently sent several thousand European-made plows to neighbouring Zambia at subsidized prices).

Implement distribution

Implement distribution in the country remains inadequate. This has been noted in a large number of MoA documents, consultancy reports and seminars over the past decade. The problem appears to be a combination of unresponsive parastatal organization and the low levels of profit and incentive involved in animal-drawn implements (a continent-wide problem: high profits usually only come from supplies to public-sector institutions and donor-assisted projects and not direct sales to farmers).

Manufacture and trading in animal-drawn implements and spares are not very attractive as sales are highly seasonal (usually one buying season a year) and dependant on weather and farmer income. Implements are heavy and/or bulky, so that transport is expensive. The capital and management effort tied up in stocks of implements and spare parts could almost certainly give higher returns if invested elsewhere. Workshops could make more income from constructing window frames and burglar bars (few specialized steels, richer urban market, year-round sales and higher turnover). Distributors and traders could generally make more money dealing in consumer goods with more regular sales.

In areas where transport links are good and clear demand has been established, private traders are selling plows and spare parts, and this is likely to continue. However, market forces will not respond adequately to all the present distribution problems. In particular, market forces will continue to neglect the supply of implements and spares to the remoter, poorer districts. Assuming it is national policy to develop such areas for reasons of social benefit and long-term investment, there will be a clear role for development organizations in facilitating the supply and distribution of implements. Wherever possible, this should be done in association with local shops, traders or farmers' groups, since public-sector equipment depots will prevent the establishment of private sector distribution systems.

Implement testing and development

The strategy developed in the preceding sections has assumed a multi-institutional, networking approach to implement research and development, involving the various manufacturers and organizations (notably donor-assisted projects and NGOs) working in close contact with farmers. In view of the problems of recent years, no central role has been assigned to CAMARTEC. It is assumed that CAMARTEC would wish to be involved, and that it should be able to make a valuable contribution to the programme.

If CAMARTEC did not exist, there would be a tendency (particularly among agricultural engineers) to recommend the establishment of an institution with a similar mandate. For over twenty years there has been a clear and identified need for some organization to coordinate work within the country relating to animal-drawn implements, objectively test implements in collaboration with farmers, and ensure that the implement manufacturers produced a range of implements well-adapted to local farming systems. CAMARTEC (and its predecessor TAMTU) has a clear national mandate to do. Unfortunately the fact that there are still widely acknowledged problems with the UFI plow, that suitable weeders have not been developed, and that there are no detailed, objective and rigorous test reports published for the various animal-drawn implements and carts on sale in Tanzania speaks for itself.

Ministry of Agriculture staff would like CAMARTEC back under their ministry. While this suggestion has much merit, it is weakened by the fact that CAMARTEC was removed from them before because of previous lack of effectiveness. The parent ministry seems much less important than the approach of the centre.

TAMTU and CAMARTEC have been station-based and technology-orientated, with great self-confidence in their own engineering prowess. They have not been basing their work sufficiently on actual farmer experience nor the results of farmer-orientated programmes in neighbouring countries.

What seems to be needed is a completely fresh, humble, farmer-orientated approach. This should really have been developed during the past twenty years, as the problems of the technology-orientated approach became increasingly apparent. If CAMARTEC can be rejuvenated and restructured to allow it to fulfil its existing mandate effectively, it could become a most useful resource for the development of animal traction in Tanzania.

Professional training

Training institutions

Formal training in animal traction could be significantly improved at all levels (certificate, diploma and degree). One problem is that most of the present course instructors (at the colleges and the universities) were themselves trained during the 1960s and 1970s, when animal traction was badly neglected and tended to be presented in a technology-orientated, "top down" way. It is important to provide these people with a farming-systems perspective, so they themselves can see animal traction from a farmer's view point. This could well be achieved through a series of professional courses or workshops organized by the national animal traction network, working with the regional network (ATNESA). Such courses should involve a significant proportion of their time working in small groups in villages with farmers.

This professional upgrading is important, and other proposed actions might well be implemented within the context of such joint professional programmes.

It is important to continue to review the animal traction syllabi at the universities and in all training institutions. In some institutions there have indeed been recent revisions to counteract the relative neglect of animal traction seen in the 1960s and 1970s. This process should be continued, to ensure that appropriate practical and theoretical aspects of animal traction are covered. One animal traction training syllabus (Massunga, 1992) has recently been prepared for discussion at the national animal traction steering committee, and such an approach is to be encouraged.

Training manuals and materials

There is a lack of appropriate books and training and extension materials relating to animal traction. Although some training booklets (in Swahili and English) have been prepared by projects in Tanzania (eg, MOP, TCRS) and in neighbouring countries, these are not yet used within training institutions.

This problem should be addressed by the national animal traction steering committee, in liaison with the regional network (ATNESA). Several institutions in the region (notably those in Zimbabwe, Zambia and Malawi) are also interested in developing new training materials, based mainly on the useful documents prepared in Zimbabwe (AETC, 1986 and 1987; Jones, 1991).

Using the coordinating framework of the national network (ATNET), copies of all existing animal traction training materials from Tanzania and neighbouring countries should be obtained, reviewed

and analysed by both training institutions and extension programmes in terms of the present needs of Tanzania. There should then follow discussions with colleagues from neighbouring countries (within the framework of ATNESA) to share experiences, and to develop (or simply adapt) new training materials. These could then be published in Tanzania, in cooperation with existing organizations.

Some of the training institutes lack a full range of animal traction equipment (in this way they identify closely with those farmers who only have worn-out plows!). As part of the proposed development initiatives on weeding technology and rice production technology, it is suggested that samples of the equipment being tested and developed are provided to the training institutions.

Upgrading extension staff

Many, or most, existing extension staff appear to have inadequate knowledge of animal traction and an unquestioning, "top-down" approach to extension. This is not surprising given the type of training provided in recent years. Many extension agents, and their supervising officers, could probably repeat the old messages learned by rote about feeding animals well, adjusting plows and the importance of good harrowing, planting and inter-row weeding. They would have great difficulty in actually training and working with animals themselves (unless they were born in an animal-using village), and they would be able to offer the farmers little, if anything, in the way of practical advice on improving their present system of using animal traction.

To upgrade all staff will take a long time, and so it should be based on priority areas and topics. In some cases, the training could be implemented in the context of the existing NALERP programmes. In most instances successful animal traction extension will depend not just on simple extension messages, but on the provision (in some form) of suitable supplies and backup services (eg. traders/projects selling carts or weeders or artisans making donkey harnesses or rice levellers).

The extension upgrading should therefore be targeted in areas where there are current farmer-training or on-farm research programmes (eg. Tanga, Maswa, Mbulu, Mbeya, Mbozi, Mwangi). The training should be carried out by, or in collaboration with, the relevant active programmes and local farmers. This is already being done in some of these areas.

Farmer training and the OTCs

It is recommended that most (or all) future farmer training relating to animal traction be based in villages, with emphasis on on-farm evaluation of

techniques, on-farm demonstrations and village-based field days. If training of groups of farmers is required, temporary village-based training centres have proved most effective in Guinea, Mali and elsewhere. Farmer-organized training of animal traction techniques has recently proved effective in Tanga.

The Oxen Training Centres (OTCs) have proved ineffective due to both lack of resources, their inappropriate (top-down) approach and their on-station training methodology. Since they are not really operating at present, their immediate closure would not effect the national situation. However, their blanket closure might give the wrong impression about the government's commitment to animal draft power and it is not recommended.

The OTCs could have been useful had they been part of an adaptive research-extension programme to develop with farmers, clear, farmer-proven extension messages relating to animal draft power. They could still be used as bases (and equipment depots) for village-based training appropriate to the local farming systems and needs.

Regional and district field agricultural staff should be asked to suggest creative ways in which the OTCs could become valuable resources.

Some OTCs might be useful in the immediate future for specialized in-service training of extension staff in areas where other facilities are unavailable. In this case they should be adequately funded through the extension and training programme.

If the Ministry has no immediate use for their facilities, they should be offered (through sale or rent) to others. These might include:

- NGO development organizations wishing to assist promotion of animal traction (e.g. TCRS, COOPIBO).
- The existing staff if they wish to try to provide self-financing (privatized) training, hire or implement supply/trading.
- Farmers' groups wishing to develop implement supply centres.
- Other entrepreneurs with creative ideas for using the facilities (cart production, trading depots, etc).

In these ways the OTCs may yet prove to have a role in the agricultural development of Tanzania.

Credit

Evidence from Tanzania and elsewhere suggests that while animal traction can spread slowly without

credit, its rate of adoption can be increased significantly by the provision of credit. There is also evidence that medium term loans for animal traction can be repaid by farmers, and that well-organized credit schemes have a very high rate of reimbursement of loans. Reimbursement is greatest where there is some form of social control relating to the loan (eg. group approval) and least where farmers see loan as government money (and their slice of it). In several countries, very effective animal traction credit schemes have been established by the companies promoting and marketing cotton or groundnuts.

The biggest need for credit is for the purchase of ox carts, which may cost about Tsh 80,000 (say US\$ 200). It is very difficult for farmers to acquire that amount of capital through savings. Farmers with reasonable herds of cattle have proved willing to relinquish four cattle for a cart, but this would be excessive for the owners of small herds, or a single pair of animals.

The agricultural, social and economic benefits of widespread adoption of animal-drawn carts can be seen in several areas of Tanzania and in many other countries in Africa. There is clear evidence that facilitating the introduction of a significant number of carts into an area leads to the development of a critical mass of users and support services. The carts then directly stimulate and facilitate increased agricultural production, crop-livestock integration, local trade and increased economic activity, with major social and economic benefits.

While it recognised that the government and aid agencies are very wary of credit schemes, there does seem to be a special case for loans relating to animal-drawn carts. This is because their purchase price tends to be prohibitive even though they are affordable in the medium term, and are justified in terms of agricultural, economic and social benefits. They are also easily recognizable and identifiable in the case of loan default.

It is therefore recommended that special consideration be given to developing creative, and effective, credit facilities to allow the purchase of animal-drawn carts. In the first instance these should be targeted on areas where draft animals are already common, but few carts are used (for example much of Mara and Mwanza and parts of Tabora, Shinyanga, Singida, Iringa, Mbeya and Rukwe). The success of such schemes will depend on there being carts of suitable quality (ie. **not** the old CAMARTEC designs that proved unpopular in Iringa and elsewhere).

In areas of introduction, farmers may well require access to credit for the purchase of draft animals. Such loans are often very important, but very risky. They are best given by organizations (such as NGOs or small development projects) working closely with farmers, in systems involving some social control. It is recommended that such organizations assess the needs for animal traction credit within their area, and develop suitable credit schemes based on the experience of similar projects in Tanzania and elsewhere.

Blacksmith support/training

Evidence from Tanzania and elsewhere suggests that blacksmiths have a valuable role to play in supporting the development of animal traction. Tanzania does not have the high density of blacksmiths found in some other countries in Africa. Blacksmiths in Tanzania often do not have the raw materials to work effectively, and in some cases they can benefit from specific skills training. There is also evidence that highly trained and supported blacksmiths often migrate to towns where they find it easier to find a lucrative market for their new skills.

Some development projects have been trying to involve local blacksmiths as implement and spares manufacturers and/or dealers in their animal traction programmes (eg. Mbeya, Mbulu). It is recommended that this experience be analysed and discussed within the framework of the national network (ATNET), in order to develop guidelines on the options for, and implications of, supporting blacksmiths to support animal traction.

National network and coordination

For a long time, there has been a clear need for improved liaison, coordination and collaboration in relation to animal traction. The recent creation of the Animal Traction Network Tanzania (ATNET) and the National Animal Traction Steering Committee is therefore to be greatly welcomed. As indicated in a previous section, this network could prove most valuable and cost effective, particularly if it maintains a light, facilitating approach to network coordination, with concrete, farmer-orientated objectives, decentralized initiative, delegation, broad participation, flexible responsiveness and regular monitoring. The network should be able to link government organizations, researchers, manufacturers, projects, NGOs, farmers' groups and other interested bodies, who would not otherwise be linked.

A networking approach seems particularly appropriate in the Tanzanian situation where certain

institutions and/or individuals may, for a time, become underfunded, stale or ineffective and where projects rise and fall quite rapidly, with changes in donor funding and personnel. In such circumstances, the flexible structure of a network allows centres of initiative and leadership within the network to change, and evolve with time. This allows those members in the position to do so, to take a lead for a time. The network can thus continue to work towards its common objectives even if one organization, project or individual ceases to be effective. This very process may stimulate changes in the weak organizations and individuals, as the success of the network is recognized.

It is extremely important that the network does not become too centralized or institutionalized, otherwise it might begin to suffer from the unresponsiveness and ineffectiveness that unfortunately characterises some Tanzanian parastatal organizations. With the present enthusiastic mix of government officers, academics, project staff, manufacturers and NGOs, this seems unlikely.

National coordination project

The members of the national animal traction network all have full-time, demanding jobs, often with regionally-specific mandates. They do not have time to concentrate on developing ways of improving animal traction within the country. The national network and steering committee would benefit from the services of a small animal traction coordination team. This might well comprise a Tanzanian animal traction coordinator and an expatriate technical adviser. It would be charged with facilitating and initiating animal traction coordination programmes, such as those discussed in this report. The unit, which could be based within the Ministry of Agriculture or at the Sokoine University of Agriculture, might well be funded through a bilateral project. A large programme is not envisaged, but there should be sufficient resources allocated to ensure the unit is mobile and is able to organize national-level workshops and planning meetings. The unit should also have the resources to sponsor some visits to animal traction programmes in neighbouring countries, and to hire national or international experts to assist on specific problems, the study of key issues and the formulation of further national or area-specific programmes.

It is recommended that an outline project proposal for a national animal traction coordination project is drawn up, in consultation with the National Animal Traction Steering Committee. It might be that Dutch organizations would show particular interest in this proposal, given the importance of animal traction to

several on-going rural development and farming systems projects sponsored by The Netherlands within Tanzania and neighbouring countries.

International network/coordination

Tanzania has much to gain from the experiences of other countries in the region. The Animal Traction Network for Eastern and Southern Africa (ATNESA) provides a framework for such exchange of information. Tanzania has already started to benefit from, and contribute towards, improved understanding of the important issues and possible solutions. It is strongly recommended that people responsible for planning and implementing animal traction programmes in Tanzania continue to actively participate in ATNESA activities.

There is to be an ATNESA regional workshop in Zimbabwe in January 1993 on the design, testing and manufacture of animal-drawn carts. Tanzania has much to benefit from the experiences with animal-drawn carts of Zambia, Malawi and Zimbabwe. It is strongly recommended that representatives from several Tanzanian organizations participate (eg. MOP/UAC, UFI, CAMARTEC, SUA and Maswa RDP).

ATNESA has proposed that a regional workshop should be held on animal-drawn weeding and ridging technology. It was tentatively suggested that Zambia might host this in 1993, but there are presently no firm dates or location. Tanzania has much to gain from the work of Zambia and Zimbabwe in weeding and ridging technology. Since it is of such importance to Tanzania (see previous section), it is recommended that Tanzania now offers to host this regional

workshop. Tanzania will in this way be able to combine a proposed national workshop on this subject with valuable expertise coming from other countries in the region. An outline proposal for this will be drawn up, as an annex to this report.

Tanzania can gain from the experiences of Kenya, Zimbabwe and Botswana on donkey harnessing. ATNESA has suggested a regional workshop on donkey technology should be held, and Tanzania should certainly be able to benefit from this. In the mean time, the Tanga Animal Draft Project has plans to build on regional experience, and prepare a donkey manual, based on a Zimbabwe publication, and this initiative is supported.

Further useful areas of regional cooperation, from which Tanzania might benefit include:

- the design and manufacture of animal-drawn implements (a workshop to be organized by the regional AGROTEC organization, based in Zimbabwe);
- the development of national/regional training materials and extension manuals (much interest/experience exists in Zambia, Malawi and Zimbabwe);
- conservation tillage (much work on this has been done in Zimbabwe);
- the use of cows as draft animals (experience in several countries in the region, including Ethiopia, Zimbabwe and Zambia).

Conclusions and recommendations

General policy issues

- Animal traction can be boosted by general improvements in crop marketing systems, increased producer prices and the development of rural infrastructure.
- Animal traction could be adversely affected by direct and indirect subsidies on tractor importation and use. Animal traction should compete on a free-market basis with human power and tractor power.
- Selective subsidies on farm inputs should be avoided, as these distort rational technological choice and inhibit the development of alternative options. Any subsidies should apply to outputs or to a *range* of inputs. In this way farmers can choose the most suitable technologies to optimise the outputs of their farming systems.
- As far as practicable, realistic market prices should be applied to locally-manufactured and imported animal traction equipment. In recent years, the market for implements has been distorted by arbitrary pricing policies of UFI.
- Animal traction research, development and extension programmes need to be farmer-orientated, self-critical, adaptive and long-term in nature.

Gender issues

- Animal traction tends to be a male-dominated technology although it can benefit all household members. Increasing animal-powered transport and inter-row weeding may have particular benefits for women. Women may gain from further use of donkeys. Gender sensitivity is required in all animal-traction programmes.

Extension policies

- A uniform, country-wide extension policy relating to animal traction is not appropriate. Areas should be classified and prioritized in terms of their present state of animal traction use and their potential for change.
- In encouraging the spread of animal traction technologies (plowing, weeding, transport, etc), extension efforts should be concentrated in areas of highest potential adoption. Efforts should be directed towards localities where a critical mass of users can develop so ensuring sustainable

supply and support services. This will assist the subsequent spread to further areas through farmer to farmer contact.

- The spread of animal traction into new areas can be speeded up by an enthusiastic extension team working closely with farmers. Small donor-assisted projects and NGOs have a comparative advantage in this field. Limiting factors to adoption should be identified by farmers at the outset and emphasis should be placed on tackling these. Efforts should be concentrated in specific villages or areas of high potential. Training of animals and farmers should be village based and gender-sensitive.
- In-service training of extension staff is required. It should be orientated to local animal traction priorities. Extensionists should be taught new skills directly relevant to the local situation (weeding technology, donkey harnessing, cart maintenance, animal training, etc). Extension agents require training in participatory methods and problem solving, to counteract the familiar “top-down” approach.
- Appropriate training materials and extension manuals are urgently required by extension workers and agricultural colleges. The National Animal Traction Steering Committee should address this issue. Any new publications should be prepared in collaboration with programmes in other ATNESA countries, such as Zimbabwe, Zambia and Malawi.
- New roles should be found for the old oxen training centres (OTCs) within the context of Ministry programmes, NGO development projects or private sector initiatives.

Credit

- Farmers have great difficulty in saving the capital required for the cash purchase of carts, cultivation implements and work animals. The provision of credit can speed up the adoption of animal traction technologies. The provision of credit for animal-drawn carts is particularly recommended.
- In other countries, credit provided by cotton and groundnut marketing organizations has proved most effective. In the absence of this, emphasis should be placed on locally-managed savings

and credit schemes with social control over loan allocation. Loans for the purchase of animals should be given with great caution, with insurance provision and agreed village-based social supervision procedures.

- Particular attention should be paid to ensuring women have easy access to credit facilities.

Animal-drawn carts

- Animal-drawn carts have numerous agricultural, economic and social benefits. A high priority should be given to increasing the number of carts in rural areas.
- Adoption would be stimulated by the provision of credit to purchase carts.
- For sustainable production and low distribution costs, carts should be built close to the end-users. There may be a role for centralized production and/or marketing of axles and components (bearings, hubs, wheels, tyres and tubes).
- Local artisanal manufacture would be stimulated by increasing the availability of appropriate axles and/or components. In areas of animal traction use, the establishment of regional, district and/or local stocks of suitable bearings, wheels, tyres and axles would be very beneficial. Where possible, development agencies and NGOs should assist private entrepreneurs and traders to develop such stocks. Emphasis should be placed on axles with roller bearings, whether derived from vehicles or imported.
- Standardization should be encouraged. If scrap axles and wheels are imported, emphasis should be on the existing preferred designs (16" wheels).
- Despite years of research and development work, controversy still surrounds the various carts being promoted in Tanzania. The main existing designs of carts and axles should be subjected to a programme of objective on-station and on-farm testing. The technical results should be published, with discussion of the relative costs and benefits of the designs. This activity should be supervised by the National Animal Traction Steering Committee, and not by CAMARTEC alone. A small, donor-assisted project could be arranged to implement this testing programme.
- Some lightweight carts for single donkeys should be made and evaluated by farmers. They should be based on the widely-adopted West African designs, incorporating two shafts and a load-bearing back saddle. This work would best be

undertaken by a donor-assisted project in a donkey-using area (eg, Mbulu, Maswa).

Implement manufacture

- Although the key problems have been discussed for many years, Tanzania is still faced with inadequacies in the range of animal traction implements, and their design and supply. The major manufacturer, UFI, is well-equipped to meet local demand, but needs a market-orientated management. This might be achieved through privatization and/or partnership with an existing private-sector plow manufacturer.
- The basic plow needs few modifications, but there is need for a suitable weeder/cultivator. A basic cart axle would be useful. Options for the local production of a range of lighter implements could be discussed if initial trials and market surveys seem encouraging.

Weeding technology programme

- Animal-drawn weeding is little used in Tanzania, but it has been successfully spread in some other African countries. Some farmers seem ready for the technology, and have started experimenting with plow-weeding.
- An intensive, coordinated farming-systems programme should be established to develop and test farmer-proven extension packages for animal-drawn weeding. These may vary with the different ecological zones, cropping systems and draft animals employed.
- A collaborative, networking approach is recommended, benefiting from the coordination frameworks of Tanzanian and regional animal traction networks.
- An initial workshop should be held to review research and extension experiences from within Tanzania and from other countries in the region. This should identify a range of suitable implements and techniques for pilot on-farm testing. Multi-locational on-farm trials should be organized by existing farming systems research programmes and agricultural development projects. After one season, progress should be critically assessed, and the more successful technologies should be tested in further locations.

Rice cultivation

- Few farmers in Tanzania use draft animals for levelling rice fields although this critical, labour-intensive operation is performed with work oxen elsewhere. Appropriate farming systems

research/extension initiatives are indicated in rice producing regions, like Mwanza.

Donkey harnessing

- Work is required on donkey harnessing. Many donkeys are yoked, as the breast band harnesses used with donkeys in other countries are not widely available in Tanzania. The Tanga animal power project has started to investigate options for designs and local manufacture. This work should be continued. The initial findings of the Tanga project should be summarized for the National Animal Traction Steering Committee, and proposals drawn up for follow-up work.

Blacksmith training

- The National Animal Traction Steering Committee should address the role of blacksmiths in supporting animal traction. It could commission a study in this area., to highlight successful and unsuccessful project experiences, and suggest a range of local or regional interventions to improve the situation.

National Animal Traction Steering Committee

- The formation of the Animal Traction Network for Tanzania and the National Animal Traction Steering Committee is greatly welcomed. These coordinating bodies should be supported by all organizations involved in animal traction in Tanzania. Their members have already exhibited enthusiasm and voluntary commitment and, provided this continues, their modest operating requirements should be met by the Ministry of Agriculture or an appropriate donor organization.

Local coordination project

- There is much need for coordination of actions to improve animal traction in Tanzania. The proposed initiatives relating to weeding technology, cart design, implement production, donkey harnessing and training materials will require efficient liaison and purposeful collaboration. Members of the National Animal Traction Steering Committee do not have sufficient time or resources to undertake all this.
- A proposal should be drawn up for a national animal traction coordination project, with a full-time coordinator, appropriate technical assistance and sufficient resources to ensure coordination. The National Animal Traction Steering Committee should act as the advisory/supervisory body for this project.

ATNESA

- The Animal Traction Network for Eastern and Southern Africa (ATNESA) provides a valuable means by which Tanzania can benefit from the experience of neighbouring countries. Such networking is highly cost-effective and beneficial, provided it is combined with self-critical, local activities.
- All organizations working with animal traction in Tanzania should endeavour to benefit from ATNESA activities and publications.
- Supporting donor agencies should be prepared to sponsor Tanzanian participation in appropriate ATNESA activities, and to co-fund ATNESA events particularly relevant to Tanzania.

Animal traction directory: Tanzania

Introduction

In the following sections, some organizations concerned with draft animal power in Tanzania are listed and their involvement with animal traction is briefly described. Relevant publications and reports produced by each organization are cited, and the full references are given in the bibliography that has been prepared for this report. Firstly, permanent government institutions and parastatal organizations are listed alphabetically, in order of the relevant ministry. There then follow more ephemeral government institutions (donor-sponsored projects) and non-governmental organizations. Private sector organizations are listed as are some of the main aid agencies involved in animal draft power.

The information contained here derives from *Starkey, 1988* and *Simalenga and Hatibu, 1992*, as well as from information collected during the mission discussions and field visits.

Ministry of Agriculture

Ministry of Agriculture P.O. Box 9192, Dar es Salaam

The Ministry of Agriculture, often known by its Swahili name "Kilimo", is responsible for agricultural research, extension and training. This includes work relating to animal traction development and promotion, carried out within normal ministry programmes and in the context of donor-assisted development projects in several parts of the country.

The mechanization section has, for many years, been advocating greater oxenization. It has also been planning and implementing tractorization programmes. It has had a theoretical development strategy based on rehabilitating oxen training centres (OTCs) and creating mobile training units. This strategy has not been implemented, due mainly to lack of resources. Relevant publications include: *MoA, 1986; Hassan, 1987; Kayumbo, 1987a, 1987b, 1987c, 1990, 1992a, 1992b, 1992c.*

The planning division has been responsible for preparing development strategies and programmes in consultation with the relevant professional departments. In the case of animal traction this has involved mainly the mechanization unit. It is generally accepted that the data on which planning decisions are made are relatively unreliable. Relevant publications include: *MoA, 1991.*

A national agricultural and livestock extension rehabilitation programme (NALERP), based on the training and visit system, has been initiated with World Bank support. A publication linking this to animal traction is: *Mwasha, 1992*

The research and training division does not have any special programme relating to draft animals, but animal traction is one area of concern of its farming systems programme. This is currently receiving technical assistance and support from The Netherlands. The division has not produced any research or training publications specifically relating to animal traction, but two relevant farming systems documents are: *Bantje, 1989* and *Ngendelo, 1991.*

MATI Mlingano, P.O. Box 5051, Tanga

Telex: 45033 NOTCO; Phone: Ngomeni 12

Ministry of Agriculture Training Institute (MATI) at Mlingano offers a two-year diploma course in agromechanization. Animal traction technology is allocated 102 hours (17 hours theory and 85 hours practical) in the curriculum. The syllabus covers selection, training, management and use of draft animals, as well as harnesses, yokes and animal-drawn carts. The institute also offers short courses to agricultural extension workers and farmers on animal traction technology. The institute lacks appropriate training publications relating to animal traction.

MATI Nyegezi, P.O. Box 1400, Mwanza

The Ministry of Agriculture Training Institute (MATI) Nyegezi received a great deal of capital assistance from GTZ during the 1980s. This was mainly in the form of tractors, tractor-drawn machinery and associated infrastructure. It also received a four-wheel ox cart, made in Germany. Most of the tractors are now out of order, and the lack of investment in the animal draft power section is very apparent. The institute is therefore now trying to develop a small animal draft centre. The institute uses local oxen. It once obtained four water buffaloes for draft work. Although these apparently worked satisfactorily for a time, they all died and were not replaced. The institute generally lacks animal traction implements and carts in working condition, and it does not have suitable training publications. The head of its animal traction unit underwent an animal traction training course in Zimbabwe.

MATI Ukiriguru, P.O. Box 1434 Mwanza

The Ministry of Agriculture Training Institute (MATI) at Ukiriguru has an animal traction unit. It identified that the supply of animal-drawn carts was a problem. It has therefore recently undertaken a small, Canadian-funded project to introduce animal-drawn carts in the area immediately surrounding Ukiriguru.

**Uyole Agricultural Centre (UAC)
P.O. Box 400, Mbeya**

Phone: 065-3081; Telex: 51039

Uyole Agricultural Centre is charged with training agricultural students at certificate and diploma level as well as carrying out agricultural research. The Agricultural Engineering Department was established in 1974 and research on draft animals started in 1979, and led to the development of some two- and four-wheel ox carts and a wooden wheeled toolcarrier. In recent years it has concentrated on weeding technology, in cooperation with the Mbeya Oxenization Project. It has also developed some extension leaflets, in cooperation with Mbeya Oxenization Project and Usangu Irrigation Project. Relevant publications include: *Kwiligwa, Shetto and Haule, 1992; Kwiligwa, Shetto and Rees, 1992; Kwiligwa et al, 1992; Shetto and Kwiligwa, undated and 1992; Shetto, Kwiligwa and Haule, 1989.*

Ministry of Industries and Trade**P.O. Box 9503, Dar es Salaam**

The Ministry of Industries (commonly known by the Swahili name "Viwanda") is very involved with animal traction development through the activities of several parastatal organizations for which it has responsibility. Through the National Development Corporation, the Ministry is responsible for the two major parastatal implement factories: UFI and Zana Za Kilimo. It is also responsible for CAMARTEC (the organization most involved with the research, development and testing of animal traction equipment), TEMDO (provides technical support to industrial-scale manufacturers) and SIDO (concerned with small workshops and blacksmith-level initiatives).

Centre for Agricultural Mechanization and Rural Technology (CAMARTEC)**P.O. Box 764, Arusha**

Telex: 42115 CAMART; Phone: Duluti 3594/3666

CAMARTEC was established in 1981 by the merger of Tanzania Agricultural Machinery Testing Unit (TAMTU) and the Arusha Appropriate Technology Project. CAMARTEC is a parastatal organization under the Ministry of Industries and Trade with seven major functions related to the design, testing and

production of agricultural equipment. CAMARTEC is charged (among other activities) with carrying out applied research on the design, adaptation and development of equipment for agricultural and rural development. It is also expected to develop and manufacture approved prototypes and technologies and evaluate their suitability for local adaptation. Furthermore it is expected to test agricultural equipment and promote national liaison concerning animal traction and rural technology. It has workshops for producing prototypes and small production runs. Some of its designs have included a heavy double-mouldboard plow, with a planter attachment. It has also produced harrows (a disc harrow and heavy wooden harrow). It has designed several ox carts. These have included carts with wooden bushes, wooden block bearings and roller bearings. The carts can have all-metal wheels or split metal rims with pneumatic tyres. Publications include: *Kiriama, 1989; Mujemula, 1992a and 1992b.*

Metal Engineering and Industrial Development Association (MEIDA)**P.O. Box 5891, Dar es Salaam**

MEIDA is an association of large scale manufacturers, including the parastatal UFI and ZZK. It has been involved in trying to enhance local production of animal traction implements, and develop improved jigs.

Small Industries Development Organization (SIDO), P.O. Box 2476, Dar es Salaam

Telex: 41123 SIDO

SIDO is a parastatal organisation under the Ministry of Industries and Trade responsible for developing the design, training and manufacturing facilities of small industries. For over a decade, the work of SIDO has included the design and development of animal traction implements for local factories and workshops. In some regions, SIDO has worked with village artisans to produce, service and maintain farm equipment and at Korogwe it has assisted the local production of animal-drawn carts. Among the implements designed by SIDO, have been a plow with a long wooden beam, a wooden beam cultivator, and wooden beam ridger and a one-tonne ox cart. Its implements have not been widely adopted. Relevant publications include: *Bapuraj, 1987.*

Tanzania Engineering and Manufacturing Design Organization (TEMDO)**P.O. Box 9503, Dar es Salaam**

TEMDO is a parastatal organization promoting product designs for the larger manufacturers,

including agricultural implement workshops, such as UFI and ZZK.

Ubungo Farm Implements (UFI)
P O Box 20126, Dar es Salaam

Telex: 41206. Phone: 48316-8

Ubungo Farm Implements Limited is a parastatal organization under the Ministry of Trade and Industry. It is the major producer and importer of farm implements in Tanzania, with emphasis on hand hoes, machetes and animal-drawn plows. Its extensive factory was built in 1970 with Chinese assistance and comprises a series of large, well-equipped workshops. UFI has a staff of about 700 people, and the capacity of producing at least 30,000 mouldboard plows per year, although it has never reached such production levels.

UFI has its own design and development department and it has also been liaising with CAMARTEC, TEMDO and SIDO concerning animal-drawn implements. For the last twenty years it has not succeeded in developing and marketing any new animal-drawn implements, nor in modifying its plow design in response to external criticism. It is currently working on an ox cart axle.

Although UFI has the spare production capacity, it has not manufactured cultivators, ridgers and harrows but has imported these from other countries. It claims that importation is actually cheaper than local production. It has imported five-tine lever-adjustable cultivators from India, ridgers from India, spiked teeth harrows from Zambia, Pitman-drive single-row planters from Zimbabwe and trek chains from India and Zimbabwe.

In 1985, following a Scandinavian consultancy report, UFI also imported about 100,000 plows, to meet the high demand reported by the consultants. As the plows were only sold at a rate of about 25,000 a year, UFI stopped producing its own plows for about four years. This drop in production did not effect employment levels in the factory. Publications include: *Lyimo, 1987*

Zana Za Kilimo (ZZK) Ltd
P O Box 1186, Mbeya

Telex: 51133. Phone: 065 2226

Zana za Kilimo Ltd, located at Mbeya, is a parastatal agricultural implement factory under the National Development Corporation of the Ministry of Trade and Industries. It was started in 1977 with financial and technical assistance from India. It has large and well-equipped machine workshops and facilities for forging, pressing, heat treatment, casting (grey cast iron) and sheet metal work. It has the theoretical capacity to manufacture more than 700 tonnes per

year of animal-drawn implements such as mouldboard plows, harrows and spare parts. In practice, manufacture of animal-drawn implements has been minimal, due to inadequate designs, management problems and cashflow crises.

In 1984, ZZK produced about 700 plows with wooden beams, but the design had not been adequately tested by farmers and sales were minimal. During the late 1980s, ZZK received assistance from Scandinavian donors, but this was not orientated towards the production of animal-drawn implements. From 1987 to 1991, the Mbeya Oxenization Project attempted to work with ZZK on the production of animal drawn implements, notably the Mkombozi toolbar, but collaboration proved difficult. In 1992, ZZK was in major financial difficulties, and while it still had excellent facilities, it was not producing animal traction implements.

Ministry of Tourism, Wildlife and Forestry

Department of Forestry
P.O. Box 426, Dar es Salaam

The Department of Forestry has, for several years, been planning to use oxen for logging operations in various parts of the country. One such initiative, for the Kilimanjaro and Arusha Regions, was proposed with assistance from FAO. Another oxen-logging proposal relating to plantations near Ifakara, Morogoro, has been discussed with the Commonwealth Development Corporation. Relevant reports include: *Humar, 1984; Starkey, 1991.*

Ministry of Science, Technology and Higher Education

Sokoine University of Agriculture, University Post Office, Morogoro

Telex: 55308 UNIVMOG

Phone: 056-3259 (Agricultural Engineering).

Sokoine University of Agriculture (SUA), located in Morogoro, undertakes teaching at both undergraduate and postgraduate level. Staff also undertake research on a range of agricultural topics. The departments most concerned with animal traction are Animal Science and Agricultural Engineering.

The Department of Agricultural Engineering is helping to coordinate research and development relating to animal traction in the country, and the Chairman of the National Animal Traction Steering Committee is currently based in this department. Research interests include draft animal management and nutrition, training and harnessing systems, minimising draft power requirements and cart and

bearings designs. Publications include: *Hatibu and Simalenga, 1992; Inns, 1980; Luziga, Nyakalo and Simalenga, 1992; Mgaya, Simalenga and Hatibu, 1992; Mrema and Hatibu, 1989; Simalenga and Hatibu, 1992; Simalenga and Hatibu (eds), 1992.*

**Department of Mechanical Engineering
University of Dar es Salaam
P.O. Box 35131, Dar es Salaam**

The Department of Mechanical Engineering in the Faculty of Engineering has an interest in animal traction equipment. In 1989, it held a professional course on the design and development of animal-drawn implements. Relevant publications include: *Hartmann, 1987; Hartmann et al, 1989; Starkey, 1989.*

**Institute of Production Innovation (IPI)
University of Dar es Salaam
P.O. Box 35075, Dar es Salaam**

*Telex: 41561 UNIVIP TZ
Phone: 49192-9 Ext 2928, 2938, 2976*

The Institute of Production Innovation (IPI) is an applied engineering research and development organization affiliated to the University of Dar es Salaam. IPI aims to contribute to the development of a viable industrial sector in Tanzania through the improvement and utilization of existing knowledge and the development of new or adapted technologies, with emphasis on agriculture, transport and energy. IPI conducts basic research and provides consultancy services. It has been working on animal-drawn scoops and ox carts. It produced jigs and bending equipment to allow the production of split-rim, steel wheels. Relevant publications include: *Wirth, 1992; Wirth, undated.*

**Institute of Resource Assessment
University of Dar es Salaam
P.O. Box 35097, Dar es Salaam**

The Institute of Resource Assessment includes animal traction as an important topic within its studies on socio-economic and rural development issues. One member of staff recently completed a PhD on the subject of animal traction in Tanzania. Publications include: *Sosovele, 1986; Sosovele, 1991; Sosovele, 1992.*

Donor-assisted projects

**Mbeya Oxenization Project
P.O. Box 2904, Mbeya**

*Telex: 5132 ZANKIL TZ;
Phone: 065-3371/73; Fax: 065-2279*

The Mbeya Oxenization Project (MOP) was initiated in 1987. It is a joint project of the Government of

Tanzania and the Canadian International Development Agency (CIDA). MOP's purpose is to assist farmers to produce food more efficiently through expanded use of ox-drawn equipment. This includes testing, adaptation, manufacturing and marketing of ox-drawn implements. Since the primary constraints to expansion of crop production using animal traction are in the areas of weeding and transport, these are the focus of project activities.

Initially project work on weeding technology focused on implement testing for identifying effective, farmer acceptable design. As hand weeding is most often the responsibility of women, they may have the most to gain in terms of reduced labour requirements from mechanized weeding.

MOP has been working with several other organizations, including the ZZK implement factory.

Publications include: *Doerksen, Janzen and Rempel, 1986; Graham, 1992; Harder, 1989; Harder and Klassen Harder 1988; Jumbe, 1992; Loewen Rudgers, 1988; Loewen Rudgers et al, 1990; Marshall, 1992; Marshall and Sizya, 1992; Masia and Clements, 1991; Massunga, 1992a and 1992b; Massunga, Kyomola and Sizya, undated; Mkomwa, 1989; Mkomwa, 1992a and 1992b; MOP, 1990; MOP, 1992; MOP, undated a and b; Rempel, 1988; Rempel, 1989; Shetto and Kwiligwa, 1988; Simalenga and Hatibu, 1992; Starkey, 1990; Starkey, Hyuha and Rempel, 1990; Syvret, 1992; Wekwe and Marshall, 1992.*

**Tanga Draft Animal Project
P.O. Box 228, Korogwe**

Phone: Korogwe 187

The project started as a component of Tanga Integrated Rural Development Programme (TIRDEP). When other external assistance to TIRDEP ceased, the draft animal project continued with GTZ support. It has had some success in introducing animal traction into areas where previous schemes had been disappointing. Activities include awareness creation through publicity, field days, demonstrations and courses. The project undertakes village based farmer training for men and women and encourages farmers to train other farmers. In addition to extension and training, its activities have included equipment development and the design of a prototype rolling weeder/brush cutter. The high demand for carts has been partially met by importing old car axles from Germany. Adoption of animal traction was assisted by a rural roads programme, which allowed farmers to pay off credit for carts very rapidly. The project has started working with donkeys, for both transport and cultivation and has been purchasing donkeys for resale to farmers.

Relevant publications include: *Barwell and Leggett, 1986; Becker, 1987; Becker, Knechtges and Holtkamp, 1989; Fischer, David and Shemdoe, 1992; Makwanda, 1992; Moshi and Mwambuga, 1990; Munzinger, 1986; NIRA, 1992; Scheinman, 1986.*

Usangu Village Irrigation Project

P.O. Box 336, Mbeya

Telex: 51244 KJMMBY TZ

Usangu Village Irrigation Project is aimed at developing rice production on the Usangu plains. It is supported by FAO, and started with a large-scale machinery emphasis. Animal traction activities started in 1985, and have included farmer training and extension and implement testing and development. Although most of its work involves the use of native oxen, it has also been evaluating the potential of castrated water buffaloes as draft animals. These were derived from the small dairy buffalo breeding herd at Mabuki Livestock Farm in Mwanza. The buffaloes have proved effective at work under project conditions of management, although not all the buffaloes have survived. No attempt has been made to introduce buffaloes to village conditions.

The project has tested a variety of animal-drawn implements from Tanzania, Malawi, Zambia and India. Animal-drawn implements developed by the project include a wooden leveller for rice fields (120 cm width), a 14-spike comb harrow (110 cm width) and a rotating puddler (110 cm working width with 4 rotating blades). Publications include: *Lecca, Kinyaga and Bunyinyiga, 1992; Shetto and Kwiligwa, 1989.*

Farming Systems Research Project (Lake Zone), P.O. Box 2807 Mwanza

Phone: 42232

The project, based at Ukiriguru Research Station, is supported by the Royal Dutch Institute (KIT) of The Netherlands. Although it has been in operation for several years, it is just starting to work on animal traction issues. It will focus on the introduction of ox-drawn weeders in Sukumaland. It intends to work closely with Maswa Rural Development Programme, also supported by The Netherlands. They have three pilot villages in Meatu District. Publications include: *Bantje, 1989 and Ngendelo, 1991.*

Iringa Soil and Water Conservation Project (HIMA), P.O. Box 1187, Iringa

Telex: 52070 HIMA TZ

The Iringa Soil and Water Conservation Project, known as HIMA, is supporting the increased use of draft animals and especially the introduction of more

diversified field implements such as plows, ridgers, cultivators planters, ox carts etc.

So far the project has embarked on the introduction of the Mkombozi plow (ZZK product) in HIMA supported villages. Eventually the project will also provide each village based extension worker with a full set of ox-drawn implements to be used on demonstration plots and which will also be lent to interested farmers. Publications include: *Kiango, 1992.*

Rukwa Development Project (RUDEP), P.O. Box 128, Sumbawanga

Telex: 49180 REGCOM

Phone: Sumbawanga 144

RUDEP intends to promote the use of animal drawn carts in the region. It is investigating the magnitude and pattern of rural household movements and transport demands. It intends to use participatory planning processes, awareness meetings and training to assist the development of animal-based rural transport in selected areas. Publications include: *Kilemwa, 1992.*

Mbulu District Rural Development Programme

Mbulu RDP, supported by The Netherlands has a strong interest in the development of animal traction. It has established workshops at Mbulu and Karatu for the production of carts and implements. The project has imported some Rumpstad plows assembled by Lenco in Zambia for testing. Publications include: *Helsloot, 1992; Helsloot et al, 1991.*

Maswa Rural Development Programme P.O. Box 278, Maswa

Maswa RDP, supported by The Netherlands, has a strong interest in the development of animal traction. It has established a workshop for making ox carts (of Them/CAMARTEC design). It has recently recruited an expatriate specializing in animal traction who will be charged with evaluating with farmers suitable implements for weeding. The project intends to work closely with other organizations, notably the Farming Systems Research Programme.

Non-governmental organizations

Tanganyika Christian Refugee Service, P.O. Box 3955, Dar es Salaam

Telex: 41258 LUTHSERVE; Phone: 50544

TCRS is a non-governmental organization working with animal traction in several parts of the country. It evaluated a range of carts and equipment including pole plows and animal-powered gears for sugar-cane crushing. Publications include: *TCRS undated.*

TCRS Singida Integrated Project **P.O. Box 365, Singida**

Phone: Singida 272; Telex: 44002

TCRS is actively involved in animal traction in Singida. It has evaluated a wide range of implements (including a wheeled toolcarrier). It sells plows and encourages the production of carts. It has recently started working at an old OTC, and intends to make donkey harnesses there.

TCRS Kibondo Integrated Project **P.O. Box 174, Kibondo**

Phone: Kibondo 10

The project purchases and trains oxen at a training centre at Kakonko. It then sells them to farmers at subsidized prices. Beneficiaries are also trained to handle animals.

Mbozi Agricultural Development Project **P.O. Box 204, Mbozi, Mbeya**

Phone: Mbozi 95

Mbozi project is supported by COOPIBO, a Belgian NGO. It has particular interest in the introduction and intensification of animal draft power. Publications include: *Beijer, 1992; Makitwange, 1992; Makitwange and Beijer, 1992.*

Mixed Farming Project (MIFIPRO) **P.O. Box 193, Mwanga, Kilimanjaro Region**

Telex: 43095 ZITA

An NGO project introducing animal traction (oxen and donkeys) into Mwanga District. It started training farmers and their oxen in their villages (4-5 weeks) but now concentrates on training selected farmers to act as trainers and resource persons for fellow villagers. The project sells implements commercially and has initiated local production of carts, yokes and harnesses. It provides some animal health and implement repair back up services. Publications include: *ATOL, 1983; Galema, 1992; Galema and Madundo, 1992; Mlungwana, 1992; Vanderschaeghe, 1991*

Village Transport Project Peramiho **P.O. Box 1, Peramiho**

Phone: Peramiho 30

This project, which was started in 1985, has been designed to procure transport to help villages grouped round Morogoro. West of Peramiho, where there is no mechanical transport available. The aim is to give young people a chance to learn useful jobs, like animal traction agriculture and forestry. There are three training "stations". Originally the project was supported by GORTA from Ireland, but at present there is no donor.

Marketing and financial organizations

Although in some countries marketing organizations (notably cotton and groundnut companies) and development banks play important roles in supporting animal traction development, this has not been the case in Tanzania.

Private sector organizations

Themi Farm Implement and Engineering Company, P.O. Box 286, Arusha

Themi Farm Implements Ltd is a small private company, established in 1981 with financial backing of USAID and technical support from SIDO. One of its activities is to manufacture and sell animal-drawn implements and carts (although the company gains most of its revenue from other workshop production). In its early years, it had great problems in marketing animal-drawn implements, largely because its prototype designs (supplied by SIDO and CAMARTEC) were not judged suitable by farmers. It has had more success in recent years, through selling batches of equipment and cart axles, wheels and jigs to development projects in Mbulu and Maswa.

SEAZ Agricultural Equipment **P.O. Box 2607, Mbeya**

A small company, established by an agricultural engineer from the Mbeya Oxenization Project. The company has taken over the manufacture of Mkombozi plow and toolbar and designs and manufactures ox carts.

OXMAC Ltd, P.O. Box 217, Shinyanga

Telex: 48102 OXMAC

Phone: 2129/2951; Fax: 3058

The company makes ox-drawn carts for sale to CRDB which sells them to farmers on a credit basis.

Aid agencies

Several donor agencies are currently supporting programmes with animal traction components, or have done so in recent years. These include:

CIDA, P.O. Box, Dar es Salaam*Mbeya Oxenization Project***GTZ, P.O. Box 1519, Dar es Salaam***Tanga Draft Animal Project**IPI, University of Dar es Salaam***FAO, P.O. Box 9182, Dar es Salaam***Usangu Village Irrigation Project***Royal Netherlands Embassy****P.O. Box 9534, Dar es Salaam***Maswa Rural Development Programme**Mbulu Rural Development Programme**Farming Systems Research Project***EC, P.O. Box 9514, Dar es Salaam***Iringa Rural Development Project***USAID, P.O. Box 9123, Dar es Salaam***Themi Farm Implements***ILO, P.O. Box 9212, Dar es Salaam**

The ILO, in cooperation with Kilimo, produced a report on agricultural equipment in 1983 and followed this up with a national workshop in 1985. One objective was to establish greater national and regional liaison in this field. Both reports contain discussion of policies and case histories relating to animal traction equipment research, development, manufacturing and distribution. Relevant publications include: *ILO, 1983; ILO, 1987.*

SIDA, P.O. Box 9303, Dar es Salaam

The results of studies relating to animal traction funded by Scandinavian organizations include: *Kjærby, 1983, 1984a, 1984b, 1987; Mothander, Kjærby and Havnevik, 1989.*

References and bibliography

- Abiye Astatke, Reed J D and Butterworth M H, 1986. The effect of diet restriction on work performance and weight loss of local Zebu and Friesian x Boran crossbred oxen. *ILCA Bulletin* 23: 11-14.
- AETC 1986. Selection, care and training of draft cattle for agricultural extension workers and extension supervisors. AP1. Agricultural Engineering Training Centre, Harare, Zimbabwe. 161p.
- AETC 1986. Ploughing with draft animals: course for agricultural extension workers and extension supervisors. AP2. Agricultural Engineering Training Centre, Harare, Zimbabwe. 103p.
- AETC 1987. Crop establishment using draft animals: course for agricultural extension staff. AP3. Agricultural Engineering Training Centre, Harare, Zimbabwe. 100p.
- Airey A, 1992. Personal communication. Based on survey findings cited in draft report prepared for the Sub-Saharan Africa Transport Programme of the World Bank. IT Transport Ltd, Old Power Station, Ardington, Nr. Wantage, Oxon, OX12 8QJ, UK. (in press).
- ATOL, 1983. Introduction of animal traction. Document with background information to prepare main options for Mwanga Project, Tanzania. Aangepaste Technologie Ontwikkelingslanden (ATOL), Leuven, Belgium. 28p.
- Bantje H, 1989. A review of literature on agriculture and land use in Sukumaland, Tanzania. Working paper No 1. Farming Systems Research Project - Lake Zone, Ukiriguru Research Institute, Mwanza, Tanzania. 82p.
- Barwell I and Leggett I, 1986. Study on promotion of rural transport in Tanga Region. Report for GTZ/TIRDEP. Consultancy report 120. IT Transport, Ardington, UK.
- Barwell I and Malmberg-Calvo C, 1988. Household travel demand in Makete District: findings from village-level transport survey. Report for Makete Integrated Rural Transport Project. Consultancy report 192. IT Transport, Ardington, UK.
- Becker H, 1987. Development and testing of a weed roller. Final report prepared for Tanga Integrated Rural Development Programme (TIRDEP), Tanzania. GTZ, Eschborn, Germany. 48p.
- Becker H, Knechtges H and Holtkamp R, 1989. Testing and evaluation of animal-drawn weeder-roller in Tanga Region. Paper prepared for the Professional Development Programme held 28-31 March 1989, Dar es Salaam, Tanzania. Department of Mechanical Engineering, University of Dar es Salaam, Tanzania. 7p.
- Beijer W, 1992. COOPIBO and draught animal power. pp. 46-48 in: Simalenga T E and Hatibu N (eds). Proceedings of an animal traction workshop held 8-10 April 1991, Morogoro, Tanzania. Mbeya Oxenization Project, Mbeya, Tanzania. 57p.
- Bowers R D, 1983. Accelerated development of mechanization based on animal power. Agricultural Planning and Marketing Division, Ministry of Agriculture, Dar es Salaam, Tanzania. 7p.
- Brewis A, 1992. Animal cart technology in Tanzania. Consultancy report 315. IT Transport, Ardington, UK.
- Constantinesco I, 1964. Development of ox-drawn toolframes. *East African Agricultural and Forestry Journal (Kenya)*. pp. 187-191
- Crees J, 1992. Animal draft power: a few words of sympathy for the power units. *Livestock Planning Adviser*, Ministry of Agriculture, Dar es Salaam, Tanzania. (unpublished). 2p.
- Dihenga H, 1979. Tanzania's experience in appropriate technology for tillage operations. pp. 117-125 in: Proceedings of the appropriate tillage workshop held 16-20 Jan 1979, Zaria, Nigeria. Commonwealth Secretariat, London, UK.
- Doerksen A, Janzen N, Kroeker D and Rempel E, 1986. Oxenization: an appropriate technology for smallholder farms of Mbeya Region, Tanzania. Project design and plan of operation prepared for the Canadian International Development Agency (CIDA). Mennonite Economic Development Associates, Winnipeg, Canada. 69p.
- Dogger J W, 1990. Final report ox-cart testing activities August 1987 — July 1990. Animal Draught Power Research and Development Project, Magoye Regional Research Station, Magoye, Zambia. 40p.
- Doran J, 1992. Transportation by women and their access to animal-drawn carts in Zimbabwe. Paper prepared for Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop on improving animal traction technology held 18-23 January 1992, Lusaka, Zambia. ATNESA and CTA, Wageningen, The Netherlands (in press). 6p.
- Fischer R, David B M N and Shemdoe M S, 1992. Role of draft animals in farming systems. pp. 36-37 in: Simalenga T E and Hatibu N (eds). Proceedings of an animal traction workshop held 8-10 April 1991, Morogoro, Tanzania. Mbeya Oxenization Project, Mbeya, Tanzania. 57p.
- Galema A, 1992. Towards a sustainable system of transfer of animal traction technology: experiences from Kilimanjaro Region, Tanzania. Paper prepared for Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop on improving animal traction technology held 18-23 January 1992, Lusaka, Zambia. ATNESA and CTA, Wageningen, The Netherlands (in press). 6p.
- Galema A and Madundo G, 1992. Participatory evaluation and planning in technology transfer: experiences of Mifipro with animal traction. Paper prepared for Coopibo seminar on participatory extension and sustainable agriculture held 26 April - 9 May 1992, Butare, Rwanda. Mifipro, Mwanza, Tanzania. (unpublished). 3p.
- Graham P, 1992. Research and extension of animal draught technologies: the experiences of the Mbeya Oxenization Project 1987 - 1992. Paper presented at a workshop on Agricultural research, training and technology transfer in the southern highlands of Tanzania: past achievements and future prospects, held 5-9 October 1992, Uyole Agricultural Centre, Mbeya, Tanzania. 12p.
- Harder J, 1989. Report of the credit consultant to the Mbeya Oxenization Project. Mennonite Economic Development Associates, Winnipeg, Manitoba, Canada. 30p.
- Harder J M and Klassen Harder K, 1988. Mbeya Oxenization Project Inception Report. Mennonite Economic Development Associates, Winnipeg, Canada. 66p.
- Hartmann K, 1987. The state of agro-mechanisation in Tanzania. Paper presented at 7th DLG Symposium on Mechanization, held 20-23 Nov 1987, Frankfurt, Germany. Department of Engineering, University of Dar es Salaam, Tanzania. 14p. (unpublished).
- Hartmann K, Hatibu N, Holtkamp R, Kiriama L, Mkomwa S, Mutoizi G and Starkey P, 1989. Design of animal-drawn pre-harvest farm implements for local production. Bound course folder produced for Professional Development Programme held 28-31 March 1989, Dar es Salaam, Tanzania. Department of Mechanical Engineering, University of Dar es Salaam, Tanzania. (unpublished). 350p.
- Hassan M, 1987. Country report: United Republic of Tanzania. Paper presented at a workshop on Agricultural Mechanization in Equatorial Africa, held 1-5 December 1987, Institute of Agricultural Research, Nazareth, Ethiopia. Ministry of Agriculture, Dar es Salaam, Tanzania. (unpublished). 14p.
- Hatibu N and Simalenga T E, 1992. Research and development strategy for improvement of animal traction in Tanzania. pp. 23-26 in: Simalenga T E and Hatibu N (eds). Proceedings

- of an animal traction workshop held 8-10 April 1991, Morogoro, Tanzania. Mbeya Oxenization Project, Mbeya, Tanzania. 57p.
- Helsloot H, 1992. Role of Farm Implements and Tools (FIT) project in the transfer of animal traction technology in Tanzania. Paper prepared for Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop on improving animal traction technology held 18-23 January 1992, Lusaka, Zambia. ATNESA and CTA, Wageningen, The Netherlands (in press). 5p.
- Helsloot J C A, Kessy F B, Makundi E N and Mbehoma C B, 1991. Manufacture of ox-drawn implements in Mbulu District, Tanzania: a feasibility study. Centre for Agricultural Mechanization and Rural Technology (CAMARTEC), Arusha, Tanzania and TOOL, Amsterdam, The Netherlands. 68p.
- Hinz H-J, 1985. A single traction bamboo-cart, specially designed for off-road transport. GATE (GTZ, Eschborn, Germany) **85/4**: 31-32.
- Humar I F, 1984. Oxen logging potential in Tanzania. Report of an animal logging mission to Tanzania, 7-22 May 1984. Food and Agriculture Organization (FAO), Rome, Italy. (unpublished). 53p.
- ILCA, 1989. Feeding strategies for draught animals: effect of body weight and condition of oxen on their work capacity. pp. 67-68 in: Annual report 1988. International Livestock Centre for Africa, Addis Ababa, Ethiopia. 156p.
- ILCA, 1990. Feeding strategies for draught animals: feed supplementation and work output of oxen. pp. 69-70 in: Annual report 1989. International Livestock Centre for Africa, Addis Ababa, Ethiopia. 144p.
- ILO, 1983. Appropriate farm equipment technology for the small-scale traditional sector: the case of Tanzania. Country Profile 3. Regional Project on Farm Tool and Equipment Technology, Basic Needs and Employment (ILO/FIN/78/RAF/2). International Labour Organization (ILO), Geneva, Switzerland. 123p.
- ILO, 1983. Appropriate farm equipment technology for the small-scale traditional sector. Synthesis report. Regional Project on Farm Tool and Equipment Technology, Basic Needs and Employment (ILO/FIN/78/RAF/2). International Labour Organization (ILO), Geneva, Switzerland. 295p.
- ILO, 1983. Tools and equipment manual for labour intensive farming. a sub-regional manual: Botswana, Kenya, Sudan, Tanzania and Zambia. Regional Project on Farm Tool and Equipment Technology, Basic Needs and Employment (ILO/FIN/78/RAF/2). International Labour Organization (ILO), Geneva, Switzerland. 119p.
- ILO, 1985. Preparatory work for the establishment of an African Regional Network for agricultural tools and equipment. Report of joint inter-agency mission from 26 January to 9 March 1985 to Sudan, Ethiopia, Tanzania, Zambia, Botswana and Kenya. FAO, Rome, Italy and International Labour Organization (ILO), Geneva, Switzerland. 126p.
- ILO, 1987. In quest of agricultural mechanisation policy and strategies in the United Republic of Tanzania. Proceedings of national workshop on farm tools and equipment technology: basic needs and employment, held 8-10 Oct 1985, Dar-es-Salaam, Tanzania. International Labour Organization (ILO), Geneva, Switzerland. 69p.
- Inns F, 1980. Animal power in agricultural production systems with special reference to Tanzania. FAO World Animal Review **34**: 2-10.
- Johnston B F, 1980. Socioeconomic aspects of improved animal-drawn implements and mechanization in semi-arid East Africa. pp. 221-233 in: Proceedings of the International Workshop on Socioeconomic Constraints to Development of Semi-arid Tropical Agriculture held 19-23 Feb 1979, Hyderabad, India. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India.
- Jones P A. 1991. Training course manual on the use of donkeys in agriculture in Zimbabwe. Agritex Institute of Agricultural Engineering, Borrowdale, Harare, Zimbabwe. 81 p.
- Jumbe J Y, 1992. Improving the distribution of animal traction implements in Mbeya Region, Tanzania. Paper prepared for Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop on improving animal traction technology held 18-23 January 1992, Lusaka, Zambia. ATNESA and CTA, Wageningen, The Netherlands (in press). 4p.
- Kalisky J (ed), 1990. Proceedings of a regional course on planning an integrated animal draught programme, held Harare, Zimbabwe from 5-13 November 1990. Bulletin No. 2. AGROTEC (Agricultural Operations Technology for Smallholders in East and Southern Africa), Harare, Zimbabwe. 235p.
- Kapinga C, 1979. The problem with foot and mouth disease. pp. 68-71 in: Proceedings of the sixth scientific conference of the Tanzania Society of Animal Production held 29-31 May 1979, Iringa, Tanzania. Tanzania Society of Animal Production, Sokoine University of Agriculture, Morogoro, Tanzania.
- Kayumbo A K, 1987. Agro-mechanisation policy and strategy. pp. 31-34 pp. 15-23 in: In quest of agricultural mechanisation policy and strategies in the United Republic of Tanzania. Proceedings of national workshop on farm tools and equipment technology: basic needs and employment, held 8-10 Oct 1985, Dar-es-Salaam, Tanzania. International Labour Organization (ILO), Geneva, Switzerland. 69p.
- Kayumbo A K, 1987. Constraints to the wider use of farm equipment in the rural areas. pp. 35-39 in: In quest of agricultural mechanisation policy and strategies in the United Republic of Tanzania. Proceedings of national workshop on farm tools and equipment technology: basic needs and employment, held 8-10 Oct 1985, Dar-es-Salaam, Tanzania. International Labour Organization (ILO), Geneva, Switzerland. 69p.
- Kayumbo A K, 1987. The local manufacture of farm tools and implements. pp. 41-44 in: In quest of agricultural mechanisation policy and strategies in the United Republic of Tanzania. Proceedings of national workshop on farm tools and equipment technology: basic needs and employment, held 8-10 Oct 1985, Dar-es-Salaam, Tanzania. International Labour Organization (ILO), Geneva, Switzerland. 69p.
- Kayumbo A K, 1990. Technology transfer. Paper presented at the Workshop on research for development on animal traction, Kano, Nigeria, 9-13 July, 1990. (Proceedings being published by ILCA, Addis Ababa, Ethiopia). Ministry of Agriculture and Livestock Development, Dar es Salaam, Tanzania, 16p.
- Kayumbo A K, 1992. Overview of present status of animal traction development in Tanzania. pp. 17-20 in: Simalenga T E and Hatibu N (eds). Proceedings of an animal traction workshop held 8-10 April 1991, Morogoro, Tanzania. Mbeya Oxenization Project, Mbeya, Tanzania. 57p.
- Kayumbo A K, 1992. Improving tillage systems in Tanzania. Paper prepared for Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop on improving animal traction technology held 18-23 January 1992, Lusaka, Zambia. ATNESA and CTA, Wageningen, The Netherlands (in press). 4p.
- Kayumbo A K, 1992. Improving weeding technology and the implements used in Tanzania. Paper prepared for Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop on improving animal traction technology held 18-23 January 1992, Lusaka, Zambia. ATNESA and CTA, Wageningen, The Netherlands (in press). 5p.
- Kiango W, 1992. Extension of animal traction in Iringa Region: experiences of HIMA Project. pp. 44-45 in: Simalenga T E and Hatibu N (eds). Proceedings of an animal traction workshop held 8-10 April 1991, Morogoro, Tanzania. Mbeya Oxenization Project, Mbeya, Tanzania. 57p.
- Kilemwa A M, 1992. Gender issues in animal traction: Rukwa experiences. Paper presented at workshop on gender issues in animal traction held 1-5 June 1992, Mbeya, Tanzania. (Proceedings to be published by ATNESA). 5p.

- King J G M, 1940. Ox pack transport in Sukuma, Tanganyika Territory. *East African Agricultural Journal (Kenya)* **5**: 306-331
- Kinsey B H, 1984. Agricultural equipment innovations and rural transformation in Tanzania. pp. 179-208 in: Ahmed I and Kinsey B H (eds): *Farm equipment innovations in eastern and central southern Africa*. Gower Publishing, Aldershot, UK. 345p.
- Kiriama L L, 1989. Field test of animal-drawn farm implements in Tanzania. 14 pp. (unnumbered) in: Hartmann K et al (eds), *Design of animal-drawn pre-harvest farm implements for local production*. Bound course folder produced for Professional Development Programme held 28-31 March 1989, Dar es Salaam, Tanzania. Department of Mechanical Engineering, University of Dar es Salaam, Tanzania. (unpublished). 350p.
- Kjaerby F, 1983. Problems and contradictions in the development of ox-cultivation in Tanzania. Centre for Development Research (Copenhagen, Denmark) Research Report No. 66. Scandinavian Institute of African Studies, Uppsala, Sweden. 163p.
- Kjaerby F, 1984. Detailed descriptive report on regional visits and interviews on household tool inventories. Annex 4:1 to Farm implements for small scale farmers. Swedish International Development Authority (SIDA), Stockholm, Sweden. 76p.
- Kjaerby F, 1984. The demand for ox-ploughs, spare parts and animal drawn equipment. Annex 8:2. Farm implements for small scale farmers. Swedish International Development Authority (SIDA), Stockholm, Sweden. 54p.
- Kjaerby F, 1987. Villagization and the crisis: agricultural production in Hanang District, northern Tanzania. Centre for Development Research (Copenhagen, Denmark) Research Report No. D87.4. Scandinavian Institute of African Studies, Uppsala, Sweden. 120p.
- Kwiligwa E M B, Shetto R M and Haule S, 1992. Experiments on weed management techniques based on animal-drawn cultivators for control of weeds in maize (*Zea mays*) in the Southern Highlands in Tanzania. Uyolet Agricultural Centre, Mbeya, Tanzania. 11p.
- Kwiligwa E M B, Shetto R M, Mkoga Z J and Haule S, 1992. Prospects for animal traction technology in Tanzania. pp. 43-48 in: Simalenga T E, Kayombo B and Hatibu N (eds), *The role of agricultural mechanization in national development*. Proceedings of conference held September 17-20 1991, Arusha, Tanzania. Proceedings Volume 4, Tanzania Society of Agricultural Engineers, Sokoine University of Agriculture, Morogoro, Tanzania.
- Kwiligwa E M, Shetto R M and Rees D J, 1992. Weed control management systems based on animal-drawn cultivators for maize (*Zea mays*) production in the Southern Highlands of Tanzania. Paper prepared for Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop on improving animal traction technology held 18-23 January 1992, Lusaka, Zambia. ATNESA and CTA, Wageningen, The Netherlands (in press). 27p.
- Lecca M L, Kinyaga I A and Bunyinyiga J B, 1992. Development of an animal-drawn puddler for rice production on the Usangu Plains of Tanzania. Paper prepared for Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop on improving animal traction technology held 18-23 January 1992, Lusaka, Zambia. ATNESA and CTA, Wageningen, The Netherlands (in press). 4p.
- Loewen-Rudgers L, 1988. Contrasting approaches to animal traction development encountered while attending the West Africa Animal Traction Network Workshop in Senegal, July 7-12 1988. Mbeya Oxenization Project, Mbeya, Tanzania. 6p. (unpublished).
- Loewen-Rudgers L, Rempel E, Harder J and Klassen Harder K, 1990. Constraints to the adoption of animal traction weeding technology in the Mbeya region of Tanzania. pp. 460-471 in: Starkey P H and Faye A (eds), *Animal traction for agricultural development*. Proceedings of workshop held 7-12 July 1988, Saly, Senegal. Technical Centre for Agriculture and Rural Cooperation, Ede-Wageningen, The Netherlands. 475p.
- Luziga A P B, Nyakalo S and Simalenga T E, 1992. Efficient utilization of animal traction in the semi-arid areas of Tanzania: a case study of Tabora Region. Paper prepared for Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop on improving animal traction technology held 18-23 January 1992, Lusaka, Zambia. ATNESA and CTA, Wageningen, The Netherlands (in press). 4p.
- Lyimo E S, 1987. Demand supply analysis: marketing and distribution. pp. 15-23 in: *In quest of agricultural mechanisation policy and strategies in the United Republic of Tanzania*. Proceedings of national workshop on farm tools and equipment technology: basic needs and employment, held 8-10 Oct 1985, Dar-es-Salaam, Tanzania. International Labour Organization (ILO), Geneva, Switzerland. 123p.
- Madundo G K, 1992. Gender issues in animal traction: experiences of Mifipro, Kilimanjaro Region. Paper presented at workshop on gender issues in animal traction held 1-5 June 1992, Mbeya, Tanzania. (Proceedings to be published by ATNESA). 6p.
- Makitwange G, 1992. Transfer of animal traction technology in Mbozi District, Tanzania. Paper prepared for Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop on improving animal traction technology held 18-23 January 1992, Lusaka, Zambia. ATNESA and CTA, Wageningen, The Netherlands (in press). 3p.
- Makitwange G and Beijer W, 1992. Trying animal traction. *ILEIA Newsletter (Information Centre for Low External Input and Sustainable Agriculture, Leusden, The Netherlands)* **8** (3): 20-21.
- Makwanda A, 1992. Women and animal traction technology: experiences in Tanga region. Paper prepared for Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop on improving animal traction technology held 18-23 January 1992, Lusaka, Zambia. ATNESA and CTA, Wageningen, The Netherlands (in press). 5p.
- Marshall K, 1992. Transfer of animal traction technology: some experiences of the Mbeya Oxenization Project. *Draught Animal News (Edinburgh University)* **16**:2-7.
- Marshall K and Sizya M, 1992. Women and animal traction in Mbeya Region of Tanzania: a gender and development approach. Paper prepared for Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop on improving animal traction technology held 18-23 January 1992, Lusaka, Zambia. ATNESA and CTA, Wageningen, The Netherlands (in press). 7p.
- Masia S and Clements D J, 1991. Report on the evaluation of the Mbeya Oxenization Project. Canadian International Development Agency (CIDA), Dar es Salaam, Tanzania. 97p.
- Massunga M, 1992. Animal drawn technology (ADT) extension and training: experiences of the Mbeya Oxenization Project in animal draft technologies. pp. 38-39 in: Simalenga T E and Hatibu N (eds). *Proceedings of an animal traction workshop held 8-10 April 1991, Morogoro, Tanzania*. Mbeya Oxenization Project, Mbeya, Tanzania. 57p.
- Massunga M, 1992. Animal draught technology course: proposed syllabus for extension staff. Paper prepared for 3rd National Animal Traction Steering Committee Meeting held 1 October 1992, Dar es Salaam, Tanzania. Mbeya Oxenization Project, Mbeya, Tanzania. (mimeo). 6p.
- Massunga M, Kyomola F and Sizya M, undated. *Kudhibititi magugu: kwa kutumia zana zinazokokotwa na maksai*. Mbeya Oxenization Project, Mbeya, Tanzania. 21p.
- Mgaya G J M, Simalenga T E and Hatibu N, 1992. Care and management of work oxen in Tanzania: initial survey results. Paper prepared for Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop on improving animal traction technology held 18-23 January

- 1992, Lusaka, Zambia. ATNESA and CTA, Wageningen, The Netherlands (in press). 5p.
- Mkomwa S, 1989. Over-the-row weeding implement design testing and extension. pp. 14.29-14.37 in: Hartmann K et al (eds), Design of animal-drawn pre-harvest farm implements for local production. Bound course folder produced for Professional Development Programme held 28-31 March 1989, Dar es Salaam, Tanzania. Department of Mechanical Engineering, University of Dar es Salaam, Tanzania. (unpublished). 350p.
- Mkomwa S, 1992. Research and development experiences of the Mbeya Oxenization Project in animal draft technologies. pp. 31-33 in: Simalenga T E and Hatibu N (eds). Proceedings of an animal traction workshop held 8-10 April 1991, Morogoro, Tanzania. Mbeya Oxenization Project, Mbeya, Tanzania. 57p.
- Mkomwa S S, 1992. Ox-cart transportation in Mbeya Region: experiences of the Mbeya Oxenization Project. pp. 49-54 in: Simalenga T E, Kayombo B and Hatibu N (eds), The role of agricultural mechanization in national development. Proceedings of conference held September 17-20 1991, Arusha, Tanzania. Proceedings Volume 4, Tanzania Society of Agricultural Engineers, Sokoine University of Agriculture, Morogoro, Tanzania.
- Mlungwana A M, 1992. MIFIPRO's experiences with animal traction extension. pp. 42-43 in: Simalenga T E and Hatibu N (eds). Proceedings of an animal traction workshop held 8-10 April 1991, Morogoro, Tanzania. Mbeya Oxenization Project, Mbeya, Tanzania. 57p.
- MoA, 1973. Cattle distribution and marketing. Map with annotations. Ministry of Agriculture and Livestock Development (MoA), Dar es Salaam, Tanzania. 2p (A1 size).
- MoA, 1973. Distribution of tsetse flies. Map with annotations. Ministry of Agriculture and Livestock Development (MoA), Dar es Salaam, Tanzania. 2p (A1 size).
- MoA, 1984. National livestock count final results. Ministry of Agriculture and Livestock Development (MoA), Dar es Salaam, Tanzania.
- MoA, 1986. Proposals for a draught animal power programme in Tanzania. Planning and Marketing Division, Ministry of Agriculture and Livestock Development (MoA), Dar es Salaam, Tanzania. 23p.
- MoA, 1991. National agricultural mechanization programme. Main volume and annexes. Agricultural Planning and Marketing Division, Ministry of Agriculture, Livestock Development and Cooperatives (MoA), Dar es Salaam, Tanzania. 99p. and 121p.
- MOP, 1990. Progress report (1990) of the Mbeya Oxenization Project's facilitation of animal drawn technology (ADT) supply and adoption in Mbeya Region of Tanzania. Mbeya Oxenization Project, Mbeya, Tanzania. 30p.
- MOP, 1992. Analysis and reports of labour studies and the use of animal draught technology in Galula Village, Chunya and Halungu village, Mbozi. Internal report for monitoring and evaluation study. Mbeya Oxenization Project, Mbeya, Tanzania. 32p.
- MOP undated. Plau ya Mkombozi: kitabu cha mtumiaji. Mbeya Oxenization Project, Mbeya, Tanzania. 9p.
- MOP, undated. Kuluma kwa maksai. Mbeya Oxenization Project, Mbeya, Tanzania. 23p.
- Moshi W S A and Mwambuga I M, 1990. Draught animal development in Tanzania: the experience of Tanga Region. Paper prepared for international seminar on draught animal technology held April 1990 in Edinburgh, Scotland. Larenstein International Agricultural College, Deventer, The Netherlands. 16p.
- Mothander B, Kjaerby F and Havnevik K, undated (c. 1983). Farm implements for small scale farmers in Tanzania. Proposals for support to manufacture and development. Volume 1. Introduction, summary and recommendations. Volume 2. Descriptive chapters. Swedish International Development Authority (SIDA), Stockholm, Sweden. 37p. and 224p.
- Mothander B, Kjaerby F and Havnevik K, 1989. Farm implements for small scale farmers in Tanzania. Scandinavian Institute for African Studies, Uppsala, Sweden.
- Mrema G C, 1990. Agricultural mechanization policies and strategies in Tanzania. pp. 132-159 in Mrema G C. (ed.) Agricultural mechanization policies and strategies in Africa: Case studies from commonwealth African countries. Proceedings of a workshop held 13-17 August 1990, Institute of Agricultural Research, Ahmadu Bello University, Zaria, Nigeria. Food Production and Rural Development Division, Commonwealth Secretariat, London, UK.
- Mrema G C and Hatibu N, 1989. Draft animal power and agricultural production: an engineering viewpoint. pp. 53-66 in Msolla P (ed): Proceedings of the 7th Tanzania Veterinary Association Scientific Conference. Sokoine Agricultural University, Morogoro, Tanzania.
- Mtenga J S, 1992. Animal traction development in Tanzania: current policy and regulations. pp. 5-9 in: Simalenga T E and Hatibu N (eds). Proceedings of an animal traction workshop held 8-10 April 1991, Morogoro, Tanzania. Mbeya Oxenization Project, Mbeya, Tanzania. 57p.
- Mujemula F K, 1992. Level of utilization of draught animal power in Tanzania. pp. 21-22 in: Simalenga T E and Hatibu N (eds). Proceedings of an animal traction workshop held 8-10 April 1991, Morogoro, Tanzania. Mbeya Oxenization Project, Mbeya, Tanzania. 57p.
- Mujemula F K, 1992. Improving animal-drawn transport technology in Tanzania: work on cart bearings. Paper prepared for Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop on improving animal traction technology held 18-23 January 1992, Lusaka, Zambia. ATNESA and CTA, Wageningen, The Netherlands (in press). 4p.
- Munzinger P, 1986. TIRDEP - Draught Animal Project. Report on Project Review Mission. Tanga Integrated Rural Development Programme, Tanga, Tanzania. 36p.
- Mwasha P S, 1992. Training and visit methodology of extension. Paper prepared for workshop on Gender Issues in Animal Traction held 1-5 June 1992, Mbeya, Tanzania. (Proceedings to be published by ATNESA). 9p.
- Namponya C R (ed), 1988. Animal traction and agricultural mechanization research in SADCC member countries. Proceeding of workshop held August 1987, Maputo, Mozambique. SACCAR Workshop Series 7, Southern African Centre for Cooperation in Agricultural Research (SACCAR), Gaborone, Botswana. 87p.
- Ngendelo A, undated (1991). Ox management in Maswa and Meatu Districts: a preliminary study on the introduction of ox weeders. Field Note No 9. Ukiriguru Research Station, Mwanza, Tanzania. 8p.
- NIRA, 1992. Jarida la mradi wa wanyama kazi Tanga. Animal Draft Power Project, Karogwe, Tanzania. 8p.
- Njiku E T, 1992. Draft animal power technologies: their scope and relevance to Tanzanian women farmers. Paper presented at workshop on gender issues in animal traction held 1-5 June 1992, Mbeya, Tanzania. (Proceedings to be published by ATNESA). 5p.
- Njiku E T, 1992. The need to extend animal traction technologies for women's farming activities in Tanzania. pp. 40-41 in: Simalenga T E and Hatibu N (eds). Proceedings of an animal traction workshop held 8-10 April 1991, Morogoro, Tanzania. Mbeya Oxenization Project, Mbeya, Tanzania. 57p.
- Rempel E, 1988. Internal papers concerning weeders, seeders, carts and axles. Mbeya Oxenization Project, Mbeya, Tanzania. (mimeo). 22p.
- Rempel E, 1989. The MOP cultivator. Tillers Report 9 (1). Winter 1989. (Tillers International, Kalamazoo, Michigan, USA).
- Semgalawe S E P, 1992. The need for policy review for effective animal traction development. pp. 10-13 in: Simalenga T E and Hatibu N (eds). Proceedings of an animal traction

- workshop held 8-10 April 1991, Morogoro, Tanzania. Mbeya Oxenization Project, Mbeya, Tanzania. 57p.
- Scheinman D, 1986. Animal draft use in Tanga region. A descriptive and analytical study assessing the implications of past, present, and future KILIMO and TIRDEP involvement. GTZ, Eschborn, Germany. 250p.
- Shetto R M and Kiligwa E M, 1988. Survey of oxcart production and use in Mbeya Region. Mbeya Oxenization Project, Mbeya, Tanzania. 69p.
- Shetto R M and Kiligwa E M, 1989. Zana zinazokokotowa na wanyama. Swahili training materials used for extension worker training programme for Usangu Village Irrigation Project. Uyole Agricultural Centre, Mbeya, Tanzania. (mimeo). 16p.
- Shetto R M and Kwiligwa E M B, 1992. Animal traction research at Uyole and research needs in Tanzania. pp. 23-26 in: Simalenga T E and Hatibu N (eds). Proceedings of an animal traction workshop held 8-10 April 1991, Morogoro, Tanzania. Mbeya Oxenization Project, Mbeya, Tanzania. 57p.
- Shetto R M and Kwiligwa E M, undated. Weed control systems in maize based on animal drawn cultivators. Uyole Agricultural Centre, Mbeya, Tanzania. 12p.
- Shetto R M, Kiligwa E M and Haule S J, 1989. Agricultural engineering research section: annual progress report 1988-89. Uyole Agricultural Centre, Mbeya, Tanzania. 40p.
- Simalenga T E and Hatibu N, 1992. Animal traction in Tanzania: a catalogue of institutions, organizations and experts involved in animal traction in Tanzania. (mimeo). 16p.
- Simalenga T E and Hatibu N (eds), 1992. Proceedings of an animal traction workshop held 8-10 April 1991, Morogoro, Tanzania. Mbeya Oxenization Project, Mbeya, Tanzania. 57p.
- Sosovele H, 1986. Agricultural production and the use of animal traction in Iringa Rural District. University of Dar es Salaam, Dar es Salaam, Tanzania. 21p.
- Sosovele H, 1991. The development of animal traction in Tanzania: 1900 - 1980s. Ph.D. Thesis. Faculty of Social Studies, University of Bremen, Germany. (unpublished). 369p.
- Sosovele H, 1992. Transfer of animal traction technology: cultural and social constraints of the organization of labour in the Tarime district, Northern Tanzania. Paper prepared for Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop on improving animal traction technology held 18-23 January 1992, Lusaka, Zambia. ATNESA and CTA, Wageningen, The Netherlands (in press).
- Starkey P H, 1988. Animal traction directory: Africa. Vieweg for German Appropriate Technology Exchange, GTZ, Eschborn, Germany. 151p.
- Starkey P H, 1988. Perfected yet rejected: animal-drawn wheeled toolcarriers. Vieweg for German Appropriate Technology Exchange, GTZ, Eschborn, Germany. 161p.
- Starkey P H, 1989. Selecting and designing animal-drawn implements: methodological principles and review of African experiences. Paper prepared for the Professional Development Programme held 28-31 March 1989, Dar es Salaam, Tanzania. Department of Mechanical Engineering, University of Dar es Salaam, Tanzania.
- Starkey P H, 1989. Design of animal-drawn farm implements for local production: results of confidential evaluation by course participants. Evaluation of the Professional Development Programme held 28-31 March 1989, Dar es Salaam, Tanzania. Animal Traction Development, Reading, UK and Department of Mechanical Engineering, University of Dar es Salaam, Tanzania. 3p.
- Starkey P H, 1989. Design of animal-drawn farm implements for local production: a report of programme highlights and suggestions for follow-up activities. Report of the Professional Development Programme held 28-31 March 1989, Dar es Salaam, Tanzania. Animal Traction Development, Reading, UK and Department of Mechanical Engineering, University of Dar es Salaam, Tanzania. 8p.
- Starkey P H, 1990. Observations on the research, development and extension components of the Mbeya Oxenization Project, Tanzania. Animal Traction Development, Reading, UK, 35p.
- Starkey P H, 1990. The potential for using work animals in teak reforestation in Tanzania. Report prepared for Commonwealth Development Corporation, London, UK. Animal Traction Development, Reading, UK, 8p.
- Starkey P H, 1992. Networking for animal traction. Network discussion paper 92/1. Animal Traction Network for Eastern and Southern Africa (ATNESA) and West Africa Animal Traction Network (WAATN). GTZ, Eschborn, Germany. 44p.
- Starkey P H and Goe M R, 1984. Report of the preparatory FAO/ILCA mission for the establishment of a TCDC network for research, training and development of draught animal power in Africa. AGA Consultancy Report, Food and Agriculture Organization (FAO), Rome, Italy. (mimeo). 82p.
- Starkey P H and Goe M R, 1985. Report of the third joint FAO/ILCA mission to prepare for the establishment of a TCDC network for research, training and development of draught animal power in Africa. AGA Consultancy Report, Food and Agriculture Organization (FAO), Rome, Italy. (mimeo). 85p.
- Starkey P H, Hyuha T and Rempel H, 1990. Mbeya Oxenization Project: Report of the MEDA Mid-Term Evaluation Team. Mennonite Economic Development Associates (MEDA), Winnipeg, Manitoba, Canada, 88p.
- Starkey P H, Sirak Teklu and Goe M R, 1991. Animal traction: an annotated bibliographic database. International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia. 255p.
- Sylwander A-C, 1992. Women and animal traction technology. Paper prepared for Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop on improving animal traction technology held 18-23 January 1992, Lusaka, Zambia. ATNESA and CTA, Wageningen, The Netherlands (in press). 8p.
- Syvret B, 1992. Policy and socio-economic constraints to animal traction facilitation in Tanzania: experiences of the Mbeya Oxenization Project (MOP). pp. 14-15 in: Simalenga T E and Hatibu N (eds). Proceedings of an animal traction workshop held 8-10 April 1991, Morogoro, Tanzania. Mbeya Oxenization Project, Mbeya, Tanzania. 57p.
- TCRS, undated. Kutumia maksai. Tanganyika Christian Refugee Service, Dar es Salaam, Tanzania. 10p.
- Tobisson E, 1980. Women, work, food and nutrition in Nyamwigura Village, Mara Region, Tanzania. Tanzanian Food and Nutrition Centre (TFNC) Report 548, Dar es Salaam, Tanzania. 135p.
- Tobisson E, 1986. Family dynamics among the Kuria: agropastoralists in northern Tanzania. Ph.D. Thesis. Gothenburg studies on social anthropology no. 9 Acta Universitatis Gothoburgensis, Sweden. 234p.
- UDSM, 1989. Summary report of the workshop on developing effective marketing strategies for animal-drawn implements in Mbeya Region held 23-24 February 1991, Mbeya, Tanzania. Report prepared for Mbeya Oxenization Project. Department of Marketing, Faculty of Commerce and Management, University of Dar es Salaam, Tanzania. 42p.
- Urasa R L S, 1992. Transfer of animal traction technology in Tanzania. Paper prepared for Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop on improving animal traction technology held 18-23 January 1992, Lusaka, Zambia. ATNESA and CTA, Wageningen, The Netherlands (in press). 4p.
- Urasa R L S, Kayumbo A and Mwanakulya R, 1990. Animal draft power status in Tanzania: various aspects. 10pp. (unnumbered) in: Kalisky J (ed) 1990. Proceedings of a regional course on planning an integrated animal draught programme, held Harare, Zimbabwe from 5-13 November 1990. Bulletin No. 2. AGROTEC (Agricultural Operations Technology for Smallholders in East and Southern Africa), Harare, Zimbabwe. 235p.

- Vanderschaeghe M, 1991. Evaluation of the introduction of animal traction by MIFIPRO in the north of Tanzania. Coopibo, Heverlee, Belgium. 54p.
- Wekwe J and Marshall K, 1992. Gender sensitivity within agricultural engineering: an experience of animal draught technologies in Mbeya Region. pp. 63-69 in: Simalenga T E, Kayombo B and Hatibu N (eds), The role of agricultural mechanization in national development. Proceedings of conference held September 17-20 1991, Arusha, Tanzania. Proceedings Volume 4, Tanzania Society of Agricultural Engineers, Sokoine University of Agriculture, Morogoro, Tanzania.
- Wirth J, 1992. Towards design, adaptation and manufacture of animal-pulled carts. Paper prepared for Animal Traction Network for Eastern and Southern Africa (ATNESA) workshop on improving animal traction technology held 18-23 January 1992, Lusaka, Zambia. ATNESA and CTA, Wageningen, The Netherlands (in press). 8p.
- Wirth J, undated. Rim bending and wheel assembly jig. Institute of Production Innovation (IPI), University of Dar es Salaam, Tanzania. 12p.

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Illustration captions and notes 1

- A Women making ridges using a mouldboard plow in Tarime District, Mara Region. Women often work with draft animals in Tarime. One of the work animals is a cow (female). The mouldboard of the plow is a replacement made by a local blacksmith. The use of a mouldboard plow for making ridges is an innovative technique developed by the local farmers.

- B Farmer with oxen and prototype weeder-roller in a zone of animal traction introduction in Tanga Region. This farmer adopted draft animals in the past ten years, as a direct result of the draft animal component of the rural development project (TIRDEP). He has subsequently trained other farmers in neighbouring villages.

- C Donkeys, with yokes, leading a team of oxen to pull a locally made cart in Mwanza Region.

- D Selling forage for animals in Kilimanjaro Region. This marketing initiative of the informal, private sector has arisen in response to the demand for fodder for dairy animals.

Illustration captions and notes 2

- A Cart axles, rims, tyres and tubes on sale in Shinyanga market.
- B Painted ox cart on sale in Shinyanga market.
- C Four-wheel cart (designed and made by a local artisan) pulled by six oxen in Mwanza Region.
- D Manure heaps transported to a field, using animal-powered transport in Singida Region.
- E Human-powered carts and bicycles are widely used for transport in Tanzania (Mwanza town).
- F Four oxen pulling a sledge with a water container, Tabora Region.
- G Two oxen pulling a sledge with fuel wood, Singida Region.
- H Two donkeys (with yokes and sacking pads) pulling a CAMARTEC cart loaded with maize stover in Arusha Region.
- I Pack donkeys are widely used for carrying sacks of grain (Singida Region).