Field visit observations

Plenary session rapporteurs: H Helsloot and F Kruit

Sixteen separate groups of five to seven participants visited different smallholder farmers. The farmers (at least two per group) differed in many respects, including gender, wealth, farm size, ownership of animals, experience of using draft animals, formal education or training and relationship with local extension services. Although the farming systems differed in several ways, all were within a two-hour drive of Lusaka, and so were not representative of all the provinces and agro-ecological zones in Zambia, let alone the whole ATNESA region. This limitation was acknowledged from the outset.

The groups had been asked to bear in mind the seven workshop themes when holding discussions with the farmers. In addition to noting the major problems and constraints to using animal traction in those farming systems, the groups tried to identify ways in which animal traction had been improved in recent years, or ways in which it could be improved. In their subsequent deliberations, the groups also reflected on whether their observations had relevance for other countries and whether there were any obvious implications for the network arising from the visits and discussions.

General

It was noted that the time spent with farmers was insufficient for the workshop groups to obtain a full understanding of the unfamiliar farming systems, and to draw valid conclusions. Nevertheless, it was agreed that, provided the field visits were viewed as a workshop participatory exercise and not a structured rapid rural appraisal survey, the group findings could be of value. Although some observations were specific to the individual farms or local farming systems, many of the identified constraints and findings were likely to have close parallels in other countries in the ATNESA region.

Economic and profitability issues

The groups noted that many constraints to the farming systems were of a general economic nature. Farm income was low and limited by poor marketing and payment systems. Farmers seldom had cash available for investment in technology or access to affordable credit. Inflation was high. Rural infrastructure was poor, and farmers could not depend on a timely supply of appropriate agricultural inputs or services. Farmers did not feel they were benefiting from government services or policies (recent political changes at a national level had not yet had an effect on farm economies). Most farmers claimed animal traction was profitable, but this was not always clearly apparent to the groups. Time and labour were often limiting factors. Some animals appeared underutilised.

Animal management issues

Animal health constraints were frequently mentioned, notably the recent problems with the tick-borne "corridor disease" (a form of *theileriosis*). Some of the farms visited were in areas where cattle ownership had not been common. In these areas, lack of knowledge of cattle husbandry and poor availability of cattle were cited as constraints. Veterinary services were generally unavailable in the villages or inadequate. Some groups noted that there was some farmer interest in the use of donkeys, although the zone visited was not one where donkeys are commonly seen.

Supply of implements and spares

Many farmers commented on the difficulties in obtaining equipment and spare parts. They were generally available only in the towns. Farmers were generally unaware of the existence of different types of plow, or of the use of weeders or ridgers. Much equipment was old (some more than 20 years old) and in need of maintenance and spare parts. Most plows had had their regulators removed. Blacksmith services were few, and blacksmiths complained about lack of raw materials. The groups who visited

Workshop participants question a farmer about his plow and availability of spares

Workshop participants discuss credit availablity and other issues with a farmer

blacksmiths felt these artisans would benefit from training and more equipment.

Animal-powered transport

Few farmers owned carts, and carts were generally difficult to obtain in the rural areas. Those carts that were owned were generally in need of maintenance and/or spare parts. Some appeared underutilised although transport appeared profitable. Most farmers expressed interest in cart ownership.

Transfer of technology

Most transfer of technology relating to animal traction had taken place through the family, neighbours and migrants. There were very few examples of knowledge or skills being obtained from the extension services (which were judged as rather irrelevant, unavailable or poor).

Tillage and weeding technology

Few farmers mentioned, or complained about, any inadequacies in their tillage systems. Some workshop participants, however, perceived possibilities for improvements. Few farmers mentioned animal-drawn weeding, although manual weed control was perceived as a problem. Animal-drawn weeders or ridgers were not generally available, or known.

Gender and age issues

Both male-headed and female-headed households were visited, and several conversations were held with wives of male farmers. It appeared that women generally had access to animal traction, but not necessarily control over the technology. Although plowing with draft animals was mainly a male domain, women generally claimed to be able to plow and some women assisted with or undertook animal traction operations. Children were extremely important in animal traction operations. Often they were the main operators of draft animal technology.

Recent improvements

Most groups were unable to identify recent improvements in animal traction. The technology, animal management and operational systems seemed similar to those used by the past generation. Some farmers had adopted animal traction in recent years, but the technology itself (transferred from other farmers) was not new. Some groups reported that farmers used cows for work, something that had never been recommended by the extension services.

Need for improvements

The groups felt that animal traction systems could best be improved by:

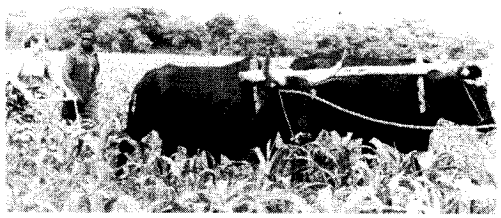
- improved supply of implements, spares and carts
- better repair facilities for implements
- availability of veterinary services and disease control methods
- some supplementary feeding of animals
- farmer-training in animal traction technologies
- different extension methodologies.

Implications for ATNESA

Most of the farm-level problems and recommendations were country-specific. ATNESA, as a regional organisation, should work with and through local bodies in order to influence those government policies that might assist the development of animal traction. For example, research and extension services should develop more participatory, gender-sensitive, farming-systems approaches. More attention should be given to promotion of self-help, traditional or private sector solutions to existing problems, including the supply and distribution of equipment.

ATNESA should be an accessible resource for those involved in animal traction research, development and extension. It should facilitate curriculum development and the training of extension workers. It should promote national-level networking, which should include farmers and field-based extension workers.

Some workshop participants have an opportunity to weed with draft animals at Magoye



Gender and animal traction technology

Group leader: K Marshall. Rapporteur: L Sylwander

The problem

Technological changes, such as the introduction of animal traction, affect women and men differently. Improved technologies are usually adopted and used by men according to the traditional gender-specific division of work. In most cases women have not benefited directly from the adoption of animal draft power because they have not had control of, or access to, draft animals.

Projects and programmes related to animal traction have often neglected the gender aspect and no special attention has been given to women in either the planning or the implementation stage.

Targets

An overall target of animal traction development work should be to ensure that women benefit from the use of draft animals. This should be a minimum condition for all programmes.

The primary target should be to provide women with access to draft animals. Access can be both indirect and direct. *Indirect access* to draft animals can be when draft animals benefit women when they are used for women's tasks (eg, transporting water), but the animals are not necessarily worked by the women themselves. *Direct access* to draft animals implies that women are the users of the technology and have the skills and knowledge to handle the draft animals and implements.

A long-term target should be to make it possible for women to have *control* of draft animals by owning animals and implements and having decision-making power over the technology. In the socio-cultural and economic setting of most African communities this could be a difficult aim to accomplish and might meet much cultural resistance instead of benefiting women.

The discussion group felt that women's indirect and direct access to (rather than control of) animal draft power is probably a more feasible target, at present, for development programmes and research projects in eastern and southern Africa.

Constraints

The group identified specific constraints for women in obtaining access to animal draft power.

Lack of time

Time is a scarce resource for women, especially for women in female-headed households. This might constrain women from learning and being trained in the use of animal draft power.

Recommendation

An understanding of women's time allocation for different productive and reproductive (domestic) tasks should be developed in order to design projects according to women's needs and preferences.

Lack of self-confidence of women

Lack of self-confidence hampers women from asserting their needs and wants. Women can gain self-confidence by being involved and participating in development activities.

Recommendations

Development programmes should endeavour to:

- provide training for women according to their needs and wants
- involve women in all aspects of planning and decision making
- develop special women's groups where women can talk and work together
- provide women with skills in related fields.

Legal and credit constraints

Women often lack the legal and/or traditional right to own resources such as land and cattle. This affects women's prospects for acquiring loans because they lack suitable collateral property.

Recommendations

Development programmes should endeavour to:

- develop credit schemes for women that are not tied to specific activities. Women should determine when credit is due
- develop credit schemes that make credit available to both individuals and groups
- encourage saving schemes, both formal (eg, through banks or credit institutions) and informal (eg, through community groups)
- influence credit institutions to adjust their policies to take account of the needs and constraints of small-scale farmers and especially those of women.

Cultural constraints

Culture can in some cases deny women access to animal traction technology. Cultural constraints are often overlooked and not dealt with in the planning and implementation of projects and programmes. However, farming communities are not stagnant and will change and adopt new technologies if it is felt that they are profitable and beneficial to the society.

Recommendations

Research, training, development and extension organisations and programmes should endeavour to:

- train planners and implementers to consider and recognise cultural aspects that can influence technology transfer and development
- sensitise the whole community to the particular cultural practices that might constrain women's access to animal draft power.

Approaches and strategies

Constraints women face in animal traction cannot be viewed in isolation from other aspects of their lives. Specific strategies have been suggested to overcome constraints and a more holistic approach to solving women's constraints in acquiring access to and/or control of draft animals was proposed by the discussion group.

Recommendations

Further studies and the development of strategies and methodologies for women's participation in animal traction adoption should focus on:

- understanding the position, status and roles of women and men in the particular farming system and community
- gender interaction analysis of productive and reproductive (domestic) tasks
- analysis of gender issues relating to the control of resources and access to resources
- involvement of the whole farming family in the activities of projects and programmes
- giving special attention to female-headed households in analysis, methodologies and implementation.

Research

Research programmes relating to animal traction have seldom considered or included socioeconomic and gender issues. Women seldom participate in current on-farm trials and research although they are very much involved in farm production.

Recommendations

Research organisations and programmes should:

- encourage and facilitate socioeconomic and gender-sensitive research in animal traction
- ensure end-user involvement in research and trials so that both female and male farmers participate.

Extension and training systems

There is a general lack of gender-sensitivity among planners, policy makers, project staff and extensionists. Most training and extension is designed for male farmers and carried out by male trainers or extensionists. Personnel are not appropriately trained and the training they receive is based on inadequate extension methods.

Recommendations

Training organisations and extension programmes should endeavour to:

- provide gender-sensitivity training to extension staff and trainers
- ensure that women have equal access to training and encourage their participation
- develop extension methods that are more appropriate and address the whole farming family
- recognise and make use of informal local diffusion of animal traction technology
- influence policy makers and planners on gender issues.

Project strategies for gender sensitivity

Project surveys and designs should:

- ensure that gender is considered whenever data collection is planned and implemented
- ensure that women's needs will be identified and addressed
- ensure the participation of all the community.

Project planning should:

- ensure that planners are aware of the gender implications of the projects
- ensure that gender-sensitivity training is conducted for all staff
- ensure that women are involved in all stages of project planning, implementation and monitoring
- ensure that budget allocation to involve women is adequate.

Project implementation should:

- ensure that a gender perspective (ie, both a female and a male perspective) is considered in all activities, including monitoring and evaluation
- ensure the active participation of women in project activities.

Tillage technology

Group leader: P Stevens. Rapporteur: F Emhardt

Review of tillage options

The tillage system was considered as the combination of different cultivation methods for land preparation over the whole farming season.

Plowing

Plowing has several advantages, notably:

- weed control
- soil loosening
- increased infiltration
- moisture conservation
- incorporation of organic matter.

However, it also has disadvantages, notably:

- power requirements are high
- erosion may be accelerated
- it is time-consuming
- loss of soil and moisture is increased
- soil structure is disturbed
- plow pans may form
- organic matter which is incorporated becomes unavailable as a mulch (a temporary advantage).

Direct hand planting

Planting by hand without primary cultivation has several advantages including:

- little disturbance of the soil structure
- few erosion problems
- crop residues can remain on surface
- no investment necessary.

However, it also has disadvantages, notably that:

- it is labour intensive
- much drudgery is involved
- it is slow, which results in a long planting period
- weeding is difficult
- water infiltration is low.

Ranking of options

The group decided that the main tillage options were:

- plowing
- direct hand planting
- ridging
- tied-ridging
- ripping
- direct sowing by seeder
- cultivation (tine tillage).

The group tried to assess the various options by giving them rough relative scores (good, medium and poor) for each of 12 criteria. These are summarised in Table 1. A simple (unweighted) overall score was obtained by considering all criteria

Table 1: Comparisons of some tillage options based on subjective scoring by discussion group members

Criteria for improvement	*Plowing*	*Hand planting*	*Ridging*	*Tied-ridging*	*Ripping*	*Planter*	*Cultivation*
Labour reduction	C	C	B	C	B	A	C
Weed control	A	C	A	A	C	C	B
Suited to available power	C	A	B *	B *	A	A	B
Environmental protection	C	A *	A	A	A *	A	C
Moisture conservation	B	C *	A	A	C *	C *	B
Low risk	B	A	C *	C *	A *	C	C
Simplicity	B	A	C	C	A	C	B
Flexibility	B	B	C	C	B	C	C
Yield stability	–	–	–	–	–	–	–
Sustainability	–	–	–	–	–	–	–
Suitable for soil and crop	–	–	–	–	–	–	–
Acceptability	–	–	–	–	–	–	–
Unweighted "score" [1]	18	15	16	17	14	18	20
Weighted "score" [2]	17	15	9	10	14	13	17

Key and notes

A = Relatively good; B = Medium; C = Relatively poor; – = Very site-specific

* *The discussion group was not unanimous in these judgements*

[1] *Raw score using all criteria and giving 1 for A, 2 for B, and 3 for C. The lower the score the better*

[2] *Weighted score giving 1 for A, 2 for B, and 3 for C for the first three listed criteria and 2 for A, 4 for B, and 6 for C for criteria four and five on list, with the other criteria ignored. The lower the score the better*

to have equal importance. Using this, ripping came out as most desirable, with plowing, cultivating and direct sowing appearing poor. A weighted score was then obtained, by giving high importance to labour reduction, weed control and suitability for the available power source. Higher scores were given to environmental protection and moisture conservation, and the scoring effectively penalised the systems that were poor in these aspects. In this case, ridging and tied-ridging came out as most suitable, and plowing again was among the least desirable options. The group stressed that its methodology and procedure had not been scientific or objective, but had helped the members of the group to reassess some of their widely-held conceptions.

Conclusions

There is no overall solution or general prescription. Tillage systems have to be adapted to local circumstances.

The group concluded there may be advantages in moving from conventional plowing to other systems.

Present research appears to be moving in the right direction.

Profitability of animal draft power

Group Leaders: J Ellis-Jones and A Panin

Aims

The group identified a need to ensure that participants had a sound understanding of the interrelationships of the factors affecting profitability and to identify priority areas where action should be taken to increase profitability.

Farmer objectives

Before analysing the farming environment, it was felt necessary to ascertain farmers' objectives. These are likely to include a combination of:

- provision of subsistence needs
- risk minimisation
- profit maximisation
- drudgery reduction.

Interrelationships with farming systems

A number of different sub-systems, each with their own costs and benefits, operate within the farming system. These interrelate with each other and changes in a single component of a sub-system can act adversely or positively on another.

At the centre of the farming system are three sub-systems relating to the draft animal, to the implement it pulls and to the operator. The costs and benefits and other factors affecting profitability are as follows:

Draft animal system

Costs	*Benefits*
Acquisition	Power
Nutrition	Meat
Health	Milk
Training	Manure
Shelter	Social/cultural

Implement system

Costs	*Benefits*
Acquisition	Tillage etc
Maintenance	Transport
The operator	

Operator system

Labour productivity
Health
Nutrition
Training
Gender issues

These three sub-systems operate within the total **farming system** where other factors come into play. Of greatest significance is the cropping system. Associated with this, various soil and water conserving technologies can be very important in the medium and long term. There are many input–output relationships which contribute to costs and benefits including:

Crop system

Costs	*Benefits*
Seed	Crop yields
Fertiliser	Crop residues
Chemicals	
Hired labour	

Household economy system

The needs of the household for firewood, water, housing, food, health and education further impact on the farming system.

National policy and infrastructure

Both the household economy and the farming system are affected by national policies and institutional framework. The major components are:

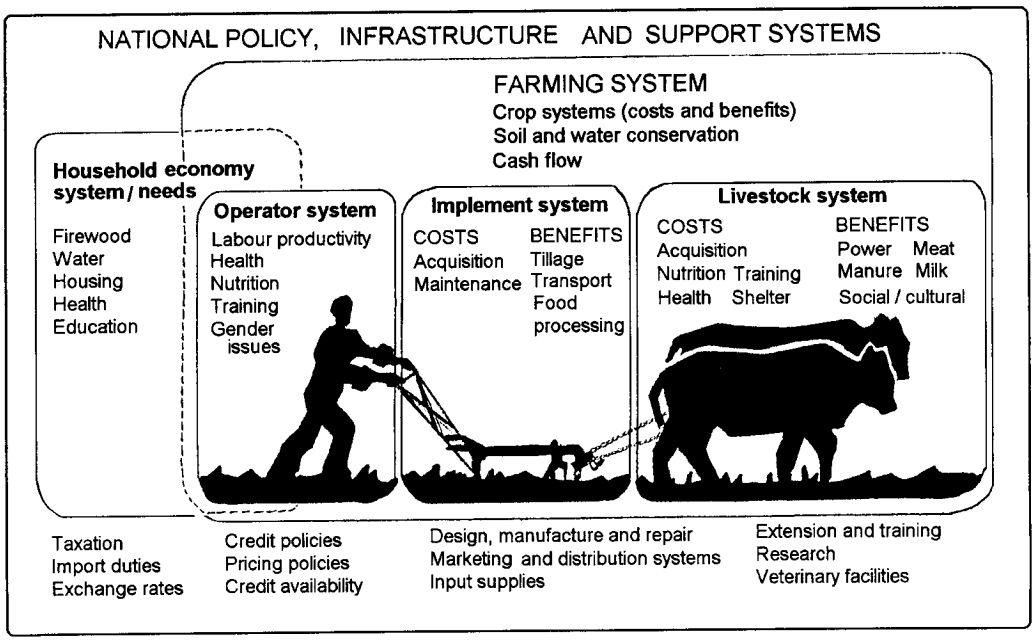


Figure 1: Farm systems model relating to the profitability of draft animal power adoption and use

Fiscal policy
- taxation
- import duties
- exchange rates
- credit policies

Infrastructure and support systems
- implement design, manufacture and repair
- marketing
- input supplies
- distribution systems
- credit availability
- extension and training
- research
- veterinary facilities

A model demonstrating the interrelationships of these factors was drawn up and illustrates the complexity of the system (Figure 1).

Financial and economic appraisal of the whole or parts of the system can be undertaken using a variety of different methods, including gross-margin analysis, partial budgets, whole farm analysis to determine profits and cash flows and detailed cost-benefit analysis.

Priority areas for further consideration

Areas of particular concern were identified within each of the various systems or sub-systems that should be given priority attention in order to make use of draft animals more profitable. These include:

Animal system
- animal availability
- animal health

Implement system
- high cost of implements
- availability of parts and repair facilities

Operator system
- training in draft animal technology

Farming system
- integration of cash crops
- tillage systems to promote soil and water conservation

National policy and institutional framework
- fiscal policies
- crop marketing systems
- access to credit
- availability of raw materials
- extension and training
- research

Recommendation

It is recommended that ATNESA gives attention to these identified priority areas and consider them in detail within small, focused workshops.

Improving animal management

Group leader: A Pearson. Rapporteur: A Aganga

Introduction

Eleven people from eight countries discussed ways to improve the management and husbandry of draft animals. The wide-ranging discussions drew on experiences from the different countries and the information obtained from Zambian farmers and extension workers during the field visits. The following recommendations were put forward during group discussions and the subsequent plenary session. The points are **not** listed in order of priority.

Recommendations

General

- animals should have adequate quality and quantity of feed available
- they should have easy access to water
- there should be appropriate strategies to control the relevant diseases in the ATNESA area
- indigenous breeds tend to be well-adapted and their use should be encouraged
- animals should be treated humanely
- in areas where farmers work cows there is a particular need to monitor animal productivity and welfare.

District level

Where appropriate, efforts should be made to:

- improve farmer knowledge of appropriate management technologies by strengthening the extension service and encouraging self help and greater farmer responsibility
- increase the emphasis on animal husbandry in the extension services
- encourage the establishment of breeding herds in areas where supply is a problem
- improve the availability of veterinary drugs at village level.

Farm level

Where appropriate, efforts should be made to:

- encourage better use of crop residues, tree fodder and industrial byproducts to complement grazing to ensure a more reliable supply of animal feeds
- improve availability of water on the farm for the animals
- learn fodder conservation techniques, storage of residues and alley cropping
- encourage farmers to practise simple management/husbandry techniques for disease prevention
- encourage better kraal construction and management
- increase awareness of the value and role of donkeys.

Points of emphasis

Disease control is a fundamental problem associated with ownership of animals in general, not just draft animals and needs to be treated as such.

Simple, affordable animal husbandry practices that do not require the use of chemicals should be promoted to ensure health and help prevent diseases, particularly for farmers who keep small numbers of animals and can give them close individual attention.

Feed supply and availability are not perceived to be a problem by many of the Zambian farmers. However, most of the draft animals would benefit from supplementary feeding if farmers could provide it.

In the present economic climate, some commercial farmers in the ATNESA region are finding animal power a more attractive option than tractor power for some farm tasks. These people are likely to have more financial scope to practise improvements in animal management than many of the smallholder farmers. This sector should not be forgotten in considering "improved animal management".

Farmers in the ATNESA region are increasingly using cows for work. In Zambia, at least, this appears to be very much a farmer-led innovation. Many extension workers appeared to be unaware of the extent of use of draft cows in their areas. There is a fairly urgent need to look more closely at the role of working cows in the region. The implications of using cows for work in terms of productivity, lactation, reproduction and feeding in the region should also be investigated.

Donkeys are considered to be a relatively untapped source of animal power in the region, cheaper than oxen. It was thought that their use should increase. Where donkeys are being used in land cultivation and transport there is an urgent need to discourage the use of yokes and promote appropriate harnessing, more suited to the conformation of the donkey. This is not only an issue of welfare but will enable donkeys to work more effectively.

Improving animal-based transport

Group leader: M Anderson. Rapporteur: F Mujemula

Introduction

Participants in the group represented a wide range of disciplines, from engineers who wanted to discuss technical problems, to socioeconomists who wanted to focus more on farmer perceptions and the process of social change. The outcome was an attempt to integrate these two approaches, which generated a valuable debate on both technical and socio-economic issues relating to transport.

The size and enthusiasm of the group underlined the view that animal-based transport is seen as playing a very important role in farming systems. There was consensus that animal transport can reduce the time and effort required to move goods at farm and village level. The use of oxen, donkeys, horses or camels for transport purposes can be almost more significant than tillage in terms of the extent of animal use throughout the year, and it can bring economic as well as social benefits.

Farming households and transport

The group agreed that the perspective of the farming households should be paramount in assessing how animal-based transport can be improved. From a farming household's viewpoint, animal-based transport technology should be:

- convenient and efficient
- readily available and affordable
- reliable (risk is not high)
- based on a technology which is well-known and understood, so that households can maintain and, if appropriate, produce it themselves
- acceptable to household members in terms of status and cultural image
- acceptable in terms of impact on the rest of the farming system, including animal health and feeding requirements
- accessible to, and open to control by, the household and by individual household members, for subsistence and agricultural uses
- developed and introduced through processes involving the whole farming household.

The group then discussed how the main types of animal-based transport relate to these farmer-centred objectives and examined how transport technology could be improved to meet these objectives.

Sledges

Farmer viewpoint

Sledges are widely used by ox-owning farmers to move moderate loads over short distances. The technology involved is simple so farmers can readily make their own sledge at minimal cash cost. Sledges therefore have the advantages of being affordable, available, well-known, understood and directly controlled by the farming household. Disadvantages are that they are difficult for oxen to pull and are believed to cause some erosion of paths and tracks (eg, at commonly-used road crossings). These erosion effects have caused sledges to be banned in Zimbabwe since before independence, but sledges still play an important role in Zambia, Tanzania and other countries.

Recommendations

- Banning sledges seems inappropriate while carts remain inaccessible to many poor farmers.
- No policy decision on sledges should be taken before weighing the economic costs and benefits to users and the community at large and before examining carefully whether erosion is in fact a problem and whether it can be alleviated in any way.
- Research could be undertaken to improve sledge design. This is regarded as a fairly low priority and should not involve any recommendations which put sledge ownership or production beyond the reach of poor farmers.

Pack animals

Farmer viewpoint

Even where animal traction is not being used for tillage, the use of donkeys (and in parts of Africa horses, mules and camels) as pack animals can play an important role in meeting rural transport needs. In Botswana and other parts of southern Africa, donkeys are playing an increasingly important role in assisting women with agricultural and subsistence transport tasks. The technology of donkey packs and harnessing is relatively simple, generally requiring only local materials such as leather and wood, and the feed requirements of donkeys are much less than those of oxen. However, donkeys are new to many parts of southern and eastern Africa, so many farmers lack the knowledge and understanding required to train, harness and care for them.

Recommendations

- Planners, policy makers and NGOs should share and disseminate information on donkey use, care and harnessing, including guidelines for load-carrying limits.
- Farmers' access to information about donkeys should be improved, through extension services and projects.
- Particular care should be given to animal health and disease when introducing donkeys to new areas.

Animal carts

Farmer viewpoint

Increased cart ownership among animal traction farmers is a high priority, because carts are generally by far the most efficient and convenient type of animal-based transport for moving larger loads. However, carts are expensive and difficult to obtain relative to other animal-based means of transport. Hire markets can play an important role in enabling poorer households to use carts, but the hiring household obviously has less control over the timing and extent of cart use. Women's access to carts is limited in many parts of Africa, as the carts are often controlled by men in the household. However, young men and boys have been observed to use carts for firewood and water collection, so the cart can effectively transfer transport responsibilities away from women. It is less common for a cart to be hired specifically for subsistence purposes (wood and water) than for cash-related activities such as harvesting or marketing.

Cart wheel and axle components are relatively complex to make, often requiring use of steel and other imported materials. This means that farming households can rarely undertake the production and repair of carts themselves and are reliant on the availability of supporting services. The group considered different options for cart design from the perspective of farming households, focusing on the two most problematic cart components—wheels and bearings. Other aspects of cart design (brakes, suspension and body design) were identified but could not be discussed due to lack of time.

Improvement of wheels

The group discussed three main options: pneumatic, steel and wooden wheels.

Pneumatic wheels are generally preferred by farmers except in areas where punctures pose a major problem. Although they are difficult to produce locally and are very difficult to obtain in rural areas, they offer high performance on rough surfaces and appear to have good status value. High priorities for improvement are to:

- improve the supply of second-hand pneumatic rims by commercial manufacturers and importers
- improve the supply of reconditioned tyres, particularly radial tyres with inner steel mesh
- develop and field-test low-cost technology for decentralised production of pneumatic rims
- develop and field-test technology for puncture prevention
- encourage the development of puncture repair workshops
- improve the distribution of materials and components for pneumatic wheels to rural workshops.

Steel wheels are preferred by some farmers, particularly where punctures are very frequent (eg, in areas with many thorns) or where repairs are difficult (ie, in more remote areas). They can be produced relatively easily from basic raw materials by metal workshops. The main technical problem is weld failures caused by impact loads on rough roads. Priority areas for improvement are to:

- encourage the development of blacksmith workshops that have welding equipment
- develop and field-test simple suspension systems to reduce impact loading (eg, rubber cushioning).

Most attempts in Africa to cushion impact by nailing or otherwise attaching solid rubber around a steel wheel have not been successful. However, channel-section steel has been successfully used on many Asian carts to hold a strip of rubber around a solid wheel.

Wooden wheels have been developed by a large number of projects, which have attempted to make simple wheels from locally-available materials. Despite the apparent attraction of this approach, wooden wheels have not been adopted on any significant scale in Africa, except in areas such as Madagascar which have a long tradition of carpentry and wheel-making. The reasons for this failure appear to be the "low-tech" image and low status of wooden wheels and the difficulty of making strong and durable wheels, which require skilled carpenters and good timber. Wooden wheels are not viewed as an acceptable option for carts in most parts of Africa.

Improvement of hubs and bearings

Two options for hubs and bearings were discussed; hubs with rolling contact bearings or wooden bushes.

Hubs using roller or ball bearings have, like pneumatic wheels, proved the most popular system for animal-drawn cart axles in Africa. The bearings themselves have to be imported, and are consequently costly and often difficult to obtain in rural areas. Hubs using roller or ball bearings are highly durable and need very little maintenance, but if they fail, some bearing elements usually need to be replaced. This requires access to a skilled workshop and poses major problems because of the limited availability of imported bearings. Improvements which are high priority are to:

- improve the supply and distribution of imported bearings, for hub repair and production
- improve the supply and distribution of manufactured hubs using rolling contact bearings, from importers and centralised local producers
- encourage the production and use of integrated hubs units, which can be removed and replaced by a relatively unskilled workshop (used hubs could then be reconditioned and resold by a central producer)
- improve the standard of seals to keep dust out and hence reduce wear
- develop and field-test low-tech roller bearings suitable for decentralised production.

Wooden bushes and other types of bush bearings are much easier to produce than roller bearings and can usually be made from locally available materials. Despite their low cost and ease of supply, wooden bearings have not proved popular with farmers. This appears to be because frequent lubrication is required; many farmers let their bearings dry out, with consequent increase in wear rates. Improvement of wooden bearings is of a moderate priority and should attempt to:

- develop and field-test oil-soaked and self-greasing bearings (eg, spring-loaded grease applicators)
- improve the supply and distribution of lubricants to rural areas
- develop and field-test other bush bearing materials which are durable and locally available.

Policy issues

Networking on cart design

In terms of cart design, which was a major focus of debate within the group, there is a need for better sharing of information on experiences of different projects. These experiences can shed light on the ongoing debate between "low-tech/decentralised" and "high-tech/centralised" approaches, by revealing what has and has not worked in different circumstances, for different cart components. It was recommended that a mechanism be found through ATNESA to share the extensive field experience of different group members. The aim of this exercise would be to develop and publish guidelines for cart design, and provide an ongoing mechanism for sharing experience. The group participants agreed to communicate after the conference to pursue this suggestion.

Increasing access to carts

It was agreed that there is a need for increased recognition by policy makers of the profitability and importance of animal-based transport within many farming systems. This should be reflected in the improvement of supply and distribution systems for cart materials and components, in the provision of credit for cart purchase and the facilitation of group use for poorer farmers and for women who have restricted access to carts. Designs for donkey carts and harnesses should be more widely disseminated.

Beyond the ox cart

Policy initiatives on animal transport should not be restricted to carts. Policy makers should recognise that while sledges and pack animals have their own limitations, they may be more appropriate than carts in some farming systems, being cheaper, easier to obtain and often more accessible to women for time-consuming subsistence tasks.

Transfer of technology

Group leader: R Fischer. Rapporteur: P Jones

The group discussing technology transfer was large, and their deliberations were wide-ranging. They considered the different groups involved in technology transfer and their relationships to each other and their respective influences. They also consider the information available and the technologies.

Current technology transfer problems

Farmers do not receive sufficient information on alternative technologies to enable them to make rational choices themselves.

Smallholder farmers have little or no influence on animal traction research programmes or the decisions of implement manufacturers.

Farmers are often ignored, misunderstood and stereotyped by research and extension staff and by manufacturers. Sometimes farmers are even dismissed as conservative and ignorant.

Smallholder farmers have insufficient influence on authorities and information sources and they tend to be marginalised both politically and economically.

The existing formal agents of change (extension workers and researchers) may face a conflict of interests if they attempt to meet the needs of the farmers. They generally find it easier to be oriented towards their urban-based supervisors, on whom their future depends.

Recommendations

Research and extension should start with farmers' problems.

Research and extension should consider the whole farming system, not isolated elements.

Research and extension should be flexible, participatory, holistic and adaptive.

Farmers must take more responsibility for their extension requirements. They should be more assertive concerning their real needs and problems, perhaps though participation in pressure groups.

Extension workers need training in participatory methods and approaches. School, college and university curricula need to be made more relevant.

National policies need to be modified to facilitate these changes.

The supply and distribution of animal traction implements

Group leader: A Wanders. Rapporteur: E Sakala

Introduction

The group tried to gain an overview of the present situation in the five countries represented in the group (Kenya, Malawi, Tanzania, Uganda and Zambia). To provide a theoretical framework, use was made of the models presented in the keynote paper on the subject by A Wanders. Although the situation in each country is complex, the issues considered to be of greatest significance are summarised in Tables 1–3, which cover supply scenarios, distribution systems and key constraints.

As these tables were produced, it became clear that the situations in the various countries were very different, although there were some striking similarities. In order to discuss concrete examples of the problems and possible solutions, the group decided to concentrate on the situation in Zambia, which had been highlighted during plenary sessions and the field visits. It was agreed that the general constraint was the non-availability and/or untimely distribution in the rural areas of a range of animal traction implements (and spares) adapted to local conditions. The group then highlighted the following associated constraints and possible solutions. Although they concern Zambia, many of the problems and possible solutions are likely to be relevant in other countries in the region.

Distribution constraints in Zambia

Constraints relating to demand by farmers

- Poor profitability of food crop farming. Poor farm prices and marketing systems. Absence of credit. Late payment for produce.

- Poor awareness by farmers of new or existing equipment options and techniques for tillage and weeding.
- Weak position of farmers. Poor representation within supplying cooperative societies leading to top-down and arbitrary decisions relating to the type, origin, quality and price of equipment supplied to farmers.

Possible solutions and recommendations

- Improve rural marketing and credit systems.
- Increase and intensify on-farm implement trials and extension programmes using trained extension staff (supported by local development programmes and Magoye/Palabana outreach).
- Strengthen the position of farmers through organisation of farmers' animal draft power groups to provide adequate feedback on actual needs and acceptability of the present supply.
- Proper marketing and advertising of implements based on implement qualities and prices (with possible role for independent "seal of approval" following testing by Magoye/Palabana).
- Regular update by Department of Agriculture of "profiles" of farmers' production systems with trends in use of (demand for) different animal traction implements. Dissemination of such information to suppliers and manufacturers to assist market forecasts.

Distribution-side constraints

- Within governmental and parastatal sectors, there are financial crises and an inefficient top-down distribution system to rural areas and within rural areas.
- For local development programmes in areas of animal traction introduction there are major problems of logistics and infrastructure.
- There is a lack of sustainable credit at realistic rates.
- The private sector does not have efficient retailer/dealer/agent networks in the rural areas and there are problems of costs, risks and logistics of setting up a new system of agents.
- Assembly workshops do not exist in rural areas and transport costs for supplying such workshops would be very high.
- Existing small rural workshops face constraints with capital and supply of raw materials.

Possible solutions and recommendations

- Government agencies to implement a more effective and farmer-oriented distribution system with depots within the rural areas (this is in line with proposed government reforms under discussion).
- Establish a distribution system with depots in areas of new introduction (with potential for private sector involvement)
- Investigate feasibility of area development projects providing credit with non-monetary "in kind" or barter systems of repayment through local development programmes.
- Establish a private sector marketing and distribution system in the main animal traction areas.
- Development of manufacturers' marketing strategies and marketing investment, with investigation of possible systems for prefinancing rural stocks (eg, bank guarantees).
- Manufacturers to take initiatives to establish basic, equipped rural workshops for local manufacture or assembly in combination with agents.
- Investigate support for initial working capital for improving rural workshop capacity (eg, for producing or assembling ox carts) with reference to the recent programme of the Small Industries Development Organisation (SIDO).
- Support for market research, market forecasts and feasibility studies.
- Creation by government of favourable conditions for initiatives of the emerging private sector.

Blackmiths

The present role of rural blacksmiths is poorly developed in both numbers and capacity and blacksmiths have poor access to spare parts and scrap materials

Possible solutions and recommendations

- Provide blacksmith training relating to techniques and business management (by local development programmes and training centres).
- Provide support to selected blacksmiths in provision of tools and equipment (by local development programmes).
- Improve supply of scrap materials in rural areas
- Establish and logistically assist effective links between blacksmiths and regional assembly workshops and spare-part outlets.

Table 1: Summary of implement supply scenarios in Zambia, Kenya, Uganda, Malawi and Tanzania

	Zambia	*Kenya*	*Uganda*	*Malawi*	*Tanzania*
Imports					
Proportion	75% imports	60% imports	75% imports	0% imports	50% imports
Equipment imported	Mainly Zimbabwe plows and some cultivators, ridgers and planters. Some imports from India, The Netherlands Italy, and Tanzania (cross-border)	Mainly plows from India, Korea and Tanzania	Indian plows (Cossul) and some ox carts		Plows, ridgers and cultivators from India and Zimbabwe
Centralised manufacture					
Monopoly situation	Until 1986, Northland plow monopoly plus small manufacturing of harrows and cultivators in Copperbelt		WACU–Acord monopoly in north and north-east	Agrimal Company	
Competing manufacturers	Since 1986, three main manufacturers: Lenco, Gameco and Northland		Saimmco, Peko and NGOs		UFI (main), Zana Za Kilimo, Mbeya and Camartec
Range of implements	Essentially plows with few ridgers, cultivators and harrows	Mainly plows, cultivators and spike harrows		Plows, ridgers, harrows and chains	Mainly plows
Ox cart manufacture	Presently only conventional carts or axle/bearing/tyre assemblies in small numbers by SKF, Lenco and T&M. Previous attempts with alternative designs failed (metal and solid rubber wheels)	No centralised ox cart manufacture.	Ox carts manufactured by Saimmco on order	Ox carts made by Petroleum Services and by Brown and Clapperton	Some ox carts produced by Camartec
Decentralised manufacture					
Manufacture in provinces	Non-existent at present, but local development projects have supported ox cart initiatives (small numbers only)	Non-existent	Private and NGOs	A few activities by Petroleum Services	Some rural craft workshops
Private-sector initiatives in provinces	Non-existent at present except ox carts made from scrap axle/bearings and wheels mainly in "line-of-rail" (scarce supply)	Ox carts from scrap axles by small workshops (scarce supply)	Peko and blacksmiths	Some ox carts	Mainly ox carts
Spare part provision					
Imported equipment	Negligible		Non-existent		15% of imports are spare parts
Local implements	Generally neglect of spares and poor standardisation. 40% of implements need repairs and spare parts	Neglected and poor quality	Non-existent	Available but poor distribution	Manufactured but poor distribution and standardisation
Blacksmiths					
Manufacturing	Poorly developed. Some cart production. Some implements made in Eastern Province			Limited	Poorly developed and neglected area
Repairs and spare parts	Limited as there are few blacksmiths and severe problems obtaining scrap and raw materials	Available but small market. Problems obtaining materials	Mainly in north and east but lack of training and raw materials	Mainly blacksmiths' own initiatives. Lack of facilities	Lack of market information and raw materials

Table 2: Summary of animal traction implement distribution scenarios in Zambia, Kenya, Uganda, Malawi and Tanzania

	Zambia	*Kenya*	*Uganda*	*Malawi*	*Tanzania*
Government and parastatal systems					
	Main distribution through cooperative unions and parastatal dealers (eg, Afe) based mainly on batch imports	Distribution by cooperatives and private companies	Distribution by cooperatives and projects	Parastatal distribution and credit provision suspended	Distribution mainly through cooperatives and parastatals
Present constraints	Financial crises and collapse of old centralised/top-down system. Distribution inside rural areas non-existent or untimely (depots exist but are poorly managed)	Target farmers have low purchasing power; high prices, notably for spares	Same constraints as cited for Zambia	Lack of materials at correct time Lack of distributor commitment	Top-down system inefficient. Rural depots ineffective
Local development programmes and projects					
	In areas of new introduction of animal traction local programmes with donor assistance have established depots and distribution systems with credit links (eg, Kabwe, Pongwe, Kaoma)	Production and local demonstrations by Rural Technology Centres	Acord (Nebbi) and Lutheran World Federation (Moyo, Karamoja)	Donor funding for training and extension and a revolving fund for veterinary products	Several donor-supported programmes and projects
Present constraints	Non-sustainable credit system, poor rural communications and infrastructure	Poor credit system	Poor credit systems; lack of funding for training	High interest rates for credit; poor credit monitoring	Poor infrastructure and no continuity
Private-sector distribution					
	Hardly exists in rural areas, except for some district hardware stores with small stocks of plows	Available in markets in some regions	Hardly exists	Available but not consistent	Few private dealers in rural areas
Present constraints	Lack of dealer or agent network in rural areas (initiatives required by manufacturers) No market studies or forecasts	Low demand due to low farmer income	Lack raw materials	Distributors reluctant to invest capital in slow-moving seasonal stocks	Prices set high Difficult logistics
	High costs and difficult logistics to establish a dealer or agent network		Difficult logistics	Needs more distributors	Lack market information
Assembly at workshops in the regions					
	There are no assembly workshops linked with or supported by central manufacturers	Non-existent	Non-existent	Manufacturer tried but failed	Past attempts by UFI, ZZK and Camartec
Present constraints	Lack of manufacturers' initiatives. Uncertain economic feasibility and logistics	Market not yet developed	Saimmco production too low at present	Manufacturer says system expensive	Logistics and infrastructure problems

Acronyms used in Tables 1–3

NGO	Non-governmental organisation	UFI	Ubungo Farm Implements
Saimmco	Soroti Agricultural Implement Machinery Manufacturing Company	WACU	West Acholi Cooperative Union Ltd
		ZZK	Zana Za Kilimo
SIDO	Small Industries Development Organisation		

Table 3: Some key constraints to animal traction implement supply systems in Zambia, Kenya, Uganda, Malawi and Tanzania

Zambia	*Kenya*	*Uganda*	*Malawi*	*Tanzania*
Demand by farmers				
Poor profitability of food crop farming. Poor farm prices and marketing systems. Absence of credit. Late payment for produce	Poor quality of implements so farmers reluctant to purchase	High price of donor-supplied equipment; poor marketing of farm produce	Low demand is *not* a problem (high demand from farmers)	Poor marketing of farm produce; low farm incomes
Limited awareness by farmers of existing or new implements for tillage and weeding systems, associated with weak or under-resourced extension services and credit agencies and lack of supplier extension (few demonstrations; little display stock in rural areas)	Farmers unaware of present and alternative animal traction implements and lack resources to acquire them	Low effectiveness of extension services due to inadequate logistical support		Farmers lack information on new equipment Equipment often available only in urban centres
Lack of availability of implements and spares in the rural areas	Low level of agricultural training and education	Cattle rustling reduces demand for animal traction		Poor credit systems and after-sales services
Supply by manufacturers				
Until recently, no local developments but copying imported Safim-type plows and relatively heavy ridgers and cultivator	Little change during past decade with no new inventions or adaptations	Lack of raw materials for local equipment	Manufacturing capacity too low for demand	Lack of raw materials
Lack of diversification of animal traction implements. No adaptation of ranges to area-specific requirements	Little profit for engineers from innovations	Supply dependent on donor support for importations		Manufacturers do not diversify ranges as risks high
Little or no feedback from regions on farmers' needs and implement acceptability (lack of marketing strategies and rural distribution networks)	Poor distribution system; farmers sometimes appear conservative			Low feedback from regions
Support by public-sector institutions				
In past, little impact of government-funded research, testing and extension services (funding and communication constraints). Since 1989, the Magoye implement testing and on-farm trial and demonstration programme has aimed to increase farmers' awareness of different tillage and weeding practices (and implements) and to improve feedback to manufacturers	Efforts being made through extension services and farmers training centres	Limited training of both farmers and staff	Some research and development of new equipment	Manufacturers and distributors are largely government-owned but not efficient
The government-established cooperative unions and credit system have proved largely ineffective in bridging the gap between actual farmers' need and implement supply		Research and development programmes have not been effective	Promising imported designs are tested	Cooperative unions and banks not providing sufficient support to farmers to stimulate demand