

# A farming systems approach to improving draft animal power in sub-Saharan Africa

by

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## Abstract

*In Zimbabwe the use of draft animals is widespread and long-established outside tsetse-infected areas. Most farmers prefer to use oxen for plowing, especially on heavier soils, as they are faster and stronger than donkeys. However, lighter operations, especially weeding and transport, are increasingly being carried out by donkeys.*

*The 1991/92 drought reduced the cattle herd from 4 million to less than 3 million animals and the donkey herd from 400,000 to less than 300,000. Peak demand for animal power is for plowing at the end of the dry season when animals are in worst condition and feed resources at their lowest. As a result, availability of draft power is a limiting factor in many areas.*

*Productivity could be improved either through increasing the supply of draft animals or reducing the demand for draft animals by increasing their effectiveness. Increased use of donkeys and increasing the carrying capacity of communal land could increase the supply of draft animals. Conservation tillage systems and improved implements could reduce the demand for draft animals.*

*Farming systems in Zimbabwe are complex and vary geographically. If research is to be relevant to farmers it is essential that existing farming systems, rather than current extension recommendations, form the basis for research programmes.*

## Introduction

This paper is based on a research project financed by the Overseas Development Administration's (ODA) Livestock Production Programme entitled 'Increasing the productivity of draft animals in sub-Saharan Africa'. The project comprises three interrelated themes:

Socio-economic studies to identify current draft animal power practices, to characterise specific target groups of farmers using draft

animals and to determine priorities for draft animal power research.

Nutrition, health and management aspects of draft animals of limited capability.

An evaluation of draft animal power equipment and, if necessary, development of new implements for draft animals of limited capability.

This paper draws from the socio-economic component of the research project.

## Animal traction in sub-Saharan Africa

Worldwide, it is estimated that 400 million draft animals (bovines and equines) are being used in agricultural operations. Starkey (1988) estimated that of these some 18.6 million animals are employed in sub-Saharan African agriculture. These are predominantly work oxen (in excess of 350 kg) but include donkeys, mules, horses and cows.

A review by Mrema and Mrema (1993) of the utilisation of animal power in sub-Saharan Africa showed that of the 11.3 million draft oxen in use, nearly 80% are found in five countries—Ethiopia (53%), Zimbabwe (7%), Kenya (6%) and Tanzania and Uganda each with 5%.

Little information is available on the use of smaller/weaker oxen, cows or equines as the preferred draft animal is the large ox. Even those countries with large populations of equines, particularly donkeys, have little information on current use, management and performance.

## Animal traction in Zimbabwe

### The role of draft animals within the farming system

In Zimbabwe the use of draft animals is widespread and long-established outside tsetse infected areas. There are some 900,000 households in the communal sector for whom mixed farming

is the main activity. Arable plots are commonly 2–3 ha in size.

Livestock, particularly cattle, play a vital role in the farming system. Eckert and Mombeshora (1987) reviewed the functions of livestock in the communal farming areas of Zimbabwe. They identified socio-cultural and socio-economic functions. The socio-cultural functions include use for *lobola* (bride price), ancestor worship and funerals. In areas of higher rainfall, draft, manure, sales, milk and meat, in that order of importance, were found to be the major socio-economic functions. Sales are mainly to raise cash for buying food, paying school fees and other emergency expenditure. In low-rainfall areas cattle provide a substantial amount of draft, but increasingly donkeys are replacing cattle, especially for transport. However, they have limited value other than the provision of draft. A comparison of the relative economic values of outputs from cattle and donkeys is shown in Table 1.

Prior to the drought in 1991/92 the communal cattle herd exceeded 4 million animals (Central Statistics Office, 1990) with stocking rates exceeding sustainable carrying capacities in many areas. The number of donkeys was estimated to be 400,000. The drought reduced the cattle herd to less than 3 million and the number of donkeys to less than 300,000.

Mrema and Mrema (1993) identify the main benefits generally associated with using animal power as:

- increasing the productivity of labour
- expanding the area under cultivation
- increasing the intensity of land use
- improving the quality and timeliness of key farming operations
- reduction in the drudgery associated with hand tool agriculture which is used on 80% of the cultivated land in sub-Saharan Africa

Problems associated with adoption of draft animal power include (Geza and Reid, 1983; Mrema and Mrema, 1993):

- the lack of animals for traction, related to poor herd composition, low calving rates, late weaning and poor management. As a result there are insufficient animals for draft (especially plowing) and for manure

**Table 1: Estimates of the relative economic values of outputs from cattle and donkeys in the communal areas of Zimbabwe**

<i>Output</i>	<i>% of total value</i>	
	<i>Cattle</i> <sup>1</sup>	<i>Donkeys</i> <sup>2</sup>
Draft	64	95
Milk	14	–
Manure	4	2
Meat	8	–
Herd growth	10	3–5
Social value	?	–
Total	100	100

*Sources: 1) Barrett, 1992; 2) Estimates from discussions with farmers*

competing demands for livestock products  
disease problems, particularly trypanosomiasis  
in tsetse areas

lack of available feed and environmental  
concerns of over utilisation of grazing areas  
(too many cattle for the amount of fodder  
available)

lack of suitable implements

increasing the work burden for manual  
operations, especially that of women

a poor image of animal power among opinion  
formers and (urban) elites in sub-Saharan  
Africa, often resulting in a preference for  
tractors even when they are not cost-effective.

Draft animal power has the potential to play a  
major role in increasing agricultural production in  
sub-Saharan Africa providing the benefits can be  
realised and the problems avoided or minimised.

### **Project study areas**

Three areas were selected that were broadly  
representative of conditions found in the semi-arid  
parts of Zimbabwe. A rapid rural appraisal, formal  
survey and monitoring of typical farmers have  
been undertaken. The project has used  
participatory methods involving farmers and  
manufacturers in both problem identification and  
seeking solutions.

In each area farmers' objectives tend to focus on food security, giving priority to production of food crops under risk minimisation strategies, generating cash from food surpluses in good years, sometimes growing a cash crop when conditions allow (cotton in one area), selling livestock when no crop is available for sale or seeking non-farm income when farming cannot provide enough. Cattle provide an opportunity for capital accumulation so cash surpluses are often invested in cattle. There is a constant demand for more cattle as few farmers are satisfied with their present herd size. Data from the Ministry of Lands, Agriculture and Rural Resettlement (1993) confirms that non-farm incomes are important in most areas and contribute nearly 50% to total income outside the cotton-growing areas.

The farming systems are broadly similar in the three areas, with similar cropping systems, management practices, livestock and implement ownership patterns even though natural resource conditions vary considerably. Important differences in the drier areas are:

- larger areas are cropped
- donkeys are more common
- small grains assume greater importance even though maize is still grown.

In all areas the farming systems are geared towards crop production, with the role of cattle and donkeys being to support this activity. Traditionally, hand hoe cultivation was practised widely, but as available labour decreased due to increased schooling, animal power assumed the importance now attached to it. Peak demand for animal power is for plowing from the end of September to early December when animals are in worst condition and feed resources at their lowest.

Components of the farming systems have a high degree of interdependence. Crop enterprises are dependent on livestock for land preparation and provision of manure. Livestock are dependent on crop residues for survival during the dry months. Both crops and cattle provide outputs for domestic consumption and cash generation. Donkeys provide input for crop production and are playing an increasingly important role in transport.

Most farmers prefer to use oxen for plowing, especially on heavier soils, as they are faster and stronger than donkeys. Where donkeys are used for

plowing, the furrow depth is often inadequate and moisture conservation poor. However, lighter operations, especially weeding and transport, are increasingly being carried out by donkeys. In households where cattle are available they are used for plowing and donkeys are used for other operations.

Communal grazing constitutes the main feed source for animals, although some farmers supplement their animals with stover, pumpkins or melons as grazing becomes scarce.

The Farming Systems Research Unit (1994) compared extension recommendations and farmer practices for livestock. Table 2 demonstrates the extreme difference between recommendations and practices. If research is to be relevant to farmers it is essential that existing farming systems, rather than current extension recommendations, form the basis for research programmes.

#### **Elements of the farming system affecting utilisation of draft animals**

Factors affecting draft power utilisation can be categorised within three major sub-systems.

##### ***Intra-household sub-system***

The components of the intra-household sub-system include the animal, the implement and the operator. These have been described by Ellis-Jones and Panin (1992). Like other production processes farming operates in a system where resources are allocated so that expenditure does not exceed income. This is done within the general framework of farmer's objectives of provision of subsistence needs, risk minimisation, profit maximisation and drudgery reduction. Resources are always limited. Farmers therefore have to prioritise on expenditure with affordability being an important factor for new technology adoption. Cost should not be viewed in absolute terms but within the context of the household system.

##### ***Inter-household and community sub-system***

Key to the inter-household sub-system are the production relationships between farmers, which enable access to draft by those not owning animals. Such arrangements involve cash, reciprocal labour, lending, payment in kind and other agreements between farmers. A major question is for how long and whether there is an obligation for those owning animals, to share them

**Table 2: Livestock extension recommendations compared with farmer practice**

<i>Activity</i>	<i>Extension recommendation</i>	<i>Farmer practice</i>
Cattle breeds	Exotic 'improved' breeds	Indigenous breeds
Objectives	Beef production	Multi-purpose use, especially draft power
Stocking rates	10 ha per livestock unit	2 ha per livestock unit
Grazing management	Rotational grazing in fenced paddocks -grazing schemes	Key resource grazing, use of high potential sites, eg drainage lines
Fodder management	Legume reinforced pastures in grazing areas Supplementary feeding, salt licks etc Stover collection and preparation with urea Agroforestry, including planting of <i>Leucaena</i> , etc	Browse management None, except in extreme drought Stover collection and storage only Some agroforestry planting; browse management
Use of draft animals	Primarily oxen Winter plowing	Mixed spans often used Most plowing done after first rains
Drought management	Destocking - early sales; movement discouraged and highly regulated	Movement to other areas; supplementary feeding, distress sales
Disease control	Weekly (wet season) and fortnightly (dry season) dipping; dosing; antibiotics; movement controls	Dipping regime followed except in drought; traditional herbs used to treat disease
Donkeys	Few recommendations with respect to management, disease control etc	Indigenous practices

Source: FSRU, 1994

with those without animals. Policies to encourage wider and more efficient use of existing draft are likely to be beneficial.

#### ***The physical and economic environment sub-system***

This includes soil types, rainfall, the equipment industry, extension, credit availability and general policy environment. It determines the overall productivity of the system and has an important influence on the production modalities within the household system and the relationships of different households.

These sub-systems combine to form the components of the farming system and are essential determinants of household decision making. In planning interventions it is vital to

incorporate them in the analysis and characterisation of farmers.

#### **Farmer recommendation domains**

The complexity of the farming systems means that animal traction research needs a new thrust to ensure the needs of all farmers are translated into appropriate technologies, national policies and support mechanisms. Researchers need to know and consult with their intended clients. Key questions include:

- what needs can be addressed by research?
- whose needs are addressed (Would anyone take-up the technology)?
- how would the entire farm system react to the technology?

**Table 3: Extension recommendation domains of farmers**

<i>Rural households</i>								
<i>No animals owned</i>		<i>Animal owners</i>						
No access to draft animals	Some access to draft animals	<i>Inadequate draft power</i>			<i>Adequate draft power</i>			
		Donkeys only	Donkeys and cattle	Cattle only	Donkeys only	Donkeys and cattle	Cattle only	

Identification of current practices and the characterisation of specific target groups of farmers (recommendation domains) are essential for addressing these questions. This will ensure:

- precise definition of farmer groups relative to their extension and research needs.
- better focusing of extension and research activities
- more efficient allocation of resources so they can be targeted at farmers who are able to respond because of the relevance to their circumstances
- setting achievable targets for each target group
- government policies relevant to particular regions or a group of farmers can be established
- relevant information for each group of farmers can be collated.

Table 3 shows how farmers have been classified into recommendation domains. This has been undertaken on the basis of research and extension needs.

### **Major draft animal power issues**

#### **Profitability**

Animal traction remains the most economic form of draft for many farmers. However, there are costs which relate to the acquisition and maintenance of animals and equipment, such as repair bills and costs of veterinary products. Farmers aim to minimise the costs and maximise the benefits to maximise profits. In the long term, benefits will exceed costs, but in the short term low productivity and animal loss due to disease or drought may mean that costs are unaffordable.

Farmers' perceptions of the relative performance of cattle and donkeys have been described by

Hagmann and Prasad (1994). Donkeys are more tolerant of disease and drought, require less water and feed supplementation and are in better condition at the end of the winter season. They require less training, are easier to handle and often preferred by women. However, donkeys are unable to deep plow, but can be more suitable for cultivation and transport. They are able to work for longer periods and have a longer working life.

A comparison has been made using indicative costs and benefits of owning and using alternative animals. Costs have taken into account differences in the purchase and resale values of the animals, length of working lives, depreciation of equipment, labour and some feed supplement costs. This shows that the cost of donkeys can be substantially less than that of cattle.

However, when the value of manure, milk, herd growth and other social benefits are taken into account, there is little difference between cattle and donkeys. This demonstrates the importance of other benefits of cattle in reducing animal power costs.

Potential benefits from cows exceed those of both oxen and donkeys, provided that fertility and milk production do not suffer.

#### **Availability of draft animals**

Prior to the drought of 1992, draft animal availability was a concern in some areas, but with up to 75% of cattle perishing in some localities, shortage of draft animals became the major issue in all areas. As a result of deaths of mature and larger animals there was a decline in older cows and oxen relative to younger and smaller animals. A similar trend occurred with donkeys. Cattle losses were generally higher than for donkeys. As a result there has been a general increase in the use of donkeys for animal power in many areas.

**Table 4: Ownership of draft animals in semi-arid areas of Zimbabwe**

	<i>% of farmers (n=248)</i>
No animals	37
Inadequate draft: donkeys only	10
cattle and donkeys	2
cattle only	4
Adequate draft: donkeys only	4
donkeys and cattle	12
cattle only	31

Source: Muvirimi, 1995

Table 4 shows the present animal ownership patterns in relation to the farmer recommendation domains shown in Table 3.

Plowing is regarded as the most critical animal-powered operation. Where there are sufficient oxen, draft is supplied by oxen, but as numbers decrease, the burden of draft is shared between oxen, cows and donkeys. A large number of farmers (53%) do not have adequate animals and therefore have to rely on alternative sources.

Government plowing services do provide limited tractor plowing, but they are largely regarded as unreliable, non-viable and not sustainable. Draft animal power contracting services are not common and are only provided when the contractor has completed his own plowing. Various arrangements between farmers have been developed to gain access to animal power. These include:

- Barter, for instance herding cattle in exchange for plowing.
- Lending land in return for plowing services.
- Persuading close relatives to assist with plowing.

Inevitably operations are carried out late with resulting low yields.

For those with no access to animal power, zero tillage (holing out with hoe at planting time) is practised, but this is universally unpopular because of the high labour demand and low yields achieved in comparison with tillage with animal power.

Consequently cattle and donkey theft has become a widespread problem.

### Management

Livestock management practices are generally poor due largely to a lack of resources, particularly finance and knowledge. Due to their higher economic value, cattle are generally better managed than donkeys. The lack of information on donkeys, their low economic value and their ability to withstand poor treatment contributes to their receiving little or no management. However, where donkeys are the major source of draft power, their value is increasing and management practices are improving. Due to the shortage of draft power, when timeliness of cropping operations is crucial, draft animals are often prescribed tasks exceeding their capabilities. This is further compounded, particularly for donkeys with inappropriate implements, such as the heavier ox-drawn plow being used due to lack of lighter implements. In many areas, farmers resort to using mixed spans of cattle and donkeys.

No routine veterinary practices are adopted even though donkeys suffer from intestinal worms, blackleg, or mouth and harness sores. Serious wounds may be treated. Males are usually castrated to stop them wandering, although no information on how and when donkeys should be castrated is available. There are no recommended breeding programmes, with the result that breeding is random and selection of males is based purely on phenotypic characteristics. Mistreatment of donkeys to make them work harder or faster is common.

Only in those areas with a long history of donkey use is there widespread use of breast band harnesses for donkeys and the traditional yoke for cattle. In other areas yokes are extensively used for donkeys. This is attributed to both the unavailability of harnesses, their high price and the belief by farmers that yokes are more efficient.

### Nutrition

Nutrition is a widespread problem affecting optimum utilisation of draft animals in communal areas. This is mainly due to lack of grazing or supplementary feed and inadequate management of those resources.

In theory, animals have access to grazing throughout the day, but in many cases the grazing

areas are distant or the animals are working so the feeding time is restricted, leading to low productivity. Donkeys are usually in better body condition than cattle at the start of the plowing season. This reflects the donkeys' ability to thrive in conditions of scarce nutrient supply. Extensive and strategic use of home-grown supplements, mainly stover and melons, would contribute to maintaining animals' body condition. Crop residues are usually removed from the lands and stored in racks above the kraals for easy access. Improvement in storage methods could improve quality. There is very limited use of bought-in supplements because of cost. However, the use of other supplements such as fruit pods and multipurpose tree species could alleviate seasonal nutritional deficiencies.

### Health

Most farmers do not have a standard health management system. Treatment is ad hoc, and only carried out when the animal is in real danger of being lost. However health problems not necessarily leading to animal loss do affect animal performance. The losses are often blamed on nutrition rather than health, and the extent of these losses has not been quantified.

Injuries caused by use of cattle yokes and poor harnesses in donkeys are common. Although cattle are dipped regularly, this is not the case with donkeys. Problems of tick-borne diseases and internal parasites are not apparent, though the effect of these on the overall productivity of draft animals, particularly donkeys, needs further investigation.

### Ownership of equipment

Ownership and use of agricultural equipment in the three areas is similar. Despite the fact that 53% of farmers do not have adequate animal power, 91% own a plow. Ownership of other implements (cultivators, harrows and planters) is limited. Table 5 shows current estimates of ownership of equipment.

Most equipment comes from Bulawayo Steel Products and Zimplot, the large-scale animal-drawn equipment manufacturers although village blacksmiths have assisted in maintenance and are capable of providing spare parts and assisting in the design of modifications.

**Table 5: Percentage of farmers owning animal-drawn equipment in semi-arid Zimbabwe in 1995**

<i>Implement</i>	<i>% of farmers owning/not owning equipment (n=248)</i>	
	<i>None</i>	<i>At least one</i>
Plow	19	91
Cart	60	40
Cultivator	69	31
Ridger	98	2
Harrow	71	29

*Source: Muvirimi, 1995*

Most equipment is purchased using non-farm income and is regarded as an asset to be passed on from father to son. This investment is unlikely to be replaced by new equipment unless major low-cost improvements can be made that provide significant benefits over existing equipment. Factors like durability, lightness and low maintenance should be of primary concern to developers.

### Gender and age considerations

Labour operations tend to be gender specific as demonstrated in Table 6.

Men undertake most work with animals with women undertaking manual operations. However, if no men are available women will handle the

**Table 6: Some labour differentiation between men and women**

<i>Operations undertaken mainly by:</i>	
<i>Men</i>	<i>Women</i>
Plowing with animals	Planting behind the plow
Planting with a planter	Planting by hand
Weeding with a cultivator	Hand weeding
Transport by cart	Head transport
Marketing produce	Most domestic tasks

animals. Donkeys are favoured by women because of their easier handling.

There appears to be a direct correlation between cattle ownership and age of the farmer. Farmers with inadequate animal power are likely to comprise younger families. Farmers between 40 and 50 years old, appear to own greatest numbers of draft animals, with older farmers having smaller numbers, having given animals to their sons (for *lobola*, bride price) or slaughtering animals for funerals.

### **Environmental concerns**

Early work (Cleghorn, 1966; Sandford, 1982) estimated communal grazing to be seriously overstocked, with livestock numbers exceeding the carrying capacity and much of the grassland bare or in poor condition. Such work has been criticised as being based primarily on range condition and assessment in commercial farming areas and has not taken into account the strategic use of high potential sites such as dambos or vleis, drainage lines and browse.

The concept of carrying capacity is unpopular because it alludes to overstocking and possible destocking. The concept that carrying capacity is greatly exceeded has been questioned from both economic and ecological standpoints. Nevertheless, pressure on land and deforestation due to expanding livestock and human populations is a matter for concern. At the same time shortage of animal power is recognised as being a major constraint to increased crop production.

### **Opportunities for increasing productivity**

The means of improving productivity are either through increasing the supply of draft animals or reducing the demand for draft animals by increasing their effectiveness. Farmers in different recommendation domains will consider technologies in the light of their own circumstances and ability to balance resources with expenditure. Those without animals are likely to use more resources for acquiring or hiring animals. They will be less receptive to technology that demands substantial resources if this will only effect a marginal improvement. Profitability of investing in new technology should therefore be assessed for each recommendation domain.

### **Increasing the supply of draft animals**

#### ***Using existing animals more effectively***

The available draft is less than that required to provide every farmer with adequate draft. The strongest demand for increasing animals is from those not owning adequate animals. As incomes rise there will be more investment in animals, thus increasing grazing pressure.

Improved management practices including strategic feed supplementation and low cost disease prevention will substantially increase draft power availability. However, this will not necessarily assist those with inadequate draft or with no animals.

#### ***Greater use of donkeys***

There is a tradition of using only oxen as draft animals. Only recently have donkeys and cows been considered seriously for draft. The increased interest in these animals necessitates greater attention to developing recommendations for improved donkey and cow management.

However, there is a controversy surrounding the role of donkeys in the driest areas. Whereas donkeys are basically kept for draft (often related to crop production), cattle are multipurpose. The driest areas in Zimbabwe have been classified suitable for extensive livestock production only. In this situation the value of donkeys is primarily for transport and encouragement for crop production may not be viable.

#### ***Encouraging draft animal power contractors***

The fact that some contracting already occurs is an indication of an existing market. It could be expanded by encouraging higher market related prices. The provision of government-subsidised tractor hire schemes undercuts both private tractor and draft animal contractors, preventing the emergence of a market-orientated service by private contractors. Such a service would need to reflect market demand as it is unlikely that those with more than adequate draft power would regard social obligation as a sufficient incentive to provide plowing services.

#### ***Increasing carrying capacity***

Despite the widely-held view that communal grazing is overutilised there is no consensus on this issue. Cousins (1987) states that there is no evidence that the communal herd has been declining due to over-exploitation of grazing

resources. It is, however, important that total biomass production and use by animals is optimised as one strategy for increasing draft animal availability. Investigations are required to ensure that available fodder resources can be sustained. Cycles of increased livestock numbers in good rainfall years and deaths in drought years need to be avoided.

## Reducing the demand for draft animals

### *Conservation tillage systems*

Tillage operations undertaken by farmers in all areas are similar, with emphasis on plowing with the mouldboard plow. Unfortunately, this has a high draft requirement, increasing the risk of not completing plowing in time. Extending the plowing period through early (winter) plowing is therefore important and methods of promoting this need encouragement. Conservation tillage offers the greatest potential for increasing productivity. The use of no-till tied ridges and ripping into crop residues, tine planting or direct drilling of seed has been widely recommended (Elwell and Norton, 1988; Elwell, 1993). Although there has been some success on heavier soils with no-till tied ridges with the crop planted in the furrow (Nyamudeza et al, 1991), adoption by farmers on lighter soils remains very low (Sarapinda, 1989, 1990; Huchu 1990).

No precise figures of the numbers of farmers in Zimbabwe who have adopted conservation tillage are available. Probably less than 1% of communal area farmers and perhaps 5–10% of commercial farmers have adopted conservation tillage (Contil, 1990). The reasons for low adoption include: shortage of labour, lack of draft power, lack of suitable equipment and the fact that most soil and water conservation systems are not compatible with the wide range of technical and socio-economic problems faced by communal area farmers. These include a high labour requirement for construction and maintenance, difficulties in planting and weeding, poor crop establishment and increased weed problems. Vogel (1993) concluded that although erosion under no-till tied ridging is negligible, the system may generate micro-environments that result in delayed crop establishment and poor crop stands. These problems help to explain low adoption rates.

Some of these problems may have been overcome as a result of recent work by the Cotton Research Institute as reported by Mashivira et al, 1995 and Ellis-Jones et al, 1993. This involves crop establishment and fertilising on the flat and ridging-up by plow or cultivator at weeding when plants are large enough not to be damaged.

### *Improved implements*

The implements that are readily available are not the most suitable for smaller animals and other alternatives are presently being evaluated. This involves on-station and on-farm testing of:

- a light donkey plow
- tine and rippers that can be attached to the beam of the ox plow. Farmers with inadequate animals will appreciate attachments requiring less draft rather than a completely new plow
- light donkey weeders
- single animal drawn weeders and tie makers
- low-cost modification to existing carts to make them more suitable for donkeys.

Small firms are able to manufacture low-draft equipment such as cultivator and ripper tines and innovative implements such as a low-cost planter.

## Conclusions

Draft animal power technology is appropriate and relatively cheap for most farmers. However, research and extension needs a new approach to ensure that current farmer needs are met. Problems should be approached in a multidisciplinary manner considering the socio-economic circumstances of farmers, the existing use and management of draft animals and implements. To promote and ensure adoption of new technologies research should ensure:

- an enabling policy environment
- research, training and extension targeted at specific farmer recommendation domains with technology options for each
- involvement of farmers, extension workers and manufacturers (large- and small-scale) in problem identification, research project design and evaluation.

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