Meeting the challenge of animal-based transport

by

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Abstract

Animal-based transport already plays a significant role in the economies of rural areas in eastern and southern Africa and in relieving the transport burden of rural households. However, it is considered that it is still greatly under-utilised and that there is considerable potential for it to make a major contribution to the economic and social development of rural communities. The aim of this paper is to identify the main constraints on wider use of animal-based transport in the region, to suggest actions which need to be taken to overcome these constraints and to propose an approach to implementing these actions. It is hoped that this will provide a theme for the working group on transport to develop and possibly to draw up a plan of action.

A questionnaire circulated to intending participants at the ATNESA conference in Kenya has been used to identify the constraints on animal-based transport. This has clearly identified the major constraint as unaffordability of carts due to a combination of high cost and lack of access to credit. Another strong constraint in some areas is a shortage of carts caused by a limited production capacity and capability. Constraints on animal ownership apply mainly to oxen and include disease, lack of grazing and high cost. There appears to be considerable potential for greater use of donkeys in transport work but this is restricted in several areas by lack of status. This is an area in which more promotion is needed and is justified.

Introduction

Access to an effective means of transport is an essential ingredient for promoting the economic and social development of rural people. This is particularly true for small-scale farmers. It enables them to provide greater inputs of fertiliser and manure to improve yields, allows them to move and market more produce, and reduces time and effort spent in household activities such as collecting firewood and water so releasing time for more productive activities.

One of the significant steps forward over the past few years has been the increasing recognition by major development agencies of the true nature of transport problems in rural areas and of the transport needs of rural people (for example, World Bank, 1995a). The need is not for primary roads for motorised vehicles, but for improvements to village level paths and tracks on which rural people can use appropriate and affordable means of transport to move relatively small loads over short distances.

Development agencies are also recognising the important role of intermediate means of transport (intermediate between head or back carrying and motor vehicles; Relf, 1995), such as wheelbarrows, handcarts, bicycles and animal-based transport, which are generally the only means of transport affordable to rural people. There are many rural people who cannot even afford to own this form of transport, although they may gain access through hiring or borrowing. Although simple and relatively low-cost, intermediate means of transport are a significant improvement for rural households and have a substantial potential to promote economic and social development.

Development agencies also consider intermediate means of transport appropriate because of their energy efficiency and low environmental impact. These features may not seem very relevant in terms of the present severe lack of transport in rural areas but they have important long-term implications. For example, there are estimated to be about 700,000 carts in Africa. If pack animals are added, assume the total (carts and pack) is equivalent to 1 million carts. Assuming these each carry an average of 500 kg for 1000 km per year, the saving in diesel fuel over trucks to do the same work is roughly 30 million litres.

Animal-based transport

Animal-based transport is a particularly appropriate mode of intemediate transport for rural areas since the animals are often already used for

other farm activities. In these cases the costs of the animals for transport are marginal, as they cover their extra upkeep for the additional work. If animals are kept purely for transport work then obviously they will add more to the cost of transport. The modes of animal-based transport are:

pack animals, where loads are carried in panniers or containers on the animal's back. The main pack animal used in eastern and southern Africa is the donkey. A few horses, mules and camels are also used. Pack animals are suited to operating on narrow tracks, particularly in hilly and rough terrain

animal-drawn sledges. A sledge is a very low-cost form of transport, often carved directly from a tree. They are usually used where carts are not affordable but may also be used for particular activities such as carrying ploughs to the fields. They are usually pulled by oxen because of their large draft requirement

animal-drawn carts. These are by far the most effective form of animal-based transport, carrying much higher loads than the other forms, but also the most costly. Most carts in the region are 2-wheel, although 4-wheel carts are also found, particularly in South Africa. Carts are most commonly pulled by oxen or donkeys.

Animal-based transport is compared with other forms of intermediate transport in Table 1. The main advantage of animal-based transport over other forms of non-motorised intermediate transport is that the operating power is provided by the animal(s) rather than the user. In the case of carts, particularly ox carts, they can also carry significantly higher loads. Their overall cost depends on whether the animals are used only for transport work or also for other farm work. For example, if donkeys are kept only for transport, their cost should be added to that of the pannier or ccart. The cost of donkeys varies through the region – in South Africa it is quoted as about US$17 (Starkey, 1995). The cost of a single donkey and cart would in this case be roughly the same as a bicycle and trailer. However, it is advisable to keep a reserve donkey and often in West Africa the reserve travels with the cart so that the donkeys can be changed over when the working one becomes tired. The load of 300 kg carried in a cart could equally be carried by about 5 pack donkeys at roughly the same cost but this would necessitate the load being broken down into smaller portions. As shown in Table 1, the cost of animal-based transport is substantially lower than that of the cheapest means of motorised transport.

Table 1: Animal-based transport and other forms of intermediate transport

Mode of transport	*Typical load (kg)*	*Average speed (km/h)*	*Daily range (km)*	*Transport capacity (tonne km/h)*	*Cost, compared to bicycle*
Human carrying	30	4–5	15–20	0.12	–
Wheelbarrow	90	3–4	5–6	0.35	0.6
Handcart (1 person)	200	3–4	10–12	0.8	0.4–0.7
Cycle with carrier	40	12	40–50	0.48	1
Cycle trailer	125	10	30–40	1.25	0.6–0.8
Pack donkey	50–80	4–5	20	0.3	0.2
Ox-drawn sledge (2 oxen)	250	2–3	15	0.75	0.1
Donkey cart (1 donkey)	300	3–4	20	1.1	1.5–2
Ox cart (2 oxen)	900	3–4	20	3.5	2–3
Motorcycle	50	50	150	2.5	16
Motorcycle trailer	300	30	100	9	2

Note: Initial costs are given relative to the cost of a bicycle (roughly US$125). Costs of animal-based transport do not include the cost of the animal(s).

The role and issues of animal-based transport in the region have featured prominently in two previous ATNESA workshops. In Lusaka, January 1992, a paper by Anderson and Dennis (1994) reviewed both the technical and socio-economic issues. Since this was the inaugural meeting of ATNESA, the aim of the paper was to survey the important published literature on animal-based transport, covering experience from both Asia and Africa, to review the role and importance of animal-based transport in the region and to highlight the main issues and problems. It is believed that the paper provides a good background to the state of the art of animal-based transport at the time of the workshop.

One of the issues raised at the Lusaka meeting by the working group on transport was the need to collect and share information on all aspects of the design and production of animal-drawn carts. A follow-up workshop was therefore held in Harare in January 1993, 'The design, production and testing of animal-drawn carts'. The output of this workshop was a set of guidelines on the design, manufacture and marketing of animal-drawn carts (ATNESA, 1996).

Possibly the major issue arising since the previous workshops is that, in spite of the increasing availability of information on animal-based transport, it is still very much under-utilised in the region and there appear to be few signs of any significant increase. In fact, the last two to three years have been difficult for rural areas in the region because of poor harvests resulting from drought and the impact of structural adjustment policies. Rural economies have been depressed, resulting in low demand for transport devices.

Structural adjustment has influenced both the demand for and supply of carts. Evidence from Zimbabwe suggests that the real value of incomes has decreased, thus reducing the purchasing power of rural households and also the flow of returned money from migrant workers. On the supply side there has been a steady increase in the cost of materials, although the availability of materials has increased through relief of import restrictions. As a result the cost of carts in particular has risen whilst rural households have less money available to buy them. It seems likely that this situation is fairly common in other countries in the region.

In the light of the above points it is felt that in terms of animal-based transport this workshop can best "meet the challenges of animal-traction" by attempting to establish and put into place a plan of action aimed at overcoming some of the barriers to wider use of animal-based transport in the region. The aim of this paper is to attempt to set the scene for the discussions of the working group by:

- identifying the main constraints on wider use of animal-based transport
- putting forward suggestions for ways in which these might be overcome and actions which could be taken.

The paper analyses information obtained from a questionnaire circulated to prospective participants at the workshop, and puts forward proposals for ways of tackling the constraints identified from the questionnaire.

Constraints on the wider use of animal-based transport

A questionnaire was sent out to members of ATNESA who had expressed a wish to attend the workshop. An extremely good response was achieved; 50 replies were received in time to prepare this paper. A copy of the questionnaire is contained in Annex 1 to this paper. It is in two parts – the first deals with constraints on the ownership of draft animals, and the second with constraints on the wider use of means of animal-based transport.

Constraints on ownership of draft animals

The results of the questionnaire are summarised in Figure 1. Brief profiles for each country from which more than one response was received are presented in Appendix 2. The first bar chart indicates the number of responses (out of 50) which identified the issue as a medium (M) or high (H) constraint. The second chart compares the strengths of the constraints, as identified by the responses, in terms of a weighted rating given by the number of high responses plus half the number of medium responses. This is a purely arbitrary weighting but gives a simple way of comparing the perceived importance of the constraints identified in the questionnaire.

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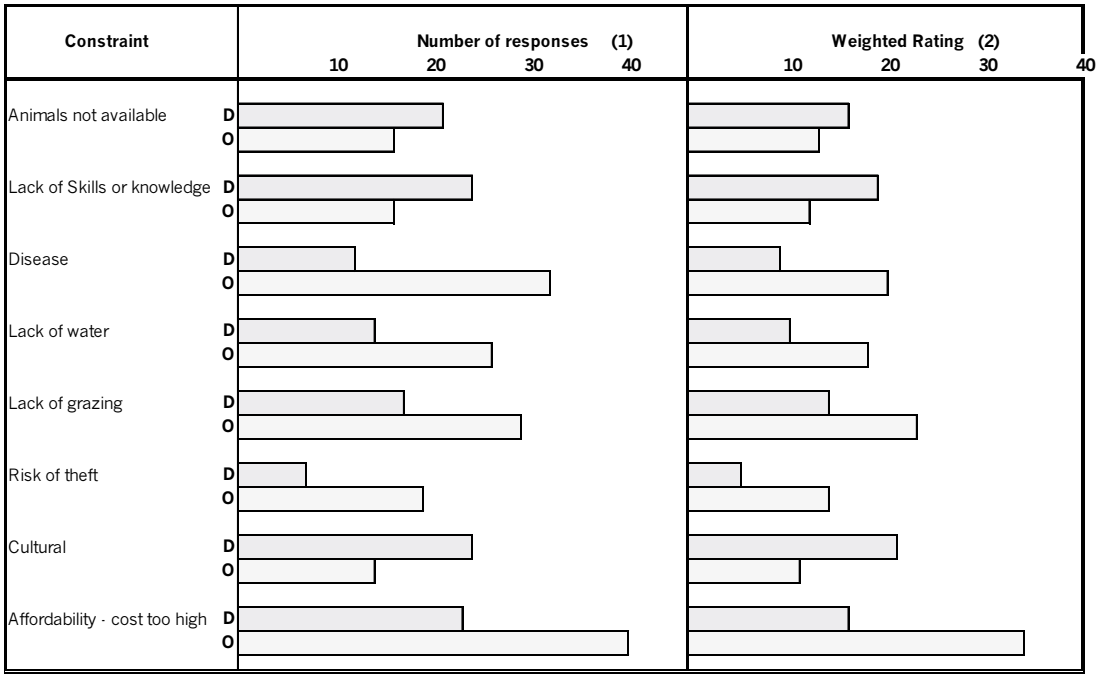


NOTES:

1. Number of responses of Medium, M, or High, H, constraint
2. Weight Rating: number of H responses + 0.5 x number of M responses
3. D - Donkey; O - Oxen

Figure 1: Constraints on wider ownership of animals

Although patterns of ownership vary across the region and some constraints are quite localised, the figure shows some trends which are common over much of eastern and southern Africa:

the high cost of oxen is considered a major constraint across the region, even though their availability is less of a constraint than for donkeys. One of the reasons is the reduction in numbers in countries such as Zimbabwe due to drought

lack of grazing is also identified as a significant constraint on ownership of oxen. This has also been identified as a constraint by a study of animal traction in South Africa (Starkey, 1995). This may be partly a result of the effects of drought over the past few years but it is also of serious concern for the future of animal traction in the region. As populations and population densities increase there will be increasing competition on land for food production and grazing. This is an issue which needs careful study to see if it is a temporary constraint or more long term

lack of water is also a serious issue but again this may be mainly a result of recent droughts. It needs further investigation

donkeys are seen to have a number of important advantages over oxen–they are less prone to disease, lack of water and grazing are lesser constraints, they are less at risk of theft and they are cheaper. The main constraints on wider ownership are limited availability in some areas, lack of experience in their upkeep and handling, and cultural resistance. The latter varies considerably through the region but is a very difficult constraint to overcome as it involves changing people's attitudes. However, donkeys could make a major contribution to increasing animal-based transport in the region and I suggest that working to remove these constraints is an important area for action.

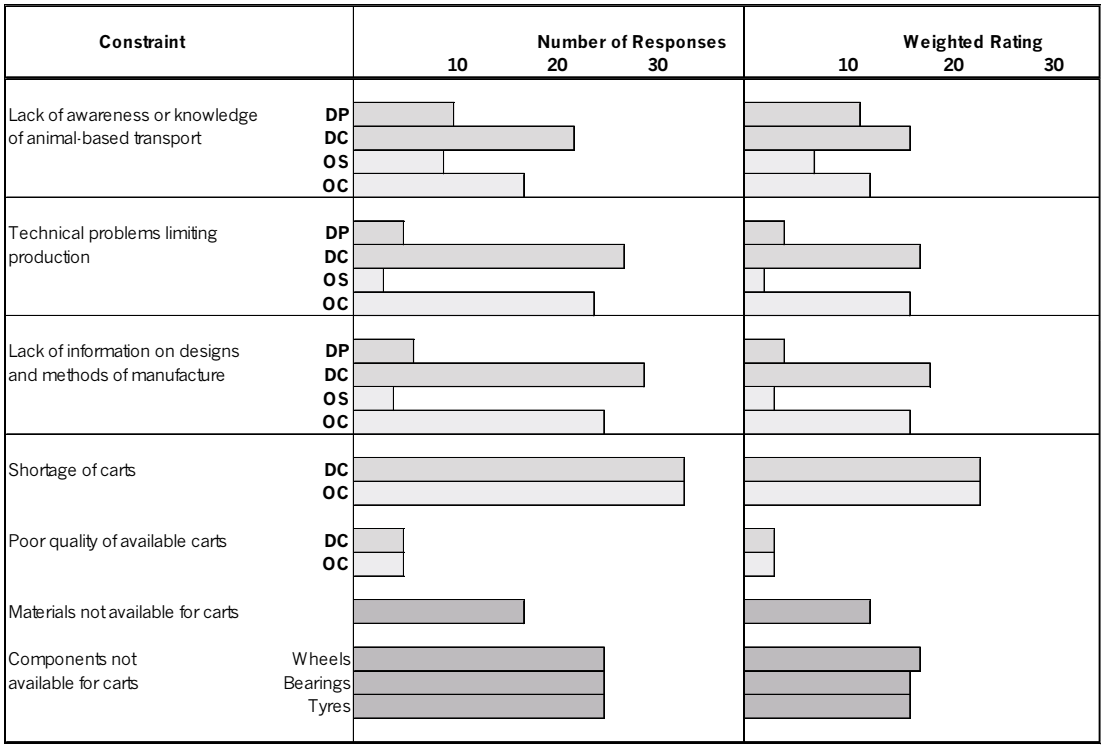
Technical constraints on wider use of animal-based transport

An overview of the technical constraints on wider use of animal-based transport is shown in Figure 2. The criteria used for comparison are similar to those in Figure 1. In the case of pack loading of donkeys the main constraint mentioned is the lack of knowledge of this form of transport, but this is a relatively low constraint. Lack of information on designs and methods of manufacture is not considered a serious constraint. However, it is apparent that some of the methods of loading used in the region are likely to cause discomfort to the animals and that there is a need to improve harnesses and distribution of loading. Users also need to be made more aware of the levels of loading that can be reasonably carried by donkeys without causing them distress.

Lack of awareness of the use of donkey carts is perceived as quite a strong constraint, more so than for ox carts. This probably relates largely to lack of knowledge on methods of hitching pairs of donkeys to a single drawpole by rural people who are more familiar with ox carts. This is clearly an area where development, testing and dissemination of suitable methods is needed. Also there is a need to increase awareness of carts for single donkeys.

Shortage of both donkey and ox carts is seen as a strong constraint. The main reasons are identified as lack of information on design and manufacture of carts, technical problems limiting production and shortage of critical components such as wheels, bearings and tyres. These problems can be partly overcome by improved dissemination of information and training of workshops, but the capacity and motivation of workshops may also be a serious constraint. This is discussed further below.

Figure 2: Technical constraints on the wider use of animal-based transport in the region



NOTES:

Pack donkey	**DP**	Ox Sledge	**OS**
Donkey Cart	**DC**	Ox-Cart	**OC**

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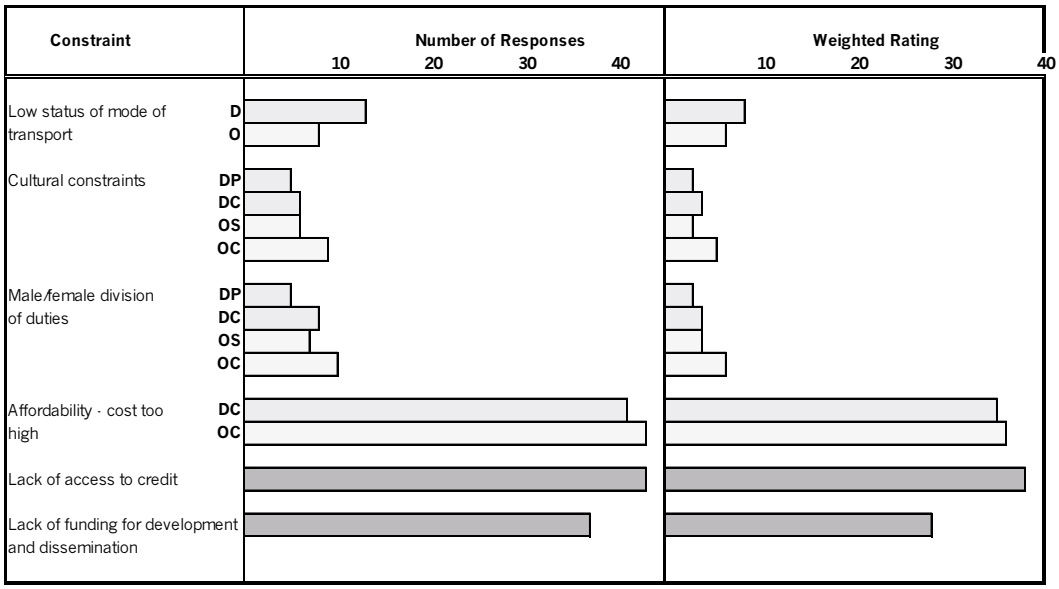

NOTES:

Donkey	**D**	Donkey Cart	**DC**
Oxen	**O**	Ox Sledge	**OS**
Pack Donkey	**DP**	Ox-Cart	**OC**

Figure 3: Socio-economic constraints to wider adoption of animal-based transport in the region

Socio-economic constraints to wider use of animal-based transport

Socio-economic constraints are compared in Figure 3. The figure shows clearly that the major constraint is considered to be affordability due to the high cost of carts and the lack of access to credit to purchase them. Both donkey and ox carts are considered equally to cost too much. This is probably because many of the donkey carts used in the region are based on ox-cart designs with a single drawpole and need pairs or more of donkeys to pull them. The smaller, lighter and lower-cost carts for single donkeys which are widely used in West Africa are not commonly found in the region. Logically, it would be expected that they should have a major role to play in reducing cart costs in the region, but introducing an unfamiliar form of cart is likely to involve considerable time, effort and perseverance. This is reinforced by a significant response suggesting that donkey transport is seen as having a low status in several areas of the region.

Lack of access to credit is seen as a major constraint across the region apart from Zimbabwe, where the Agricultural Finance Corporation has played a significant role in promoting the relatively high number of ox carts found in rural areas, and Namibia where household incomes are possibly higher than in other countries. Other socio-economic issues are considered to have little impact on the level of use of animal-based transport in the region.

Unaffordability of animal-drawn carts

Unaffordability is identified clearly as the main constraint on increasing the use of animal-based transport in the region. It is a combination of the high cost of carts and the lack of access to credit. Affordability is also linked closely to household income. At low income levels there is little produce to move or excess crops to market and a means of transport has a relatively low priority for the household. Even though it might be very useful in reducing their transport burden, particularly collecting water and firewood, households would be unlikely to consider purchasing a means of

Table 2: Estimates of the cost of ox carts in various countries in the ATNESA region in 1993

Country	*GNP/Capita (US$)*	*Estimated annual household income (US$)*	*Assumed cart cost (US$)*	*Number of months' income to buy cart*
Ethiopia	100	100–200	350	21–42
Kenya	270	270–540	200	4.5–9
Malawi	200	200–400	550	16.5–33
Mozambique	90	90–180	350	23.5–47
Tanzania	90	90–180	200	13.5–27
Uganda	180	180–360	200	6.5–13
Zambia	380	380–760	350	5.5–11
Zimbabwe	520	520–1040	350	4–8

Notes:
1) Data for mid 1993 fromWorld Development Report, World Bank (1995b)
2) Estimated household income is based on data obtained from World Bank sub-Saharan Africa Transport Programme Surveys (Airey, Barwell and Strandberg, 1993; see also Table 3). These suggest for rural areas in the region typical household income is 1 to 2 x GNP/capita.
3) Assumed cart costs are based on following actual data from mid 1993.
Kenya: cost of ox cart made in small workshop US$180–220
Zimbabwe: ox cart produced by small/medium workshop US$300–400
ox cart produced by large manufacturer US$900
Malawi: ox cart produced in informal sector US$550
Sudan: donkey cart produced by small/medium workshop US$340
Costs are assumed similar in neighbouring countries.

transport that would not pay for itself. As household income rises a means of transport may become essential to support the earning of income and may well generate enough extra income to pay off the loan needed to buy it.

It is not clear if there is a definable relationship between household income, affordability of a particular means of transport and hence ownership levels. However, this must clearly be an important criterion in assessing a household's ability to repay a loan for intermediate means of transport. Table 2 shows estimated data for household income and cart costs, and based on these, estimates of months of income needed to buy a cart. A number of points may be noted:

actual cart costs are used for some countries, and it is assumed costs will be similar in neighbouring countries. There is quite a wide variation in costs across the region, being particularly low in Kenya and very high in Malawi. Different forms of construction and costs of materials would be expected to give some variation, but the range seems excessive

average household income is estimated from fairly limited data obtained from surveys carried out within the World Bank Sub-Saharan Africa Transport Programme (Airey, Barwell and Strandberg, 1993) and relating this to GNP per Capita. There could therefore be quite large variations from these estimates

because ownership of carts varies considerably within a country it is not possible to draw any general trends regarding household incomes and level of ownership of carts. More specific data is needed on localised household incomes. It is possible that high levels of cart ownership in an area are associated with higher than average levels of income. Relationships can also be confused by income returned by migrant workers. However, the estimates for Zimbabwe suggest

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Table 3: Bicycle ownership and rural household income

Country (District)	*Months of household income needed to buy a bicycle*	*Bicycle ownership (% of households)*
Zambia (Kasama)	4.7	28
Zambia (Lusaka Rural)	2.6	26
Uganda (Mbale)	8.6	15
Burkina Faso (Dedougou)	2.9	90

Source: Airey, Barwell and Strandberg, 1993)
Note: The high level of ownership is associated with widespread access to credit in Burkina Faso

that, in the presence of an effective credit scheme, quite high levels of ownership of carts become possible when their cost is equivalent to about 6 months' income. Information shown in Table 3 for bicycles suggests that even when only 3 to 4 months' income is needed, ownership is low unless credit is readily available

This is clearly an area where more information would be useful to improve estimates of demand for carts and to differentiate between actual demand and apparent demand (when households say they would like a cart but they cannot afford it). This would lead to more effective strategies for dissemination of carts and other animal-based transport.

Actions to increase use of animal-based transport

Main constraints and needs for action

The main points from the responses to the questionnaire are summarised as follows:

oxen are generally more popular for transport activities, but there are concerns regarding disease, availability of grazing, security and above all their high cost. Their main advantages are that their use in transport usually supplements their use in farming so that their transport cost is marginal, and they provide high draft

donkeys have several advantages for transport use but they have a low status in a number of countries. It is not clear whether farmers can afford to use them purely for transport or whether their cost would have to be spread over other farming activities

the main constraint on increased use of animal-drawn carts is unaffordability resulting from their high cost and the limited availability of credit

there is considered to be a shortage of carts in many areas of the region. However, it is not clear whether in the light of lack of affordability there is an actual demand for more carts or if it is only apparent demand. The shortage is considered to be caused mainly by lack of information on design and manufacture, technical problems in production and limited supply of wheels, bearings and tyres

lack of funds to promote the development and dissemination of animal-based transport is considered a major constraint. It is clear from the nature of the workshops producing carts that problems of manufacture, supply and marketing are unlikely to be resolved by purely commercial initiatives, and assistance will be needed in upgrading the capacities and capabilities of workshops.

There are clearly a number of issues relating to supply, upkeep and training of draft animals where action is needed but these are considered outside the scope of this paper.

The following needs for action on transport issues are suggested and discussed briefly:

reducing the cost of carts

improving the capacity and capability of workshops

improving access to credit

a coordinated approach to development and dissemination.

Although these actions are concerned mainly with supply, it is equally important to work with communities to assess more clearly their transport needs, estimate their priority and demand for means of transport and determine what means of transport are affordable and acceptable. Recent development experience suggests that new or improved technologies are more likely to be successfully accepted and assimilated through this kind of participative approach. Once initial surveys have indicated what forms of intermediate transport, if any, are likely to be affordable and appropriate then prototypes can be introduced to demonstrate their potential and to create an awareness in the area of the possible options. This needs to be done on a sufficiently large scale to stimulate interest and awareness.

Options for reducing the cost of animal-based transport

Carts are the most effective and acceptable form of animal-based transport. Sledges cost very little but they have limited applications and cannot be encouraged because of the damage and erosion they can cause. Improved sledges with wooden wheels and crude wooden carts ('flintstone') are used in a few areas and these forms of transport can play an important role in poorer communities. It may be worthwhile putting some resources into developing these but it is uncertain whether they are likely to achieve any wider acceptance. I suggest that further work is needed with poor communities to assess if transport is a priority and if there is real demand for very low-cost transport devices. Experience suggests that most rural households want carts with pneumatic tyres and rolling contact bearings and the main need identified by the survey is to make these more affordable.

A breakdown of the production costs of a range of cart designs is shown in Table 4. The table is in two parts:

the costs of materials, components and consumables for a number of cart designs

Table 4: Breakdown of cart costs

i) Estimated costs of materials and components (based on costs in Zimbabwe in 1994)

Type of cart	*Frame and body (US$)*	*Axle and tyres (US$)*	*Total cost of materials (US$)*
Ox carts:			
Steel frame and body, pneumatic tyres, ball bearings	115	140	255
Steel frame, wood body, pneumatic tyres, ball bearings	85	140	225
Wooden cart, pneumatic tyres, ball bearings	57	140	197
Wooden cart, wood wheels, hardwood bearings	57	93	150
Single donkey cart:			
Steel frame, wood body, pneumatic tyres, ball bearings	35	105	150
Wooden cart, pneumatic tyres, ball bearings	25	105	130

ii) actual cost breakdown of ox carts for 3 countries in 1994

Item	*Kenya*	*Malawi*	*Zimbabwe*
Materials and consumables (US$)	160 (67%)	432 (72%)	280 (63%)
Labour (US$)	10 (4%)	8 (1.5%)	15 (3.4%)
Overhead and profit (US$)	70 (29%)	160 (26.5%)	150 (33.6%)
Selling price (US$)	240	600	445
Cost of axle assembly with tyres (US$)	70	280	155
Proportion of material cost	44%	65%	55%

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presented in the ATNESA guidelines (ATNESA, 1996)

a breakdown of the selling prices of carts produced by workshops in Kenya, Malawi and Zimbabwe.

The information in Table 4 shows that material costs make up a major part of the production cost and that the cost of the axle assembly, including tyres, usually makes up at least half of this and significantly more on the lower-cost carts. The large influence of the cost of the axle assembly on the selling price of the cart is seen by comparing the prices in Kenya and Malawi. Both prices are for carts with scrap axles and tyres but the costs of these components are much higher in Malawi, presumably reflecting their limited availability there. Where scrap axles are readily available, they provide a relatively simple and cheap base for making carts. However, the wheel bearings are often nearing the end of their life and are a common source of unreliability. If the cart breaks down it may be out of service for a considerable period because replacement bearings are not available or the owner cannot afford to repair it. The repair cost and loss of income while the cart is out of service can substantially increase the effective cost of the cart to the owner. A slightly more costly cart which is more reliable may often be better value for money.

Since material costs make up the major part of the cart cost, the approach to cutting cost must be either to reduce the amount of material used through smaller carts and/or better design, or to use cheaper materials. This suggests the following options for reducing cost:

a cart with a wooden body on a steel frame is about 10% cheaper than a sheet steel body

a wooden cart mounted on a steel axle assembly with pneumatic tyres and rolling element bearings reduces cost by a further 15%. This is simple to construct and will be adequately strong and durable provided that good quality wood is used and treated regularly with a preservative

a smaller, lighter cart for a single donkey should cost little more than half the cost of a standard ox cart. It would have a much lower load-carrying capacity but it is felt that ox carts are seldom used to their full capacity and a smaller cart may suffice for many of their needs. For example, in recent trials of a small handcart/donkey cart in Zimbabwe, one of the participants claimed to use the small cart six

Figure 4: An intermediate design of 2-wheel cart - wooden body with steel axle frame. Carts like this are used widely in West Africa

Photo: Paul Starkey

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times more frequently than his ox cart. Single donkey carts are used widely in West Africa (see Figure 4) and it is possible that a good quality, low-cost cart of this type has good potential in the region. It appears particularly appropriate for women.

The other possibility for a smaller cart is a cart for a single ox. I do not know if any are used in eastern and southern Africa but they are quite widely used in Asia (see Figure 5). The cart has a pair of shafts and is hitched by a yoke/collar which is attached to the ends of the shafts and rests on the withers of the ox. The cart would have a capacity of about 500 kg and cost 60 to 70% of the price of a double ox cart.

I suggest that the best option for reducing cost is a cart for a single animal. The actual load-carrying requirements of rural households should be investigated to see if a smaller cart would meet most of their needs. If a large capacity is only needed once or twice a year, for example to carry grain to a depot, then this may not justify the cost of a larger cart. To help to overcome resistance to an unfamiliar type of cart it should be of good quality with a modern and attractive appearance. A particular selling feature, possibly a seat for the operator, may help to promote a market for this type of cart.

Figure 5: A single bullock cart in Sri Lanka
Carts like this are common in Asia.
A yoke is fixed between the ends of the shafts and rests on the withers of the animal.

Photo: Paul Starkey

Upgrading workshops

Cart production can be classified generally into centralised production in factories and localised production in small- to medium-sized workshops. Centralised production has better access to materials and tools but incurs significant extra costs from higher overheads, distribution costs and often additional mark-ups for selling through agents in the rural areas. Large producers tend to produce one or two standard models which are at the top of the price range. Small- and medium-size enterprises tend to produce a range of models, varying from high quality carts which may be 20 to 25% cheaper than those from central producers, down to poor quality carts incorporating scrap materials which may be less than half the cost of the centrally-produced carts.

Localised production has a number of advantages: more direct contact for buyers, a better ability to respond to local needs and demand, and more effective back-up support for repair and maintenance. Disadvantages are lack of information on designs and manufacturing techniques, difficulties with access to materials and components, and limited finance so that cash flow often restricts manufacturing capacity. It is suggested that the advantages to rural communities of localised production outweigh the disadvantages and there is a strong case for putting resources into upgrading the capacity and capability of small- and medium-sized workshops to help overcome the disadvantages. This would not only help rural communities but also be of general benefit to rural economies. Three areas of action are suggested below.

Training of workshops

The following areas are important:

- training in manufacture of improved designs, particularly wheel/axle assemblies
- training in techniques to improve productivity and quality (see also Oram, 1995)
- the basics of business management, including keeping records, managing production, controlling cash flow and planning for expansion.

Promotion, marketing and customer relations

To maximise the use of resources some care is needed in the selection of workshops for support and training. Experience in Zimbabwe (see Box 1)

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suggests that artisans need to have a certain level of skill, business acumen and motivation to put training into productive use. It is likely that a successful small manufacturing sector will be built around workshop owners that are capable and have ambition to succeed and better themselves.

Improving access to tools and equipment

Many small- and medium-sized workshops only have access to basic tools, hand tools – a welding set and possibly a power drill and grinder. Manufacture of cart bodies is generally not a problem since, even if electricity and welding are not available, good quality bodies can be made from wood providing these are locally acceptable. The main problem for smaller workshops is access to good quality axles, particularly when, as is often the case, there is a shortage of scrap axles. It has been suggested (ATNESA Harare Workshop) that axles might be centrally produced and supplied to smaller enterprises. This appears to have a number of problems:

Box 1: A project at the Institute of Agricultural Engineering, Zimbabwe

This project arose out of a number of surveys in the rural areas of Zimbabwe which yielded two significant conclusions:

ox carts are very important to the economy of small farms

the supply of ox carts from rural workshops was severely restricted by a shortage of scrap axles which had traditionally been used by these workshops

A 3-year project was set up at the Institute of Agricultural Engineering (IAE) to overcome this bottleneck by training workshops to produce wheel/axle assemblies using a technology developed by Intermediate Technology. Support was provided by IT Zimbabwe and IT Transport. Some of the features of this project have been:

Fifty workshops have been trained covering all areas of Zimbabwe. About half of these are now using the technology on a commercial basis. Over 400 carts and 150 axles have been produced by these workshops in spite of the depressed rural economy. A number of workshops are also using the technology to produce parts of axles, for instance rims for scrap hubs and hubs for scrap rims.

As experience was gained in the selection of workshops for training it became apparent that to benefit from the training the workshops needed to have a certain level of business sense and ambition to develop. Some were content to carry on making a few carts on an irregular basis when they were able to find a scrap axle. Those that adopted the technology were able to produce carts on a regular and reliable basis without wasting time in searching for scrap axles.

There was some initial resistance to carts incorporating a new technology. However, this was gradually broken down by the quality of carts produced by some workshops. The numbers sold have increased each year. Some workshops are offering 12-month guarantees on their carts and also delivering carts to buyers. These are strong selling points.

Initially some workshops used scrap bearings but as supplies dried up costs increased and this became a bottleneck. A supply of low-cost bearings from China was therefore arranged through a local importer. These needed to be ordered in a batch of 2000 so that it was necessary to obtain estimates of needs from workshops and advise them of the source of supply. The arrangement has worked well to date. The bearings sell for about US$4 each.

IAE continues to monitor the progress of the workshops and provides back-up support as required. A number of regional training institutions are beginning to offer training in wheel making and providing support to local workshops. In a few places other workshops have seen the success of neighbouring workshops that are using the technology and have copied it themselves. The production tools needed are produced locally and sold commercially.

axles are costly and many small workshops would have problems in buying them outright

the income earned per cart by the smaller workshops would be substantially reduced and might not be compensated by increased sales

the cost of the carts supplied by the smaller workshops would increase

the scheme would require a good level of organisation.

It is possible that centrally producing axle components, rims, hubs and axles, may be more feasible, but even so there may be resistance from smaller enterprises. It is suggested that smaller-scale workshops may prefer to be independent of other suppliers and to make as much of the cart as possible themselves to maximise their income from the cart. A more appropriate and acceptable approach may be to upgrade the capabilities of small and medium-sized workshops by helping them gain access to a wider range of tools.

Workshops making carts would benefit from access to such tools as a power saw for cutting steel sections, a lathe for machining hubs and axles and wheel-making equipment. However, they may not be able to afford these or their degree of usage may not justify the investment. A possible solution may be to organise a better equipped workshop, possibly a mission workshop or technical training centre, to provide support to a group of smaller workshops. Support might include supervised use of machine tools, hiring out of portable tools and stocking of some standard materials and components. Training of the workshops might also be organised through the support centres.

Improved access to materials and components

Small workshops can only afford to buy in small quantities and so have low priority in access to materials and are unable to benefit from discount schemes. Bulk buying for groups of workshops could improve this situation but this requires outlays of money and may be difficult to organise. It may be possible through a local wholesaler. Relaxation of any government duties on materials used for cart manufacture would be a considerable boost for small workshops. Limited availability of wheels, bearings and tyres was identified as a strong constraint on cart production. Possibilities for overcoming this are:

The manufacture of wheels is covered in detail in the ATNESA Guidelines on cart design (ATNESA, 1996). A number of practical methods for different levels of workshop are described.

Bearings are a critical component for good performance of a cart. Scrap bearings are widely used but tend to be unreliable and are often in short supply. New bearings from major suppliers (SKF, NSK etc) are expensive but cheaper versions are available from some of the emerging industrial countries such as China, Korea and Eastern Europe. Although of lower quality, they are adequate for use on animal-drawn carts. It may be possible to obtain these at low cost by ordering in large batches of about 2000 (see Box 1). This involves a substantial investment and is probably best organised through an importer or wholesaler. However, the importer needs some guarantee of demand and considerable effort will be required to introduce a standard hub design and to obtain reliable pre-orders of bearings from workshops.

New tyres are also expensive, particularly the larger sizes preferred for carts and scrap tyres are widely used. These are usually of poor quality, often with no tread, and are prone to punctures. It may be possible to import better quality scrap tyres from countries where regulations on the wear of vehicle tyres are stricter. For example, a preliminary study indicates that it would be possible to import 16" tyres with at least 1mm of remaining tread from the UK into Zimbabwe at a cost of about US$20 each.

Improving access to credit

Figure 6 illustrates the relationship between the important parameters of a credit scheme. Although simplified so that the interest rates shown are not exact, the graph does show accurate trends and illustrates the following important points:

Operating costs of the scheme – vetting and setting up loans, administration and collecting payments – must be minimised. Typical rates seem to vary between about 5 and 30% of the total amount loaned out. It is best to work through existing schemes which are efficiently

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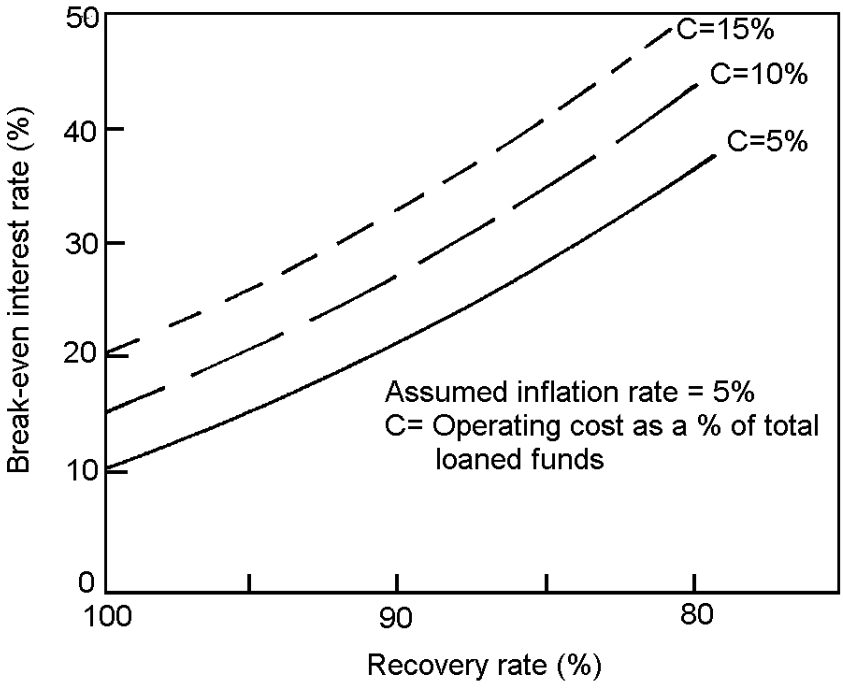
organised and have a reasonably large loan portfolio to offset their operating costs.

Achieving high recovery rates is very important to keep interest rates down. For example, if the recovery rate drops from 95 to 90% the interest rate needed to keep the scheme sustainable must be increased from 14 to 20% (at C=5%). Strategies to encourage repayment are therefore very important. For instance loaning to groups to create peer pressure on members of the group that receive loans has proved quite successful (Devereux, Pares and Best, 1987). However, much of this success has been for relatively small loans over short periods of time and where members wish to keep taking out loans on a regular basis. There is less experience with larger one-off loans over longer periods of time where group pressure is more difficult to maintain, although the Agricultural Finance Corporation in Zimbabwe reports that about 40% of its loans for ox carts are now given to groups (IFRTD, 1994).Other strategies that encourage repayment are to create a sense of involvement in the scheme – any sense of the loan being a grant must be dispelled – and maintaining firm and consistent action on defaults.

Interest rates must be high enough to make the scheme sustainable taking into account the depreciation of capital caused by inflation. Since operating costs of rural credit schemes tend to be high – clientele are scattered over a wide area and recovery is affected by irregular and variable incomes – interest rates may need to be higher than commercial rates. For example, the AFC rate for cart loans in Zimbabwe is 21% and the general rate for rural credit in Malawi is 40%.

Box 2 gives a brief overview of the Agricultural Finance Corporation scheme in Zimbabwe. It would be very useful to obtain more detailed information on this and other schemes for relatively large loans in rural areas, including guidelines on household incomes needed to service the loans.

Figure 6: Illustration of the effects of recovery rate and operating costs on the interest rate needed to break-even on a credit fund. This graph represents a simplified approach and is used only to illustrate the relatively high interest rates needed to break even on a credit fund and the critical need to minimise operating costs and to maximise recovery of loans. Break even means that the fund sustains its value taking into account inflation



A plan for implementing action

I hope that this discussion of the problems of animal-based transport and potential solutions for them will provide a stimulative base for discussion to refine and redefine the constraints on animal-based transport and to define a possible plan of action.

The next stage is the most difficult – how to implement a plan of action? It seems clear that at present there is not a sufficient commercial basis to animal-based transport for action to occur through pressure of market demand. This suggests that considerable inputs will be required to promote the action proposed and that substantial resources and funding will be needed for this. I suggest that a coordinated approach across the region is likely to be most effective with a high level of networking which builds on the networks established by ATNESA and the International Forum for Rural Transport Development. There are clearly a number of common constraints across the region which can be tackled through a coordinated approach, but at the same time the programme must have sufficient flexibility to deal with local issues. It is possible that a coordinated approach may also be more effective in raising funding.

A coordinated programme might include the following components:

Consolidation of the work started in the questionnaire into a database on animal-based transport in the region. There is probably a great deal of information available, particularly in project appraisal reports, which could be usefully collated and disseminated. Lessons learnt are especially important. For example, why has animal-based transport been widely adopted in some areas and not others?, what are the catalysts or conditions?

Much more information is required on transport needs and priorities in rural areas, particularly for lower income households. This should give a clearer picture of where interventions are worthwhile and which transport options are likely to be appropriate and acceptable. Universities in the region could take a lead in this through student project and research work.

There are some options which seem logical solutions to overcoming affordability constraints, for example single-animal carts, but it is not clear whether these will be

Box 2: Credit for animal carts in Zimbabwe

One of the central development objectives of newly-independent Zimbabwe was to encourage a substantial increase in smallholder agricultural output. Towards this end, a package of assistance was aimed at small-scale farmers including improved extension and crop marketing facilities and the provision of credit facilities for a range of agricultural equipment, including animal carts.

The principal source of credit for small farmers since independence has been the Agricultural Finance Corporation (AFC), a parastatal with offices in every district in the country. At first, loans were generally made to individuals, but in recent years, groups have become more important as AFC clients - today they account for around 40% of new loans. Group loans have the advantage of being cheaper to administer, as well as having higher recovery rates since peer pressure tends to support credit discipline.

Only farmers with no loans in arrears qualify for AFC credit. While no collateral is required, the borrower must contribute 25% of the supplier-quoted price as a deposit. The interest rate on a scotchcart is 21 per cent plus a 1.5% life insurance cover. The repayment period ranges between 3 and 5 years. While the AFC retains the right to reclaim the vehicles for which the credit was used in the event of default, this is seen as a last resort.

Today, there are impressive numbers of ox- and donkey-drawn carts to be found in all parts of Zimbabwe and they have contributed to the leap in smallholder output. Access to credit facilities has been essential in making this possible.

Source: IFRTD, 1994.

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acceptable. I suggest that prototypes are developed and tested in areas where they are most likely to be accepted to gain experience in their operation and impact.

Where there is clearly a demand for animal-based transport, but it is restricted by lack of production capacity or capability, the intervention needed may be fairly straightforward to identify and introduce. In these cases the action needed will be to obtain the funding required.

I suggest that the programme could be carried out through a network of support centres that would be responsible for implementing and coordinating the programme. These would be located in institutions which have the interest, resources and commitment to be involved in the programme. They would probably cover a fairly large area of a country and be linked to localised support centres.

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Appendix 1: questionnaire on animal-based transport

1. What do you estimate to be the level of household ownership of animals in your region? Please tick where appropriate.

Level of ownership	*Donkeys*	*Oxen*	*Other*
Less than 10%			
10 to 30%			
30 to 50%			
50 to 70%			
Greater than 70%			

Comments:

2. What do you think are the main constraints on wider ownership of animals? Please indicate by marking **L** - low constraint; **M** - medium constraint; **H** - high constraint.

Constraint	*Donkeys*	*Oxen*	*Other*
Animals not available			
Inadequate skills or knowledge in looking after the animals			
Disease			
Environmental conditions -lack of water -lack of grazing land or alternative feed			
Security/risk of theft			
Cost too high - cannot afford			
Cultural attitudes such as status of ownership			
Other			

Comments:

3. (i) What do you estimate to be the level of use of animals in transport? i.e. what percentage of the animals that are available do you estimate are used for transport activities. Please tick where appropriate.

(Ii) What is your estimate of the level of household ownership which could be achieved if constraints listed in 4 are removed or lessened? Please mark **X** where appropriate.

	Donkeys		*Oxen*		*Other*	
Percentage	*Pack*	*Carts*	*Sledges*	*Carts*	*Pack*	*Carts*
Less than 10%						
10 to 30%						
30 to 50%						
50 to 70%						
Greater than 70%						

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4. What do you consider are the main constraints on the wider use of animals for transport in your region? Please indicate **L** - low constraint; **M** - medium constraint; **H** - high constraint.

Constraints		*Donkeys*		*Oxen*	
		Pack	***Carts***	***Sledges***	***Carts***
Limited availability					
Lack of awareness or knowledge of use of animals for transport					
Terrain too hilly					
Roads, tracks not suitable					
Limited supply of implements (eg carts)					
Technical problems in manufacture/production					
Lack of information on designs and methods of manufacture					
Materials not available					
Components not available	Wheels				
	Bearings				
	Tyres				
Affordability	Cost too high				
	Lack of access to credit				
Not acceptable due to: poor quality devices					
low status of animal-based transport					
cultural issues					
male/female allocation of duties					
Lack of funding for development and dissemination					
Other forms of transport more effective, appropriate or acceptable, such as:					
Other constraints; please list below					

5. Please list in order of priority the **three (3)** issues which you feel are most important in your region to promote greater use of animal-based transport.

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Appendix 2: Brief country profiles

Although the patterns of animal-based transport vary considerably across a country due to different topographics, cultures, soil fertility etc. some general trends can be drawn from the responses. These are summarised briefly below for countries from which at least two responses were received.
(L - low constraint; M - medium constraint; H - high constraint)

Botswana (2 responses)

donkeys common (owned by 30–50% of households) - little used for pack carrying, mainly for carts (about 30%)

oxen less common, little used for transport

constraints on oxen - disease, cost, lack of grazing

limited supply of carts due to constraints of design and manufacture

improved harnessing for donkeys is a strong need

Ethiopia (2 responses)

donkeys widely owned (50% of households) - mainly used for pack loading

oxen widely owned (50% of households) but not used for transport

constraints - grazing for donkeys and oxen (2 H)

Kenya (11 responses)

donkeys quite common (generally around 20% of households with local variations) - used for pack-loading in several areas, but not widely for carts

oxen common, and high ownership in some areas (over 70% of households in two areas) -sledges not common, although over 50% in one location (SE from Nairobi). Cart usage generally less than 20%

constraints on donkey mainly cultural but not strong

constraints on oxen, disease (8 M, 2 H), lack of grazing (3 M, 4 H) and cost (3 M, 4 H)

shortage of carts is a significant constraint (2 M, 6 H) for both donkey and ox carts. Causes are technical problems in production (2 M, 5 H) and lack of wheels and bearings (3 M, 3 H)

Mozambique (2 responses)

great shortage of animals resulting from war

negligible use of animal-based transport

Namibia (4 responses - all from N or NE)

donkeys common in North (30% of households) but not in NE (<10%). Mainly used with carts

oxen less common in North (<10% of households) than NR (50%). High use of sledges in NR (60%) but few carts

lack of water and grazing significant constraints for oxen (M, 2H), less so for donkeys. No other serious constraints apart from high cost of oxen

shortage of carts is not a serious constraint. Cost of carts and need for credit are lesser constraints than in other countries (probably because of significantly higher household incomes)

South Africa (4 responses)

donkeys not widely owned (20% of households) - mainly used with carts (50–60%) - pack-loading not common. Main constraints on ownership are strong cultural resistance (M, 3 H) and lack of grazing (M, 2 H)

Tanzania (12 responses)

donkey ownership is not high (<10% in 7 responses and 20% in 5). Mainly used for pack loading - carts not common (although 50% in Tanga region). Constraints are lack of skills (2 M, 4 H) and cultural restrictions (2 M, 5 H)

oxen much more common (greater than 50% of households in some areas). Quite high use of sledges in most areas and also of carts. Constraints are disease (5 M, 3 H) and cost (2 M, 6 H)

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shortage of carts is not a serious constraint, although with manufacture and lack of information are mentioned by 7 respondents. Lack of components - wheels, bearings, tyres - is also a medium constraint

more information on harnessing of donkeys is mentioned as a constraint by 3 respondents

Uganda (6 responses)

limited ownership of donkeys and no significant use in transport. Main constraint is lack of availability (M, 5 H), lack of skills in husbandry (4 H) and high cost (M, 3 H). Cultural restrictions not mentioned as a constraint on ownership, but reasonably strong on use for transport (4 M)

oxen more widely owned, but in some areas seen as an investment for security and not used for draft. Sledges common in two areas and carts in 3 areas. Lack of skills in handling oxen mentioned as a constraint (3 H). High cost is a significant constraint (3 M, 3 H)

shortage of carts is a constraint (4 M), due to lack of information and capability for manufacture and also shortage of wheels, bearings and tyres.

Zimbabwe (7 responses)

ownership of donkeys is generally low. Where they are available, use for pack-loading and carts are about the same. Main constraint is cultural (M, 5 H)

ownership of oxen is still generally high (40–60% of households in 6 areas) despite losses from drought. Sledges are banned, but use with carts is quite high (40—60% in 3 areas). Constraints are lack of water (3 M, 2 H), grazing (3 M, H) and high cost (7 H - very strong due to losses resulting from drought)

shortage of carts is a medium constraint (4 M) and high cost of carts a strong constraint (2 M, 5 H). Lack of access to credit is not such a constraint as in other countries.

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