THE CONTRIBUTION OF DRAUGHT ANIMAL POWER TO SUSTAINABLE LIVELIHOODS IN SUB-SAHARAN AFRICA: AN EXAMPLE FROM ZIMBABWE

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Introduction

Draught animal power (DAP) provides an intermediate level of mechanisation between human power and engine power. As such, it is attractive to smallholder farmers, who wish to improve their productivity within the availability of their limited livelihood assets, particularly in sub-Saharan Africa (SSA). Whilst, in many cases, DAP can be sustainable, affordable and appropriate, requiring few external inputs, there can be problems associated with its use (see Table 1).

Table 1: Justification for promoting the use of DAP and problems with its use

Benefits of the use of DAP	Problems associated with DAP
Expanding the area cultivated Increasing intensity of land use Improving the quality and timeliness of operations Increasing productivity of labour Reducing drudgery Dependent only on indigenous resources and technologies Cost effective and low depreciation Ability to adjust span to draught demand Self-reproducing	Poor image, old fashioned Preference for tractors, even when not cost effective Can involve capital expenditure Inadequate supply of animals Non-availability of suitable implements or parts Increases the work burden for manual operations (especially for women) Competing demands for livestock products (milk, manure, draught, reproduction, social uses) Health, nutrition, training and management

Worldwide, there are an estimated 400 million draught animals being used for agricultural operations (Barwell and Ayre, 1982). Starkey (1988) estimated that, of these, some 18.6 million are employed in SSA agriculture. These are predominantly oxen but also include cows, donkeys, mules, horses and some camels. A review by Mrema and Mrema (1993) of the utilisation of DAP in SSA showed that of the 11.3 million draught oxen in use, nearly 80% are found in five countries viz Ethiopia (53%), Zimbabwe (7.1%), Kenya (6.2%) and Tanzania and Uganda each with 5.3%.

SSA is the least tractorised region in the world (see Table 2), and shows the lowest intensity of land use in terms of the percentage of land under irrigation and fertiliser use (kg/ha). SSA relies most on human muscle power, less on DAP and least on mechanical power compared to other regions.

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Table 2: Proportional contribution (%) to total power use in 93 Developing Countries (FAO, 1987)

Area	Human	Animal*	Tractor*
N Africa	69	17	14
sub-Saharan Africa	89	10	1
Asia (excl China)	68	28	4
Latin America	59	19	22
Overall	71	23	6

* Estimated by converting energy expended to man-day equivalents per hectare

There is however considerable variation between countries in SSA with South Africa and Zimbabwe having greatest use of tractors and least of human power for crop production operations[2]. Botswana and Zimbabwe make the greatest use of DAP (see Table 3).

Table 3: Sources of power for primary land preparation (COSMEC, 1992)

	% of cultivated land		
	Human power	DAP	Engine power
Sub-Saharan Africa	80	16	4
India	18	21	61
China	22	26	52
Botswana	20	40	40
Kenya	84	12	4
South Africa	10	20	70
Tanzania	80	14	6
Zimbabwe	15	30	55

Experiences from Zimbabwe

In Zimbabwe the role of livestock within the farming systems is widespread and long-established, with some one million households practising mixed farming with crops and livestock. Livestock functions include provision of both draught power (for transport, land preparation and weeding) and products such as manure, milk, meat, skins and inheritances (see Table 4). The prime, and almost only use of donkeys is to supply draught for tillage and transport.

[2] This is explained by the existence of so many commercial farms, as well as a long tradition of using draught animals

Table 4: Estimate of economic output of communal area cattle and donkeys in Zimbabwe

Economic use	% of total value	
	Cattle[1]	Donkeys[2]
Draught	63.6	93
Milk	13.6	-
Manure	3.9	2
Meat	8.5	-
Herd growth	10.4	5
Social value	(?)	-
TOTAL	100	100

Source: [1] Barrett, 1992, [2] Ellis-Jones, 1997

Ownership of draught animals is highly skewed with the poorest 40% of households not owning any, even if they possess some DAP implements. Access to other resources and production is also skewed (see Table 5).

Table 5: Access to resources and productivity of households (n=750) in Masvingo Province, Zimbabwe (from Ellis-Jones, 1999)

Household resource category	RG1	RG2	RG3	RG4
% households	22%	38%	25%	15%
Livestock owned				
Cattle	9.9	3.2	0.3	0
Donkeys	2.0	1.1	0	0
Implements owned	Full range	Plough	Plough	None
Arable area (ha)	2.9	2.4	2.1	1.7
Maize harvested (kg)	1250	520	390	255
Cash expenditure on crops (US$pa)	42	26	17	12
Income from crop (US$pa)	51	21	11	3

RG1=Well resourced households, RG2=Average resourced households, RG3=Poorly resourced households, RG4=Very poorly resourced households

For comparison, a survey (94 households) in the Eastern Cape Province of South Africa revealed that 79% used DAP (O'Neill *et al*, 1999), with only 36% reporting they had insufficient oxen for ploughing (the usual preference being a span of six). The occasional use of tractors, mainly for land opening, was reported by 74%, indicating the generally greater availability of tractors in South Africa compared to Zimbabwe.

Table 5 shows that only the better resourced households have sufficient draught power for their own purposes. Others are almost totally dependent on hiring or some form of reciprocal arrangement. Where there are sufficient oxen, DAP for land preparation is

supplied by oxen but, as numbers decrease, the burden may be shared between oxen, cows and donkeys (Nengomasha, 1998). Government or occasionally private contractors do provide limited tractor ploughing services, but these are largely regarded as unreliable, non-viable, and not sustainable. A similar situation exists in South Africa where tractor hire services (once fairly common) are now on the decline. DAP contracting services are not common and are only provided when the contractor has completed his own ploughing.

Various arrangements have evolved between farmers to help the poorer gain access to DAP. These include:

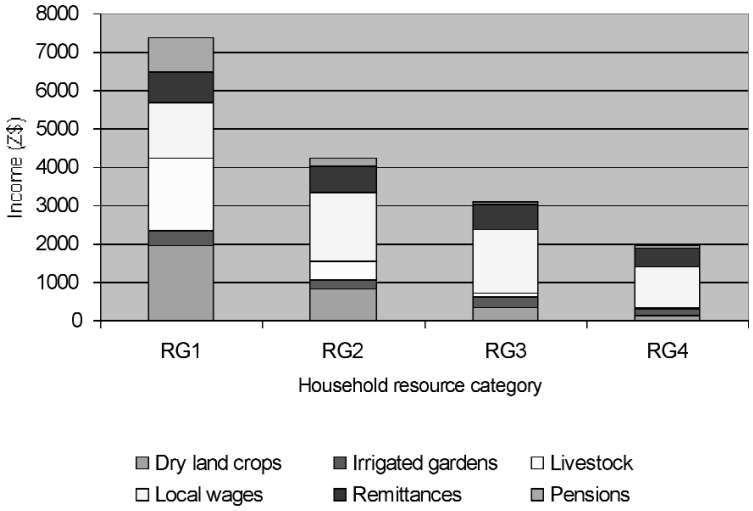
- barter, for instance herding cattle in exchange for ploughing;
- weeding in exchange for ploughing;
- providing food for ploughing;
- lending land in return for ploughing services;
- persuading close relatives to assist with ploughing.

Unfortunately, such arrangements mean that ploughing is often carried out late, after owners have completed their own tasks, resulting in late planting and lower yields.

Livelihoods

Income sources differ markedly in both real and percentage terms between households (see Figure 1).

Figure 1: Income sources[3] for different household resource categories (from Ellis-Jones, 1999)



[3] Z$60 is approx 1 US$

Whilst crop and livestock production are the most important sources of income for category RG1 and to a lesser extent for RG2 households, for the poorer households (RG3 and RG4) local wages and remittances are the most important income sources. In the Eastern Cape (South Africa) the balance is somewhat different with the typical situation being closer to that of the RG1 category in Zimbabwe. The household-generated income tends to be a lower proportion of the total (van Averberke, 1999), with up to 90% of income from external sources (pensions, wages, remittances). Typically, income generated within the household would be more strongly influenced by dealings in livestock than by crop production. In one case (O'Neill, 1999), a crop of maize was found to involve cash exchanges of the order of R300[3] whilst the sale of two oxen raised R6400.

Land preparation

The preparation of land to grow a crop is usually the most energy-demanding task undertaken by a smallholder farmer. The use of animal-drawn tillage implements is now widely accepted in SSA to increase the productivity of both labour and land resources. However, even where DAP has been adopted, farmers complain of shortages of draught power. This has been a problem in Zimbabwe for a number of years, especially since the loss of communal cattle during the droughts of the last two decades. Because cattle are valued for their draught above other outputs (see Table 4), the reduction in the national herd has had a negative effect on the supply of DAP and, as can be seen from Table 5, the poorest households are the worst affected and their livelihoods the most threatened.

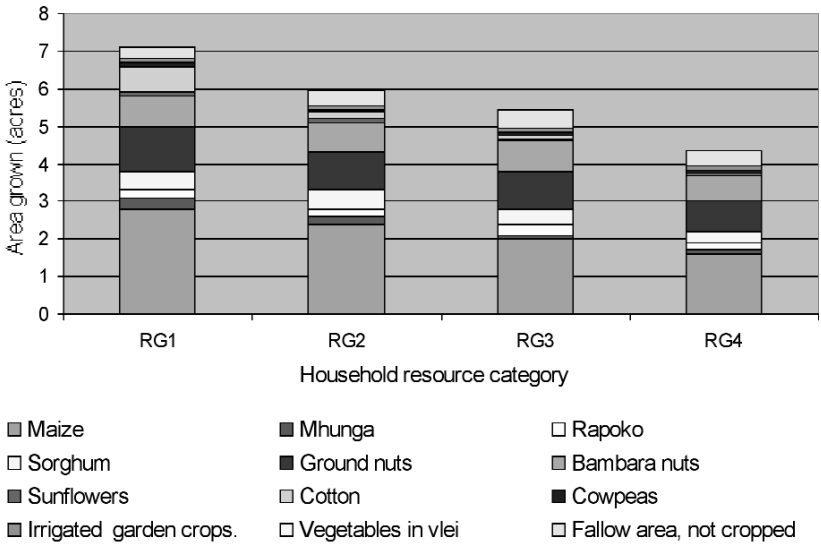
It is generally held in Zimbabwe that there are two approaches to tackle the shortage, firstly to increase the draught animal population and secondly, to make more effective and efficient use of the current draught animal resource. Although increasing the supply of animals would be regarded as the more conventional approach, recent evidence on the poor state and inefficient use of animal-drawn implements (Chatizwa and Ellis-Jones, 1997) has suggested that there is considerable potential for the latter approach to improve livelihoods. Research is now in progress to investigate the issues surrounding more effective use of implements and initial on-farm trials have given promising results. For example, renovated ploughs have been found to work, on average, over 32 mm deeper and 11 mm wider, whilst being easier to control and less stressful to both operator and animals (Koza *et al*, 2000).

Crops grown

The area of crops grown by each RG (Figure 2) shows that RG4s cropped some 40% less than RG1s with proportionately smaller areas of maize and cotton but insignificant differences between other crops. Maize, groundnuts and bambara (round) nuts are the most important crops across all categories. Cotton is important primarily for RG1 and RG2 categories, with nearly all RGs growing small areas of mhunga, rapoko (millet), sorghum and sunflowers. Irrigated gardens are not widely found and, as may be expected, are associated primarily with the RG1 households.

[3] R6 is approx 1US$

Figure 2: Mean areas of crops grown



Weeding methods

Weeding is mainly done by hand. Despite high ownership of cultivators by RG1s and RG2s only 34% of RG1s use a cultivator for the first weeding and 21% for the second weeding. Of this same group, 15% use the plough for the first weeding and 9% for the second weeding. Use of the cultivator and/or plough, even when DAP is available is surprisingly low, considering hand weeding is regarded as the most tedious labour intensive farm operation. This is attributed to:

- mechanical damage caused by use of the cultivators, made worse by poor maintenance and setting;
- crop rows being rarely straight;
- inter-planting of some crops;
- the ready availability of paid labour often provided by RG3 and RG4s to undertake the work as a reciprocal arrangement for earlier hiring/borrowing of DAP for land preparation;
- weeding being primarily womens' work.

Livestock use for fertility improvement

Most households are aware of the need to enhance the fertility of their soils, with manure application being the most widely used, especially for maize production but rarely for other crops. Use of manure is largely confined to the better-resourced households, whilst anthill soil and leaf litter are more widely used by the poorer households. The use of purchased

inorganic fertiliser is decreasing as a result of increasing costs. The increased use of DAP may generate more manure and, thereby, contribute to improved soil fertility.

Crop productivity

Average yields are considerably lower for the poorer groups. This reflects not only the lower level of resources utilised but also the timing of critical operations due to shortages of draught power. Crop sales are derived mainly from maize and cotton, with RG1s selling some fifteen times as much as RG4s in value terms. Most RG1s and RG2s occasionally sell maize, while most RG3 and RG4s never sell maize. Other crops are almost entirely for household consumption.

Conclusions

Livestock plays a critical role in the livelihoods of rural people, generating some cash income from sales but, in Zimbabwe particularly, making a larger contribution in terms of crop production through both provision of manure and draught. Livestock, particularly cattle, however, are generally found to belong to the better-resourced households, which often means that poorer households' access is limited to sub-optimal periods, resulting in lower crop productivity.

Livelihoods derived from dryland crops and livestock constitute more than 50% of income for RG1s, 30% for RG2s, but only 13% for RG3s and 7% for the poorest RG4s. Any increases in the availability of DAP and its more efficient use could increase productivity of both the better-off households directly and the poorer households indirectly, through more timely access to DAP. This, in turn, would improve economic security and have a positive impact on livelihoods.

Extension and research needs to be carefully targeted taking into account the varying needs, based on household access to resources.

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References

van Averberke, W. (1999) Farmer priorities in small-scale agriculture in the Eastern Cape: a researcher's perspective. In Pearson, A., Wythe, S., Joubert, B., O'Neill, D. and Simalenga, T. (Eds) *Management and feeding of animals for work*, Procedings of a Workshop at University of Fort Hare, 20-22 April 1999. Draught Animal Power Technical Report 4, Centre for Tropical Veterinary Medicine, University of Edinburgh, Edinburgh. pp137-142 ISBN 0-907146-09-0.

Barrett, J.C. (1992) The economic role of cattle in communal farming systems in Zimbabwe. ODI Pastoral Development Network, Network paper 32b.

Barwell, I. and Ayre, M. (1982) The harnessing of draught animals, Intermediate Technology Publications.

Chatizwa, I. and Ellis-Jones, J. (1997) Zimbabwe smallholder farmers: an assessment of the use and maintenance of tillage implements. In Ellis-Jones, J., Pearson, A., O'Neill, D. and Ndlovu, L. (Eds) *Improving the productivity of draught animals in sub-Saharan Africa*, Procedings of a Technical Workshop, Harare, 25-27 February 1997, International Development Group Report IDG/97/7, Silsoe Research Institute, Silsoe, UK. pp131-134.

COMSEC, (1992) Report of an expert consultation on the establishment of NAMA. Nairobi, June 1992. Edited by G.C. Mrema, 108p. FPRD – Commonwealth Secretariat, London.

Ellis-Jones, J. (1999) Small dams and community resources management project. Baseline socio-economic survey. Descriptive statistics. (Silsoe Research Institute and CARE Zimbabwe). Internation Development Group Report IDG/99/12, Silsoe Research Institute, Silsoe, UK.

Ellis-Jones, J. (1997) A farming systems approach to increasing the productivity of draught animals. In Ellis-Jones, J., Pearson, A., O'Neill, D. and Ndlovu, L. (eds) *Improving the productivity of draught animals in sub-Saharan Africa*, Procedings of a Technical Workshop, Harare, 25-27 February 1997. International Development Group Report IDG/97/7, Silsoe Research Institute, Silsoe, UK. pp9-25.

Koza, T., Ellis-Jones, J., O'Neill, D.H. and Twomlow, S.J. (2000). Enhancing the use of draught animal power (DAP) by smallholder farmers in Zimbabwe. Paper no. 00-RD-006 to AgEng 2000, International Agricultural Engineering Conference, 4-7 July 2000, University of Warwick, UK.

FAO (1987) The next 25 years, FAO, Rome.

Mrema, G.C. and Mrema, M.J. (1983) Draught animal technology and agricultural mechanisation in Africa: its potential role and constraints. In *Network for agricultural mechanisation in Africa*, NAMA Newsletter, Vol 1, No. 2, pp12-33.

Nengomasha, E.M. (1998) The donkey (*Equus asinus*) as a draught animal in smallholder farming areas of the semi-arid regions of Zimbabwe: I. Characterisation of the donkey. Department of Research and Specialist Services, Matapos Research Station. PhD thesis, University of Edinburgh.

O'Neill, D.H. (1999) A survey of current use and management of draught animals by smallholder farmers in Eastern Cape. In Pearson, A., Wythe, S., Joubert, B., O'Neill, D. and Simalenga, T. (eds) *Management and feeding of animals for work*, Procedings of a Workshop at University of Fort Hare, 20-22 April 1999. Draught Animal Power Technical Report 4, Centre for Tropical Veterinary Medicine, University of Edinburgh, Edinburgh. pp13-25 ISBN 0-907146-09-0.

O'Neill, D.H., Sneyd, J., Mzileni, N.T., Mapeyi, L., the late Njekwa, M. and Israel, S. (1999) The use and management of draught animals by smallholder farmers in the former Ciskei and Transkei. *Development Southern Africa* 16 (2), 319-333.

Starkey, P. (1988) Animal traction directory: Africa. GTZ Friedr. Vieweg & John. Braunschweig/Wiesbaden. 151pp.