Improving animal traction technology in Malawi: some recent investigations and trials

by

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Abstract

Research on farm machinery in Malawi is now directed towards smallholder farmers who are responsible for the bulk of agricultural production in the country. Most smallholders operate at the subsistence level and practise hand-tool farming because motorised mechanisation is technically and economically beyond their reach. Also, imports of tractors and fuel into Malawi are restricted in an effort to conserve foreign exchange reserves. A similar situation is found in most of eastern and southern Africa. This paper describes some of the efforts of the Agricultural Mechanisation Research Programme to develop the use of draft animals as an efficient source of agricultural power. The emphasis that has been placed on the use of animal-drawn implements for crop production and farm transportation is also indicated.

Introduction

The low productivity of land and labour contributes to the poor achievements in food production and economic performance seen in eastern and southern Africa and other developing regions. Greater emphasis on animal-drawn equipment for smallholders should improve labour and land productivity without the drain on foreign currency reserves associated with tractor use and oil imports. The use of different sources of animal power and associated mechanical innovations could help improve timeliness of agricultural operations, which is particularly important in a country like Malawi which has unimodal rainfall (Singa, 1984).

Options for animal power for Malawi

The choice of draft animal species in any area has to be based on technical principles as well as on socioeconomic and environmental factors.

The size of animals influences draft provision. Small animals are able to develop a greater gross efficiency than large animals because their power/weight ratio is smaller. Working speed of animals in relation to loading capacity is a factor that needs to be taken into consideration when choosing animal species for transport work. Table 1 shows a range of speeds and draft capabilities for different animals.

Horses are not suitable draft animals for smallholder farmers in Malawi as they are not resistant to local pests and diseases. They also require complicated harnessing systems.

Water buffaloes do not necessarily need water to wallow in: they can survive and work in many tropical areas, including semi-arid zones. They may be suitable for rice-producing areas, but they are unlikely to be as well adapted as local cattle.

In terms of overall animal power suitability in the environmental conditions prevailing in Malawi, and in the light of management and feeding limitations, it has been recommended that emphasis be placed on oxen and donkeys, with the possibility that water buffaloes be assessed in rice areas.

Donkeys are being recommended in Malawi particularly for transport as they are quicker than oxen. Some 45 donkeys have been imported into Malawi from Botswana for crossbreeding with the local animals. A donkey cart is being manufactured by the local Petroleum Services Company.

Evaluation of draft animal equipment

Malawi is now self-sufficient in domestic manufacture of all ox-drawn implements.

Over the past three decades the Farm Machinery Research Team of the Ministry of Agriculture has been engaged in research, development and coordination of appropriate technologies with special emphasis on the use of animal power. Assessments have been made on different sources of oxen and donkeys and their associated field and farm transportation equipment. Field trials have also been conducted, and recommendations made.

Multipurpose toolframe

In recent years a highly promising multipurpose toolbar has been developed and tested: it is now being made by Agrimal, the local implement manufacturing company. Attachments currently

Table 1: Estimates of draft capacity of several species at low and high speeds

		Low speed			*High speed*		
Animal	*Mature weight (kg)*	*Speed (km/hour)*	*Draft (N)*	*Power (kW)*	*Speed (km/hour)*	*Draft (N)*	*Power (kW)*
Horse	500	2.4	630	0.46	4.0	500	0.53
Ox	450	2.4	640	0.46	4.0	450	0.53
Buffalo	650	2.4	910	0.61	3.2	650	0.61
Camel	430	3.5	640	0.61	4.0	480	0.53
Elephant	2900	2.0	2300	1.29	–	–	–
Dog	32	5.4	90	0.08	8.4	30	0.06

Source: After Goe and McDowell (1980)

available are a plow, a ridger and a groundnut lifter. Work on a planter, cultivating tines, weeding sweeps and a clod crusher is underway.

The toolbar with plow and ridger costs about 35% less than two single-purpose implements. This is important as it has been found that the lower the capital and operating costs of the animals and equipment, the higher are the chances of successfully introducing animal traction (Starkey, 1986).

Animal-drawn planters

In 1969 and 1970 the Farm Machinery Unit (FMU) of the Ministry of Agriculture investigated four types of ox-drawn planter. Two were proposed attachments to the National Institute of Agricultural Engineering (NIAE) wheeled toolcarrier, and the third was part of a human-powered toolbar designed for planting maize: none of these proved to be appropriate, and they were not recommended. The fourth, a "Safim" design manufactured by Agrimal, was recommended for planting maize and soy bean: it was, however, not suitable for groundnuts because it damaged the seed. Only this planter reached the farmer.

A double-row ridge planter attachment to the toolbar was designed and tested by FMU from 1982 to 1985. It plants on two ridges per run, placing a seed 3–5 cm deep every 30 cm. The planter comprises two drive wheels (which move in the furrow), two hoppers and seed plates, an opener and a cover. Following the final stage of development, Agrimal and Lilongwe Sheet Metal have been approached as possible manufacturers.

Rice planter

A four-row rice planter was tested by FMU in 1975. The tests showed that it would have limited appeal to farmers because it was complex, with many parts that needed frequent maintenance, and its use would have required extensive training in operation and care. However, use of the machine could reduce farmers' seed costs by about 60% because broadcast seed is sown at approximately 110 kg/ha while the average seed rate recorded for the machine was only 43 kg/ha.

Harnessing

In Malawi, zebu oxen are usually harnessed in pairs with withers or shoulder yokes. Single yokes are rarely used. Use of a single yoke was investigated at Bunda College of Agriculture in 1977 and at Chitedze Agricultural Research Station from 1984 to 1987. The results were encouraging in terms of power provision and operational efficiency in field work (especially for weeding, where it is difficult to use a pair of animals when crops—such as late maize—are tall).

Ox carts

The Farm Machinery Commodity Team is currently working on a single-animal ox cart constructed mainly of wood to reduce weight and cost. Hardwood is used for load-bearing components, while the main body is made of softwood. The wheels are positioned in the centre of the cart body to allow the loading pressure to act on the wheels rather than on the animal's neck. The dissel booms are made from light poles, also to reduce weight. The animal pulls are between the two poles which have a yoke in front. The loading capacity of this cart is about 500 kg. The estimated cost is about 400–600 Malawi Kwacha (when US$ 1 ≈ MK 2.8). It is easy and cheap to maintain because it is made with locally available materials..

Animal power in forestry

A recent study of log extraction (skidding) with oxen in Malawi showed that oxen skidding is technologically, economically and socially superior to skidding with tractors (Solberg and Skaar, 1987). Research is continuing on many aspects of oxen logging, including the work organisation and the skidding equipment used.

Field cultivation trials

Plowing, harrowing and ridging

Trials were conducted at Bunda College in 1976 to compare traditional hand cultivation with ox plowing and ridging, and with plowing, harrowing and ridging, for cultivation of maize.

The overall results were not statistically different (except for soil aggregate size), but plowing, harrowing and ridging produced the best seedbed (with 56% of the soil aggregates less than 4 mm in diameter), led to higher germination percentage, resulted in the lowest soil compaction, and gave the highest grain yield. Hand cultivation produced the best ridge stability.

A wooden clod breaker was made and tested, and reported to work adequately. Work conducted by Salima Agricultural Development Division in 1980 using a steel roller with cast iron ballast weights was abandoned because the cost was prohibitive.

Weed control

Weed control and crop response to alternative cultivation systems and subsequent weeding methods using ox-drawn equipment on maize and groundnuts were studied from 1981 to 1984. Results showed that:

- tine cultivation provides less residual weed control. Cultivators (deep-tine) have higher draft requirements than plows
- although ridge formation requires extra labour there are substantial labour savings in ridge planting, particularly when animal-drawn implements are to be used for weeding: ridge planting is faster than flat planting in straight lines
- weeding with an animal-drawn cultivator (tines and sweeps) is only effective when the soil has average moisture and weeds are small
- if soil is well-plowed, it makes no difference to yields if planting is on ridges or on flat land
- ridger weeding on flat-planted crops provides good banking systems and saves labour
- only two weedings are required, that is, up to the time maize reaches ox-shoulder height
- groundnut lifting using animal-drawn implements is easier when the crop is grown on ridges
- crop performance for flat plant/flat weed plots kept on deteriorating over three years of trials. Poor root extension was noticed under such conditions.

Based on these results, the following recommendations can be made.

Where residual weed control and proper soil tilth are required, a mouldboard plow should be used instead of deep tines or a chisel plow. Deep tines and front tines can only be used where drainage is required and weeds are not a problem in land preparation (for example, on an old field with no residual weeds). The animals should be strong as these implements require high power.

Although planting on ridges is faster than planting on flat land, initial ridge-making requires a lot of labour.

Ridging is appropriate where the slope of the land would lead to erosion. Otherwise, for maize and groundnuts, flat planting on well-plowed land requires less labour and leads to superior yields.

A ridger is recommended for weeding flat-planted crops (grown in straight lines) because it requires less labour, and achieves simultaneous earthing-up.

Weeding with a cultivator saves time but this should only be done when weeds are small and the soil is not too wet. When crops are gown on ridges, hiller blades should be used.

Minimum tillage can be safely practised only for three years, after which the land should be fully plowed again. During the three years all recommended inputs should be applied; otherwise the crop will be badly affected during the last two years, compared to normal tillage.

Groundnut lifting

Between 1968 and 1970 FMU carried out trials on the use of blades and shares for lifting groundnuts. These trials showed that a curved blade mounted between supports spaced at 600 mm was the most suitable implement for this work: the blade penetrates the ridge effectively, but has a low draft requirement.

A modification to this design was made by the FMU in 1982. This has additional advantage of circular legs which enable the lifted groundnut haulms to slip off easily during the lifting operation. This implement is being manufactured by Agrimal as one of the attachments to its toolbar.

References

Goe M R and McDowell R E, 1980. *Animal traction: guidelines for utilization.* International Agricultural Development Mimeograph 81. Department of Animal Science, Cornell University, Ithaca, New York, USA. 84p.

Singa D D, 1984. Sources and utilization of animal power and equipment for Malawi's agricultural sector. Unpublished paper summarised (pp. 32–34) in: *Report of a networkshop on draught power and animal feeding in Eastern and Southern Africa held Ezulwini, Swaziland, 4–6 October 1983.* Networking Workshops Report 2. CIMMYT (Centro Internacional de Mejoramiento de Maíz y Trigo) Eastern and Southern Africa Economics Programme, PO Box 1473, Mbabane, Swaziland. 93p.

Solberg B and Skaar R, 1987. *A technical and socioeconomic study of skidding with oxen in Malawi.* Agricultural Development Report 5. Norwegian Centre for International Agricultural Development (Noragric), Agricultural University of Norway, Aas-NLH, Norway. 104p.

Starkey P H, 1986. Introduction, intensification and diversification of the use of animal power in West African farming systems: Implication at farm level. pp. 97–117 in: Starkey P H and Ndiamé F (eds) *Animal power in farming systems.* Proceedings of Second West Africa Animal Traction Networkshop held 19–25 September 1986 in Freetown, Sierra Leone. Vieweg for German Appropriate Technology Exchange, GTZ, Eschborn, Germany. 363p.