Improving animal traction technology

Photo: Paul Starkey

The management of draft animals

Improving draft animal management

by

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Abstract

In some areas of the world draft animal power is traditional; in others it is a relatively new technology. When thinking about improving management of draft animals it is important to be aware of these two categories.

Some aspects of management, including training, feeding, consequences of using draft cows and the need to maintain healthy animals, are discussed in this paper. In some cases strategies to influence and improve management are available, largely as a result of research; in others, more information is required.

Introduction

Animal power is used in virtually every environment and on every continent in the world. Although the location, type of animal and role they play may vary, many of the goals of management remain the same: the provision of adequate feed, housing, disease protection and training. The aim is to ensure that animals are capable of expressing their full potential for work, given the resources that are available.

Resource availability is often the deciding factor. In practice, management often means management of resources rather than of the animals themselves. If feed is in short supply it is difficult to provide the required level of feeding. If vaccines or drugs to protect against disease are too expensive or not available, disease must be controlled using local medicines and good management practices. Good management and husbandry are often a matter of compromise because of the various constraints in a system. For example, using cows to provide draft power makes heavy demands on management skills; requirements for work and the availability of feed are often seasonal, and cannot be changed, and so the aim of good management is to ensure that these requirements can be met without jeopardising reproduction and lactation performance.

In this paper some important issues in managing draft animals are considered. Although this discussion concentrates on livestock issues, animal power also encompasses agronomic, engineering and socioeconomic issues—and these can have a significant effect on animal management decisions.

Patterns of draft animal use

Management of draft animals is greatly influenced by the importance placed on them in a farming system. Animals are used alongside mechanical and manual power. There are many factors that can influence the relative proportions of these power sources that are used in any particular area. For example, where high population pressure leads to expansion of arable land at the expense of grazing land, animal power can become less available and farmers may have to resort to greater use of manual labour. Tembo (1989) stated that shortages of animal power in the communal lands in Zimbabwe are a major constraint to increased productivity of these areas.

A shortage of animal power is often made worse by drought and disease outbreaks which reduce the populations of all animals, including those used for draft. Following good harvests mechanised power is more available as farmers can afford to hire tractors.

It is important to remember that although the "technology" of animal (and mechanical) power may be available within an area, other factors can restrict its use. Changing economic factors may dictate that farmers switch between power sources. The priority a farmer gives to management of draft animals may be constantly changing.

Farmer experience of animal power

In areas of the world where draft animals are part of the traditional way of cultivating the land, for example, in Ethiopia, India, Indonesia, Nepal, North Africa and most of Latin America, people are accustomed to keeping, training and managing their draft animals. Implements are readily available locally, usually made from local materials, and there is a local system for repairing and replacing them. Decisions on whether to own, or to hire or borrow, draft animals are mainly influenced by farm size and family structure.

In the Koshi hills of Nepal, where 85% of farmers keep adult male oxen, mainly for draft purposes, hiring or lending is common (Gurung et al, 1989). A survey carried out in 1989 found that 72% of farmers had hired or borrowed oxen and that

Table 1: Energy expenditure of draft animals under various production systems compared with beef and dairy animals

Type of animal	*Function*	*Estimated energy expenditure as a multiple of maintenance*
250 kg draft ox	5 hours plowing small hill terraces as a pair in Nepal	1.30–1.38
400 kg draft buffalo	5–6 hours pulling loads over level tracks as a pair in Nepal	1.76–1.79
620 kg draft ox	5.5 hours cultivating large fields as a pair in Costa Rica	1.42–1.67
650 kg draft horse	8 hours pulling a loaded cart singly in Chile	1.86–2.35
300 kg dairy cow	producing 3 litres of milk per day	1.4 [1]
500 kg dairy cow	producing 10 litres of milk per day	2.0 [1]
400 kg beef steer	gaining 0.20 kg per day	1.2 [1]
500 kg beef steer	gaining 0.75 kg per day	1.7 [1]

[1] *Theoretical calculations from MAFF (1984)*

lending and borrowing was often a reciprocal arrangement (Gatenby, Pearson and Limbu, 1990). In Tanjungwangi village near Subang in west Java, Indonesia, only 7.5% of draft animal "rearers" use their animals solely to prepare their own crops, over 50% also rent them out and 30% both rent out and use their animals for shared work where they join forces with other farmers and cultivate together to speed up operations. One such example of this is the plowing of flooded rice fields when water is too scarce to allow flooding of all fields at the same time (Santoso et al, 1987): this communal use of draft animals could be considered as an example of management of draft power at its best. Preparation of land by trampling using groups of cattle (over 100 head have been recorded in some places), a relatively common practice in Timor, is another example of communal management. Farmers pool their animals and work on their fields in turn until "cultivation" is completed.

In areas of the world where draft animal power is a relatively new technology, for example, in many parts of eastern and southern Africa, the infrastructure necessary to train and manage animals or produce and repair appropriate implements is often not available locally. As a result, management of animals in these areas can be considerably different to that in the traditional areas. Training animals is often a problem, and it is not uncommon to see two or three people working a pair of oxen; this is a rare sight in traditional areas of animal use. A further complication in the "newer areas" of animal traction is the cost of obtaining the draft animals and implements. This can restrict the amount of additional money that farmers may be able or willing to spend on animal management.

Feeding

Probably the key issue farmers are faced with when keeping draft animals is the provision of sufficient (quantity and quality) feed at the time when the animals are required to do the most work. Most of the food eaten by draft animals is used to provide energy; their requirements for protein, vitamins and minerals, other than for maintenance, are negligible, unless they are growing or are pregnant or lactating. Expressed as a multiple of maintenance, the extra costs for work are relatively low. Even under conditions of optimum feeding and management oxen rarely expend more than 1.8 times maintenance in a working day (Lawrence, 1985; Pearson, Lawrence and Ghimire, 1989; Pearson, 1989a) which is similar to that seen in beef or dairy cattle (Table 1).

Information gathered on oxen and buffalo at the Centre for Tropical Veterinary Medicine, Edinburgh, UK, and elsewhere has been used by Lawrence (1990) to produce tables predicting total energy requirements, food intake and changes in liveweight of draft oxen, taking into account liveweight, quality of diet normally fed to draft ruminants, the decrease in energy expenditure over the working day and the effect of work on resting metabolic rate. The tables can be universally applied where quality and availability of feed for draft animals are known, so helping to improve the management of the feed resources available, to benefit not only draft animals but also other farm animals. Similar information is not readily available for equines. Information on requirements of donkeys and small horses for work, particularly in tropical areas, is largely anecdotal.

The start of the cultivation season is usually the time when feed stocks are at their lowest, particularly in areas where the dry season is long. In many areas the quality of food is so low that

Table 2: Mean daily work output of single oxen in Mali, according to liveweight and condition score

Condition score	Mean work output (MJ/day)		
	310 kg liveweight	*360 kg liveweight*	*Mean*
Medium (M+)	0.95	3.49	2.22
Lean (L+)	2.55	3.44	2.94

The work involved walking around a flat circuit for up to 10 km pulling a loaded sledge with an average draft of 374 N
Conditions scores followed the classification of Nicholson and Butterworth (1986)
Differences between liveweights and between condition scores and the interaction between liveweight and condition score were significant (P<0.001)
Source: ILCA (1988a)

animals can only just maintain their liveweight, even when they are not working. When working, they lose weight.

There is some evidence that horses increase their intake of moderate roughage diets when working for short periods (Orton, Hume and Leng, 1985). However, when oxen (Lawrence, 1985; Pearson, 1990), buffaloes (Wanapat and Wachirapakorn, 1987; Bamualim and Ffoulkes, 1988) and donkeys (Pearson and Merritt, 1991) receive high roughage diets they do not increase their feed intake to match their increased energy demands. When work occupies more than five to six hours a day intake may even decrease, as less time is available for eating (Pearson, 1990). Only by increasing the quality of the diet can both work and liveweight be sustained. Where the quality of feed is very poor it is often better to have two animals doing what little they can, rather than one large animal.

Management of weight and body condition prior to work

As many animals lose weight when working, particularly over a long season when the feed is of low quality, it is not surprising that liveweight and body condition are important in determining the optimum management of draft animals. The amount of work an animal can do is proportional to its liveweight—the larger the animal the higher the draft force it can generate. This means that the larger the animal (irrespective of body condition) the easier it will be able to carry out a particular task and the less stressed it will be doing this than a smaller animal. A large-framed animal may also be better able to respond to an increasing supply of food over a rainy season than a smaller, fatter one. However, animals in good condition have "fuel" in reserve, which may be mobilised to compensate for any shortages in feed which may occur at the start of the cultivation season. Thin animals do not have this reserve. Kartiarso, Martin and Teleni (1989), in a study of the pattern of utilisation of free fatty acids by working cattle and buffalo of different body conditions, suggested that in a short working period (30–50 days) animals in good condition can be worked on their fat reserves with minimal nutritional input, whereas thin animals would do best on a diet of high glucogenic potential.

Despite the apparent benefits of having heavy animals in good condition at the start of work, studies in which animals have been supplemented over the dry season have not always shown any significant benefit in work output or crop yields. Studies by Bartholomew in villages in Mali and on-station showed that supplementation of work oxen during the dry season increased their body weight and condition, but that heavier weights and better condition were not associated with the highest work outputs (Table 2; ILCA, 1988a; Bartholomew, 1989). Since dry season weight gain did not seem to improve subsequent work output, Bartholomew (1989) suggested that there may be little benefit to be gained by dry season supplementation of draft oxen in these areas. The implication would seem to be that feeding during work has a greater impact on performance. In the village studies in Mali, animals had an average weight gain of 17% from the start of field work to the end of the rainy season work, presumably due to the improvement in feed supply.

Clearly the economics of dry season feeding vary with location. In areas where animal working periods are short (20–30 days), supplementary feeding in the dry season may not be cost-effective, but in areas where animals work for longer periods, or spend considerable time transporting loads during the drier parts of the year, the economic return of such a practice may be considerable.

Feeding and management during work periods

The level of feeding and management during the working season has a marked effect on work

Table 3: Optimal model solutions obtained by linear programming for representative farms in the Ethiopian highlands using traditional (two ox), single ox and cow traction for power

	Optimal model obtained by linear programming		
Item	*Traditional two ox*	*Single ox*	*Cow traction*
Net farm income (birr)	848.7	438.5	2535.0
Total arable land (ha)	2.55	2.55	2.55
Area cropped (ha)			
Teff	0.68	0.68	2.28
Wheat	1.66	0.27	0.27
Faba bean	0.21	1.42	–
Area left fallow	–	0.18	–
Total labour use (labour hours)	**1098.8**	**981.4**	**1881.0**
Productivity			
Land (birr/ha)	332.8	172.0	994.1
Labour (birr per hour of family labour)	0.77	0.45	1.35

Conversion: 2 Ethiopian birr = US$ 1
Source: ILCA (1988b)

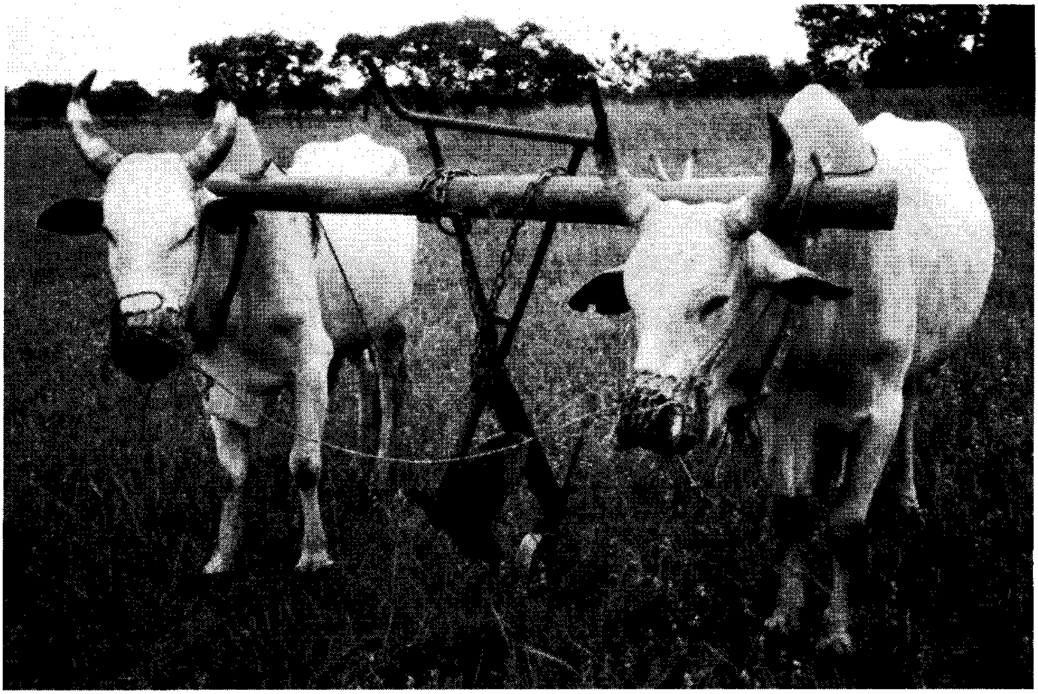
achieved. Unless body condition score is high at the start of work, weight loss during work is almost always associated with a fall in work output and in willingness to work regularly, whereas increases in nutrient intake, liveweight and body condition produce increased work output. For example, Lawrence (1985) observed that under conditions of moderate feeding three pairs of oxen doing regular work in Costa Rica maintained weight and used energy equivalent to 1.51 times maintenance when working a 5.5-hour day: the same oxen on a poorer diet, such that they lost substantial amounts of weight, only used energy equivalent to 1.42 times maintenance. This response was more evident in inexperienced animals. In Nepal, improvements in work rate of buffalo carting loads regularly over a three-month period were associated with good feeding and improved body condition (Pearson, 1989a). When feed is in short supply some farmers prefer to supplement their draft oxen at the expense of other livestock to ensure that the animals can work regularly enough to meet cultivation requirements (Tennakoon, 1986).

Management of draft cows

Cows are becoming more widely used as draft animals. In places where pressure on land is high and the ratio of pasture to cultivated land is decreasing, the use of cows for draft purposes is one way of reducing the numbers of animals kept. A linear programming model was used to show that cow traction was more efficient in terms of resource use and productivity than traditional (two ox) or single ox traction in the Ethiopian highlands (Table 3; ILCA, 1988b).

Although cows can be used for animal traction, this is not without a cost. If a cow is to work as well as produce a calf and a good supply of milk it needs good quality feed. In a study in Costa Rica, cows in mid-lactation needed to be fed food energy equivalent to 2.2 times maintenance to work and maintain milk production (Lawrence, 1985). To achieve this energy intake the basal diet must normally be supplemented with considerable amounts of concentrates. Because these are not always available, or are too expensive, most farmers have to accept that milk production is unlikely to be maintained if cows are also required to work.

Reports in the literature show different effects of work on milk production. Jabbar (1983) in Bangladesh found that milk yield fell when cows were used for draft. Goe (1983) reported that on work days, cows can show a 10–20% decrease in milk yield. Similarly, Matthewman (1989), in experiments with Hereford x Friesian cows, found that milk yields (as well as yields of lactose and protein) fell during exercise, but recovered following two days of rest; yield of milk fat was not affected by exercise. When supplements based on barley, fishmeal or sugarbeet (glucogenic, aminogenic or lipogenic) were fed with straw diets, the nature of the dietary supplement did not seem to have any significant effect on the impact of exercise on lactational performance. Rizwan-ul-Muqtadir, Ahmad and Ahmad (1975) in Pakistan found no reduction in daily milk production during work. In Ethiopia, Zerbini found no marked effect on milk



Fulani oxen with muzzles transporting plow in Kufana, northern Nigeria

production in crossbred dairy cows worked for 90 days (four hours a day pulling sledges at an average draft force of 400 N for four days a week), starting two weeks after calving (ILCA, 1991). However, he noted that work had a dramatic effect on cow weight: three months after giving birth, working cows had lost an average of 26 kg, whereas non-working cows had lost less than 11 kg. Supplementary feeding with noug (*Guizotia abyssinica*) cake, wheat millings, salt and bone meal did not eliminate these weight losses. These differences in response may well be a reflection of differences in availability of nutrients and competition for these nutrients between the mammary gland and muscle. Any situation which results in an increase in this competition (such as a sudden increase in work done) is likely to result in a reduction in milk production and/or liveweight, since muscle contraction is a basic tax on the nutrient economy of the animal (Teleni and Hogan, 1989).

In some areas where draft cows have been used for a considerable time, even if work during the later stages of pregnancy and lactation is avoided, there is evidence that calving intervals are getting longer (Robinson, 1977; Petheram et al, 1982) and there is a danger that the supply of replacement milk and draft animals will not match demand in the future. It was reported that oestrus occurred on fewer occasions in working cows than in non-working ones during a trial in Ethiopia (ILCA, 1991). Although supplementary feeding increased oestrous activity, some of the supplemented working cows cycled during their resting period, but none of the unsupplemented ones did so. Similarly in Indonesia, Bamualim, Ffoulkes and Fletcher (1987) reported reduced ovarian activity in working buffalo cows compared with non-working animals. Even if working cows do show oestrus, they may miss the chance of service by a chosen bull because of their work.

Again the emphasis is on good management so that productivity is not jeopardised too much by the use the cows for work. Matthewman, Dijkman and Zerbini (1993) drew up an annual management calendar for draft cows in areas where food supply is seasonal, to help ensure that requirements for work, pregnancy and lactation could be met with minimum supplementation of the basal diet.

Health care of draft animals

There is some evidence and much conjecture in the literature that sub-clinical diseases reduce work output and, equally, that the additional stress of work can predispose draft animals to disease (Hoffmann and Dalgliesh, 1985; Wells, 1986).

Draft oxen weeding with an Arara *cultivator in Niger*

Pearson (1989b) suggested the reduced power output and inability to work of otherwise well-fed and apparently healthy buffaloes may have been due to chronic fasciolosis. Payne et al (1991) observed that although exercise did not appear to exacerbate the effect of *Trypanosoma evansi* infection in buffaloes, the infection had a marked effect on body temperature and blood packed cell volume (PCV) profiles of infected buffaloes, both of which could adversely affect an infected animal's work output and heat tolerance.

Helminth parasites are thought to be a major cause of unthriftiness and low life expectancy of working donkeys. In Morocco (Khallaayoune, 1991) and Greece (Bliss et al, 1985), for example, anthelmintic treatments resulted in healthier and stronger donkeys. The study by Samui and Hugh-Jones (1990) is one of the few to attempt to quantify the financial and production losses due to a disease in draft animals. They conservatively estimated that the cost of draft oxen being affected by bovine dermatophilosis in Zambia was 428 Kwacha (US$ 193) per affected ox. This was based on loss due to reduction in area of land plowed and lowered income from hire of the animals.

A dead draft animal cannot work and so land cultivation and crop production suffer. In places where a farmer relies on a single animal this can have serious consequences. Even where a pair of animals is used, the loss of one of the pair, especially just before or during the working season, can be critical. Some efforts to prevent acute diseases in an area would seem to be economically justified by a farmer who keeps draft animals, whether it be by management, local medicines or purchased drugs.

The sub-clinical diseases are more difficult to cope with than the acute diseases; they may not kill the animal, but they can severely reduce its productivity. Systematic studies are now underway in West Africa and Indonesia to investigate the consequences of sub-clinical diseases on work and, conversely, work on disease. In both these areas trypanosomiasis is the first disease to be studied in this context. The basic questions that need to be answered are: what are the risks involved in not treating draft animals to prevent disease; and is there an increase in work output and farm income that justifies the expense involved in treatment? The results of these studies should provide information that can be used to assist farmers in such areas in planning the management of their animals to ensure that they remain healthy and are fit to work when required.

Management of draft power

This paper has concentrated on highlighting some of the main issues in the management of draft animals—training, feeding and health care. However, management of draft animals is not only a matter of good husbandry; it should also involve efficient management of the power itself, both when it is required in seasonal tasks (management as a communal use, referred to above, is one such example) and over the rest of the year so that the resource of animal power is not wasted.

One way of optimising the use of animal power is to encourage other uses for draft animals. In areas where the draft animal is unlikely to be replaced on farms, there is considerable potential for this. Reducing the number of idle days in the year is a relatively easy way to increase efficiency of animal power on a farm. Water-lifting, milling, and other stationary power devices have been designed and built throughout the world incorporating animal power, some more elaborate than others. Earthmoving and road building are less conventional uses which have application in some places.

It is usually the simplest idea or design that is the most successful as it is the one that can be most easily adopted. When improvements in management of draft animals are being considered this aspect should not be overlooked.

With the increases in population pressure in many areas, and problems of dwindling feed resources for animals as pressure on grazing land and fodder supplies increases, the management of the resource of animal power is likely to become an even more important issue than it is at present.

Future developments

While much is known about the training, feeding and health care of draft animals, particularly in areas where they have been traditionally used and research has gone some way towards identifying the consequences that particular management strategies can have, in some areas it is apparent that more information is required. There is scope for research into the role and management of draft equines, particularly donkeys, in tropical agriculture. The donkey is often the first source of power the least wealthy farmer can afford, other than family labour. In the past donkeys have had a relatively low social status and have largely been ignored by agriculturalists.

Donkey cart in southern Niger

Photo: Anne Pearson

Investigation of the effects of liveweight, body condition and nutrient intake of draft animals would seem to be of high priority in areas where seasonal fluctuations in feed quality and supply are considerable. In these areas feed strategies need to consider the number and frequency of working days required of the draft animals. It is in these areas that draft animal power is often being encouraged as a new technology to increase farm productivity, and positive guidelines on feed allocation are needed, perhaps more so than in areas where farmers have traditionally kept working animals.

The use of cows for draft is likely to become increasingly common on many farms. The partition of feed energy between maintenance, body reserves, milk production, work and pregnancy is clearly one aspect which requires greater understanding if cows are to be successfully used for work at minimum cost to their other functions on the farm. The productive and economic consequences of disease and the interaction with nutrition have until recently been largely neglected and would benefit from further study. In short, there is much that can still be done to provide information to assist in the improvement of management practices such that draft animal power is used to its maximum effect on farms in tropical and sub-tropical areas.

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