# Strategies to improve the effectiveness of supplementary feeding of working cattle in semi arid crop/livestock systems

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***Abstract***

*Feeding is one of the major problems which farmers have in maintaining draught oxen in smallholder crop-livestock system in Eastern and Southern Africa. This paper reviews some of the studies that have been carried out to improve the effectiveness of supplementary feeding of work cattle. Most studies have involved draught oxen, although supplementation clearly becomes more justifiable economically as more outputs are expected from the animals. While body condition and weight losses during work may not constrain the animal when it is used for a short period they take on greater significance when animals are used for longer periods or are required to provide a calf or milk in addition to work. Studies have shown the supplementation is most effective when it is given within the working period although some supplementation before the working period starts can also enhance performance. Crop residues on their own do not always provide sufficient supplement to meet requirements for work to animals maintained on dry-season grazing. Good quality feed supplements need to be provided if supplementation is to be of any value to the working animal. Various supplements can reduce weight loss and enhance performance of working oxen and can reduce the time the animals need to spend in feeding activities. The paper concluded with some examples of the development of improved feeding practices for draught animals in Zimbabwe, Niger, Bangladesh and Indonesia to illustrate the range of factors which need to be considered in improving the feed supply to draught cattle.*

## Introduction

The main source of power in smallholder crop-livestock systems in semi-arid areas of the tropics and sub-tropics, other than human power, comes from animals (usually cattle). In these small-farming systems one of the major problems that farmers have is that of feeding their animals. The animals rely mostly on grazing of natural pastures that are communally owned. These pastures are generally poor in quality and due to lack of control they are overgrazed. During the dry season the pastures do not produce enough fodder to maintain the animals. The animals have to mobilise their body reserves for maintenance and other activities and end up losing body weight. On these farms the hardest task of ploughing usually takes place at the end of the dry season when feed supplies are low and work animals are in poor condition. The work performance of the animals is likely to be impaired unless some measures are taken to reduce their food deficit. One obvious method that farmers are increasingly adopting in Eastern and Southern Africa is the storage of crop residues from the previous harvest to be fed in the period of food shortages for working cattle. This practice is replacing the traditional practice of leaving the crop residues standing in the field to be grazed by locally owned livestock in the community. Farmers maintaining draught animals are sometimes unsure of how best to use the stored residues to give most benefit to the working cattle in terms of when and how they should be fed. This paper reviews some of the research that has been undertaken to improve the effectiveness of supplementary feeding of working cattle in semi-arid areas. The information is useful to those working closely with farmers to develop appropriate feeding strategies for work animals to match the resources of the individual farmers. As well as the needs of the working animals, labour available and other needs and priorities of farmers have to be considered in developing feeding strategies. Some examples of the development of 'improved feeding strategies' to emphasise this latter point are given at the end of the paper.

## Live weight and body condition

Despite the apparent benefits of having animals in good condition at the start of work, there is little conclusive evidence to show that animals in good body condition work faster and/or longer than those animals in lean condition at the start of a work season. Nor is there evidence that crop yields are improved by dry/winter season supplementation of oxen (Dicko and Sangaré, 1984; Astatke *et. al.,* 1986; Khibe and Bartholomew, 1993). Studies in Mali (Bartholomew *et. al.,* 1994) and Niger (Fall *et al.,* 1997a) have shown that live weight and not body condition is the main determinant of work capacity in oxen. Oxen can work well at a body condition score of from three to six on a scale from one (emaciated) to nine (obese) as devised by Nicholson and Butterworth (1986) and regardless of condition within the range, the heavier animals do the greatest amount of work in the day.

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Animals leaner than three and fatter than six are likely to have problems in working, the former being too weak and the latter unfit and prone to heat stress (Fall *et. al.,* 1997a), therefore these body conditions should be avoided. It may seem then that feed supplementation of animals before work produces little reward. However the situation is not as simple as this. While body condition and weight losses during work may not constrain the animal when it is used for a short period, of for example three to four weeks, they take on a greater significance when animals are used for longer periods or are required to provide other outputs (calf, milk, meat).

**The need to supplement staple feeds of working animals – economics**

The economics of feed supplementation of working animals, particularly in the dry or cold season needs to be carefully considered by each farmer. They depend mainly on the productivity expected from the animals. Where work periods are short (e.g. 20 - 30 days) returns from supplementation of draught animals may be small, since animals will have ample time to make up any losses in the rest of the year. Bartholomew *et. al.* (1994) and Fall *et. al.* (1997a) emphasised a lack of necessity for dry season supplementary feeding when oxen were to be used for a short period each year and suggested that supplementation should only be considered when the working period exceeds six weeks. If work is performed over longer periods, for example if animals are used for transport as well as cropping, then supplementation can be beneficial. The aim should be for the adult animal to have maintained its live weight over the year, although it may have shown some even quite dramatic fluctuations in weight change within the year.

In areas where animals are scheduled to be sold for meat after work then supplementary feeding is worthwhile, even when the animals are worked for short periods. This prevents work from adversely affecting their market value. The aim of supplementation in these cases should be to achieve an increase in the animals' live weight over the year.

There is now considerable evidence to show that unless draught cows are given good quality feed, particularly during work, then the associated weight losses will result in production losses. The aim should be to feed to maintain live weight. This can be difficult when requirements for pregnancy and lactation as well as for work have to be met. Live weight loss in working female cattle can lead to reduced ovarian activity and longer calving intervals. Total milk yield can also decrease on working days. The use of cows for work offers the greatest management challenge to a draught animal farmer. Farmers need to insure that not only is there enough feed to maintain production, but that calving does not coincide with the peak demand for draught animal power on their farm.

**The effects of strategies of supplementation on work performance**

***Time of supplementary feeding in the season***

Francis and Ndlovu (1995), in Zimbabwe, investigated the effects of feeding cobsheath-groundnut stover as a dry season supplement to oxen consuming a basal ration of natural grazing and maize stover. They looked at whether it would be better to feed small quantities (400 g/head/day) for a long period (10 weeks days prior to ploughing) or larger amounts (800 g/head/day) for a shorter duration (five weeks) and compared weight losses and performance with those of un-supplemented animals. In both cases they reported beneficial results in terms of live weight changes, work and power output, and area ploughed compared to un-supplemented cattle. However, their results did not show any significant differences between a long period at a low level or a short period at a high level of supplementation before work. They concluded that whatever the strategy on supplementation, farmers should aim to at least maintain a reasonable live weight of their animals before they start working. However they suggested that when labour bottlenecks occurred farmers would probably find it better to feed their animals much closer to the peak ploughing time.

Bartholomew *et. al*. (1995), working with farmers in Mali assessed the likely impact of supplementary feeding of draught cattle, worked in field operations for 36-46 days per year and subjected to an annual dry season of seven to eight months, which resulted in the mature animals commonly losing 20 % of their weight in the dry season (Wilson *et. al.,* 1983). Within a wide range of animal live weight, change in weight had no measurable impact on work output. Bartholomew *et. al.* (1995) suggested that in this situation feeding supplements before the working season in order to maintain or increase live weight was of little value in increasing the potential capacity for work. They suggested that the additional energy requirement during the working period could be more efficiently supplied from a stock of conserved forage than from a body fat reserve on the animal itself produced through dry-season feeding (Bartholomew *et. al.,* 1995).

In order to investigate this further, an experiment was conducted in South Africa at Fort Hare University research farm (Israel, 1999), to investigate the appropriate time for supplementation relative to the working period, as judged by live weight changes and

**Figure 1: Weekly average live weights of oxen on treatment 1 (supplemented before and during work i.e. week 1-14) and treatment 2 (supplemented during working i.e. week 8-14)**

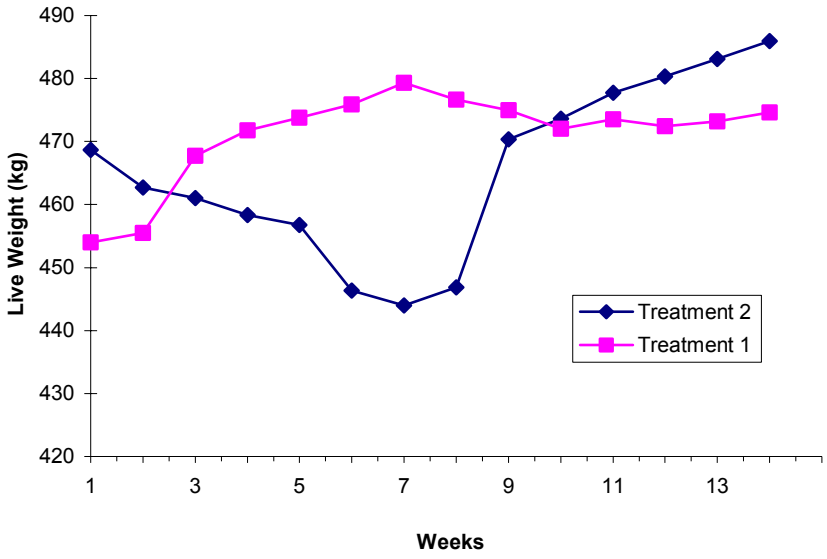


**Table 1: Average live weight at start and average work performance parameters for oxen on the two treatments - treatment 1 – supplemented before and during work and treatment 2 only supplemented during work. See text for details of dietary treatments**

| Parameters | Treatment 1 | Treatment 2 |
|---|---|---|
| **Average live weight (start)** | 454 kg | 469 kg |
| **Average live weight (end)** | 474 kg | 488 kg |
| **Average daily work (MJ)** | 11.2±1.2 | 11.7±1.2 |
| **Distance walked (km)** | 14.6±0.2 | 14.2±0.9 |
| **Draught force (N)** | 776±72.2 | 832±47.9 |
| **Power (W)** | 1042±71.0 | 1078±76.5 |
| **Speed (m/s)** | 1.4±0.04 | 1.3±0.02 |

work performance, when cattle were fed a poor quality basal diet (*Chloris guyana* hay). The supplements used were lucerne and cob meal with a mineral supplement (salt and calcium phosphate). They were fed daily either in a small amount (500 g lucerne/100 kg live weight and 1.5 kg/head/day) for seven weeks before work and during a seven-week working period or a larger amount (1000 g lucerne/100 kg live weight and 3.0 kg/head/day) only during the working period.

Figure 1 shows average weekly live weights of oxen in the two treatments over the whole experimental period. Oxen that received the supplements throughout (treatment 1) gained weight during the first seven weeks when there was no working. During work (weeks 8-14) oxen in the first treatment at first lost weight (weeks 8-10) and then their average body weight remained stable up to the end of the working period. Animals that received no supplements for the first seven weeks (treatment 2) lost weight (up to 34 kg or 9 %) during this time, but they regained it during the working period when they were supplemented. Although the animals in treatment 2 showed a great fluctuation in live weight than those in treatment 1, differences between initial and final weight (+20 kg treatment 1 and +19 kg, treatment 2) were similar.

Table 1 shows the average work output from oxen in the two treatments. There was no significant difference in the average working performance of animals between the two treatments. However all oxen in the second treatment completed the working day with some difficulty during the first week of working. There was a tendency for these oxen to become tired compared to their counterparts and they needed more pushing from their drovers. In subsequent weeks they worked well.

The similarities in live weight gain on each treatment from start to end of the experiment suggested that both strategies of supplementation were equally efficient at providing energy to the working animals. Whichever strategy is adopted would depend on the conditions under consideration. If the aim of supplementing is to ensure that live weight is maintained in order to preserve working capacity, as

would probably be the case when dealing with small-sized or young oxen, it is appropriate to provide supplements for a period before working begins. If on the other hand, there is no risk of lowering capacity for work, or dry season feed is difficult to obtain, or labour is in short supply, then it could prove more beneficial to use feed resources to supplement only during work, so as to supply only the extra energy needed for work. In the latter situation, given the observations on ease of working, it would be advisable to supplement work oxen, regardless of size for a short period (about one week) before actual working begins. Adopting this strategy would be important in areas with very severe shortages of feed at the end of dry season and where the planting period is short and the oxen are required to work long hours over a short cultivation season.

***Time of feeding in the day***

During the working season timing of feed supplementation on working days may be important. Supplementary feeding after work in ruminants minimises intraruminal heat production while working. Conversely it has also been suggested that feeding at least 2 h before work insures a ready supply of energy-yielding substrates for working muscle and in horses feeding in rest periods during work may be beneficial. Farmers adopt all these strategies when feeding cattle, however it is not clear whether this is an informed decision or based on traditional practices by those unaware of any alternatives.

***Type of feed supplementation***

Working oxen fed on cereal crop residues alone are unlikely to consume quantities that will be sufficient to provide the extra energy required for working (Soller *et al*, 1991; Fall *et al.,*1997b). This is due to the fact that crop residues are low in nitrogen content and they have low levels of rumen degradable nitrogen, thereby limiting microbial synthesis in the rumen, the capacity for fibre digestion and hence dry matter intake. Intake and utilisation of cereal crop residues and dry season grazing could be improved by supplementation with nitrogen sources (Foulkes and Bamualim, 1989) or by increasing amounts or crop residues offered to the animals so that they can select more of the digestible parts (Fall *et. al.,* 1997b). Where animals will be subjected to long periods of hard work or are in poor condition and cannot maintain body weight, Foulkes and Bamualim (1989) suggested supplementation with rumen-undegradable concentrates.

In Zimbabwe different forms of supplement have been studied to improve the nutrient intake of cattle kept on communal grazing lands. Prasad *et al.* (1994) supplemented working cattle (275 kg) grazing on a dry season pasture in Zimbabwe with either 2 kg maize stover/head /day, or 1.5 kg maize stover plus 0.5 kg groundnut haulms /head /day. Both groups of steers had a higher rate of ploughing during a one hour ploughing test (1.18 m/s and 1.28 m/s, respectively) than an unsupplemented group of oxen (0.9 m/s). They suggested that crop residues are a suitable source of supplementation to maintain live weight and/or improve performance of oxen during work.

Ndlovu *et. al.* (1996) in a trial with farmers supplemented smallholder oxen (250-290 kg) on dry season grazing with either maize stover alone or maize stover plus silverleaf hay (2:1 w/w) or urea-treated maize stover (50g urea/kg stover). Each supplement was given at 1 kg/head/day. Un-supplemented animals and those on the maize stover alone supplement, lost weight, the other animals maintained weight. Supplementation reduced the time that cattle spent on feeding activities by 10%. This is an important advantage of supplementation, when feeding work oxen, that is often overlooked. The animals on the urea-treated maize stover or stover plus silverleaf hay had a higher rate of work than the animals in the other groups (Ndlovu *et. al.,* 1996). The results showed that supplements need to be of good quality to be of any value to the working animal and confirmed that maize stover alone is rarely a satisfactory supplement, when fed in restricted amounts.

An experiment was undertaken in South Africa to assess the relative effects of three all locally available supplements, sunflower cake, cob meal or lucerne, on intake and digestibility of a low quality basal diet (maize stover) by working oxen (Israel, 1999). The oxen (500 kg) were given maize stover *ad libitum* and either 2.5 kg lucerne/head/day, or 3.6 kg of either cob meal or sunflower cake/head/day. The supplements were offered before the basal diet each day. Intake of stover, the basal diet, was greatest when the oxen received sunflower cake supplement and least when they received the more bulky lucerne as the supplement. There seemed little difference in performance of the animals on each supplement, although weight gain and power output tended to be greater on the sunflower supplement (Table 2). This supplement had the highest crude protein content and energy content of the three supplements.

**Table 2: Average live weight at the start, voluntary dry matter intake (DMI) of stover and work parameters for oxen receiving the different supplements, see text for details of amounts given**

| Parameter | Treatment A (Lucerne) | Treatment B (Sunflower) | Treatment C (Cob meal) |
|---|---|---|---|
| **Intake of stover (kg DM)** | 12.5± 2.3[a] | 14.9± 3.3[b] | 13.6± 2.3[c] |
| **DMI stover (g/kg $M^{0.75}$)** | 57.8±5.1[a] | 69.2±5.9[b] | 64.56±2.2[c] |
| **DMI stover work days (kg DM)** | 10.9±1.4[a] | 13.3±1.5[b] | 12.9±0.8[c] |
| **DMI stover non-work days (kg DM)** | 13.2±1.2[a] | 15.7±2.2[b] | 14.1±0.6[c] |
| **Average weekly gain (kg)** | -0.46 | 0.54 | 0.33 |
| **Average daily work (MJ)** | 11.5±1.9 | 13.4±2.1 | 12.6±2.1 |
| **Speed of working (m/s)** | 1.3±0.2 | 1.3±0.03 | 1.3±0.1 |
| **Average draught force (N)** | 835±44 | 862±55 | 831±34 |
| **Average power (W)** | 1060±68 | 1127±105 | 1056±5 |

means with different superscripts along a row are significantly different ($p<0.05$)

Voluntary dry matter intake of stover by animals in all treatments was higher on non-working days. Pearson and Smith (1994) observed that daily dry matter intake of animals prevented from feeding for four hours everyday was not affected. The number of hours worked per day in this experiment was at most four hours, but there was a tendency for the animals to rest for some time after finishing work before they began to eat. Therefore the actual time spent eating on working days was far less than on non-working days. This might have been the main contributing factor to the lower voluntary dry matter intake. At a daily food allowance adjusted to 30 % higher than the amount consumed the previous day, intake was 57.8-69.2 g/kg $M^{0.75}$. Fall *et. al*. (1997b) obtained very similar intakes (65.5 g/kg $M^{0.75}$) when feeding millet stover to oxen working for 5 hr/day at a daily allowance adjusted for refusals to amount to 50 % of food offered. In order to allow working oxen enough time to feed, it would be good practice to ensure that work begins early so that it also ends early enough to give the oxen enough time for feeding, before night time. This is especially relevant where the animals are able to graze only during day time, and are kraaled at night.

If several supplements are available for use they should be combined so as to take advantage of each and possibly reduce the overall cost. Where a supplement is to be offered it should be given before the main diet to ensure that it is all consumed (Israel, 1999).

**Feeding in practice**

Although results of various supplementation strategies may look promising on-station, farmers have to consider many other factors in developing their feeding strategies. They need to consider not just the supply of feed for the working animals, but feed requirements for other livestock on the farm, other productive outputs expected from working animals, and labour available. Labour availability is a factor, which is often overlooked by livestock advisors when recommending feeding practices. Children have traditionally been responsible for supervision of grazing animals in many areas, as well as having an involvement in cut-and-carry activities in other places. Provision of schooling for children can leave the farmer with a shortage of labour, reducing grazing time and/or the amount of forage that can be cut or residues that can be collected to supplement animals. In some areas men are also away working and women run the farm. While this increases the household income it also places constraints on the labour available to manage the livestock on the farm. Schemes to improve the quality of the diet given to the working animals either by improving the digestibility of the staple feed, or by supplementation of the daily ration, need to bear in mind these pressures on the labour pool. Failure to consider the other priorities of farmers before developing feed interventions can result in failure of nutritional projects. There have been several projects throughout the world to raise the nutritional status of cattle used for work. Some schemes have been more successful than others. The following selection (from Pearson, 1996) have been chosen to illustrate some of the factors which have a bearing on the success or failure of adoption of feeding strategies for draught animals on smallholder farms.

***Sub-Saharan Africa – Zimbabwe***

Mangwende is an area that is representative of the high potential communal areas of Zimbabwe, with an annual rainfall of about 800 - 1000 mm. The animals there tend to be in poor condition when needed for work. Maize stover is one of the main feeds available to supplement rangeland grazing. Traditionally farmers leave the stover in the field to be grazed *in situ*. Some farmers collect the stover and store it at the farm. However during the late dry season the stored stover is piled into the night kraal so it is available to all animals. An improved management system was tried out (Chikura, 1994),

whereby farmers harvested and stored the maize stover then in the late dry season they fed it separately to their work oxen; approximately 6 kg /day between finishing work and being returned to the herd. A block lick (24% crude protein and 5% urea, Rumivite Economy) was also made available in each pen for the hour allowed for the supplementary feeding. During the three month working season (November-January) there was no significant difference in the rate of live weight gain between the supplemented group (200 g/d) and un-supplemented animals (170 g/d), nor was work output or frequency of work any different between groups. In this case supplementation had no benefit on outputs. Farmers were mainly interested in ploughing their fields as early as possible, and would do so whatever the condition of their oxen and whatever the stress. Farmers knew the animals would recover later in the season and could see little benefit in adopting the modified feeding practice (Chikura, 1994).

***West Africa- Niger***

In Niger urea treatment of roughages (rice straw, sorghum and millet stalks) to increase digestibility has been adopted by many farmers in three departments of Niger (Tillaberi, Dosso and Maradi). A drought had resulted in an increasing number of cattle moving into these important crop-producing areas of Niger. Poor growth and health of the livestock were identified as problems by the farmers. The farmers normally had a reliable market in which to ultimately sell their cattle for meat. Unlike the previous example in Zimbabwe, farmers were therefore receptive to feeding strategies to improve the condition and health of their animals. Uptake was good, mainly because the technique proved to be cost-effective. The draught animals had a greater capacity for work, fattening was less time-consuming, fewer supplements were needed and the final market price was higher than in the Zimbabwe example (Sourable *et. al.,* 1995).

***South Asia – Bangladesh***

In Bangladesh Saadullah *et. al.* (1994) provided urea-molasses blocks to draught cows fed *ad libitum* on rice straw and allowed to graze 2-3 h daily. They found that supplementation was associated with an increase in feed intake, daily live weight gain for dams (79 g/d vs. 44 g/d) and calves (316 g/d vs. 160g/d), higher calf birth weight (16 kg vs 14 kg), and reduced calving interval (685 d vs. 691 d). Daily milk yield (530 g vs. 243 g) and lactation length (275 d vs. 230 d) were also increased. Productivity was comparable with that of cows supplemented with wheat bran in place of the molasses-block. Supplementation was seen by the farmers as a necessary consequence of using cows for work and most were concerned that the most effective supplement be used. As a result they tended to prefer the urea-molasses block.

***South Asia – Indonesia***

In West Java producers of draught animals face a severe decline in forage quality and quantity in the late dry season (October-November) and a severe labour shortage for collecting forage in the early wet season (November-January). These shortages are responsible for poor weight gains of the stock as well as stretching family labour resources. The introduction of suitable forages was seen as a relatively inexpensive way of overcoming these constraints, which farmers were likely to adopt (Petheram *et. al.,* 1989). Early trials with farmers selecting areas to plant the forages on the farm, and assessing the usefulness of various species, were promising. However practical difficulties such as which species to use, survival, and the management, particularly in the early stages of the forages, meant that considerable input had to be made before the benefits were apparent. As a result adoption has been low. A similar delay in benefit is often seen in schemes to introduce tree fodders as supplementary feeds, although once selected, planted and protected (at least in the early stages), little extra labour input or cost is required for the trees before they are large enough to lop for animal feed.

**Conclusions**

The main conclusions to be drawn from the experiments and trials described here are that recognition of the considerations that influence the feeding and managing of draught animals on specific farms is essential, in addition to a knowledge of the feeds available and their quality. It is equally important to understand how the working animal will respond to the feeds and management it is subjected to. A consideration of all these factors allows recommendations on feeding strategies and supplementation to be proposed that are likely to meet the animals needs as well as meeting with the approval of farmers. If these needs are met by the 'improved' feeding strategies then they have the potential to have a high adoption rate in an area. These points may seem obvious, but it is surprising how often one of these components is overlooked at the planning stage. The involvement of farmers in the identification of the appropriate feeding intervention is the key to the development of successful feeding strategies for cattle used for work in any area. What is right in one area is often unacceptable in another. Good feeding strategies result in improvements in health and productivity of the working animal (milk, calving interval, and sale price where appropriate), and provide the farmer with a more reliable and better draught animal power when required.

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