SOME TOOLS TO COMBAT DRY SEASON NUTRITIONAL STRESS IN RUMINANTS UNDER AFRICAN CONDITIONS

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Abstract

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Dry season nutritional stress is a major constraint to ruminant livestock production in semi-arid areas. After the rains finish, quantity and quality of grazing fall rapidly, leaving cereal crop residues as the major feed resource. These residues are low in N and high in crude fibre, characteristics which restrict intake and digestibility, so that underfeeding results. Improved handling and storage procedures as well as chemical and physical treatments can all improve their quality. Other strategies include: rate of offer of stover; compensatory growth; conservation of fodder. Farmer-selection should also consider multiple use of the options available.

1. INTRODUCTION

Zambia, typical of the Central Southern African region, usually receives rain from November to April (hot season), followed by a long dry period (winter and spring). These defined seasons are characterised by the live-weight gain/live-weight loss patterns, typical in tropical livestock production systems.

In the traditional farming sector cattle and goats are the major species of domestic livestock. They rely on natural pasture during the wet and early dry seasons and crop residues for the remainder of the dry season (goats should benefit from the browse flush before the arrival of the rains).

When the rains cease the quantity and quality of grazing falls rapidly [1], so that winter grazing is fibrous and low in crude protein (CP.; around two per cent). As the grazing fails, accepted practice is to redress the deficit with crop residues. However, whilst the ruminant can digest fibrous feeds (this is the characteristic which ensures its place in the crop/livestock farming system), efficient use of these resources demands supplementation and, or, modification of them. This is especially true where production targets (growth; reproduction; lactation; draught) have to be met. Under-supply of nutrients is often a combination of lack of feed coupled with an imbalanced diet.

Efficient rumen function depends on supplying sufficient N to act as a substrate for the growth of cellulolytic bacteria. Maximisation of microbial protein production requires protein and energy sources with similar breakdown rates. Dry season feeds generally require supplementary N, and this is often supplied as non-protein-nitrogen (NPN, urea). It is rapidly broken down in the rumen and, therefore, requires a source of readily available energy (e.g. molasses or green forage) if it is not to be lost from the system as ammonia [2]. True proteins, for example legume stovers and oilseed cakes, also contain some energy but can be costly if not home produced.

Total nutrient supply is a summation of intake and digestion, both dependent on adequate dietary N. The requirement for protein is twofold: firstly the rumen needs a source of N to ensure a maximum supply of digestible nutrients; secondly, when microbial protein is insufficient to meet the production requirements of the animal a supply of bypass protein will be needed. Preston and Leng [2] considered that between 10 and 20% of digestible nutrients should ideally bypass breakdown in the rumen.

Before discussing crop residue utilization two general points need discussing. The first is choice of breed of animal. An animal must be adapted to its environment, both in its ability to tolerate the stresses of that environment and its nutritive requirements relative to the amount of feed on offer. Introducing large exotic breeds with a high production potential will not succeed unless management, including nutrition, can also be changed, not often possible for resource poor farmers. Moyo [3] found that the small indigenous Mashona cattle produced the highest weight of weaners, per cow per year, compared to larger breeds and their crosses.

Water intake is related to dry matter intake [4]. In a dry hot climate there are differences between breeds in their water requirements, in that *Bos indicus* cattle have a lower intake than *B. taurus*, the difference increasing as ambient temperature increases [5].

2. CROP RESIDUES

With the dominant role of crop residues in dry season feeding, especially towards the end of the season, the farmer needs to know the options for: storage; supplementation; modification of the residues; and management of his animals. He needs a 'tool box' from which he can select appropriate options.

2.1. Harvesting and storage

Rapid removal of stover from the field after grain harvest reduces leaf loss and senescence ([6]; S. Ncube personal communication). Storage under cover, with some movement of air will allow completion of the drying process and reduce the absorption of moisture during damp weather (not unusual during the dry season), thus preventing, or reducing, the formation of mycotoxins [7].

Where residues have to be moved over relatively long distances, the cost of transport becomes an issue. Separation of leaf and stem, the stems being left *in situ* and the leaves being compressed in a box baler, has been carried out in The United Republic of Tanzania [8, 9]. Another advantage of this technique was a reduction in the amount of storage space required.

2.2. Supplementation

The extent and rate of digestion of fibrous feeds are increased by a nitrogen supplement, resulting in a greater dry matter intake [2]. This will be reflected in the extent of live-weight change.

The amount of CP required is usually expressed as a percentage of the dry matter and varies according to the production target: beef finishing diets 12–14 percent [10]; more for high yielding dairy cows [4]. However, maximum intake of poor quality roughage is probably achieved with six to eight percent CP. True protein, especially that with a low solubility, such as fishmeal or cottonseed meal, will give a larger response than those with a high solubility [11], which will include NPN [2]. However, the choice will depend on availability and cost, the largest differences being between no supplementation and some N, rather than source of N (iso-nitrogenous supplements of cottonseed meal or combinations of cottonseed meal and urea fed to steers grazing natural range land in the dry season) [12].

Locally available protein sources, such as legume residues, pods, green fodder, poultry manure and oilseed residues (e.g. from the extraction of sunflower oil for household use) all have a part to play [2, 13–16].

In semi-arid areas green fodder is often not available in the dry season. However, fodder from multi-purpose trees can be ensiled and their value as protein supplements for milking cows has been demonstrated [17]. Many species are leguminous, thereby contributing both to soil fertility and the supply of fuel wood [2].

As in Zambia, where there is an established sugar industry and, therefore, a supply of molasses, the molasses/urea multi-nutrient block can be a cheap and effective supplement, formulated to meet a range of circumstances. Its manufacture and use will be dealt with elsewhere in this proceedings [18].

2.3. Physical treatment

In smallholder livestock systems most physical treatments of residues are either too expensive, the equipment is not available or too labour intensive. However, there are benefits in reducing particle size (not necessarily fine grinding), for ensiling (see below) and in stall-feeding. The level of CP required in the diet will depend on a number of factors: nature of the diet; form of protein; age of animal; physiological status of animal [4]. Reduction in particle size can be achieved by using a power driven chopper, a hand operated chaff cutter, a panga or a guillotine blade.

There are other advantages, in that the surface area of non-lignin material exposed to microbial attack in the rumen is increased, thus increasing the rate of digestion, thereby reducing a possible limitation to intake [19]. The smaller the particle size the less scope there is for selection. Fine grinding (expensive and not common in practice) can reduce intake by increasing dustiness). Osafo et al. [20] found that chopping increased intake in sheep but not in cattle.

2.4. Chemical treatment

The potential for increasing digestibility and intake of fibrous residues through treatment with alkali has been widely researched and comprehensively reviewed [21]. Urea treatment is of most practical significance in the tropics, acting both as an alkali and a source of supplementary N to materials inherently low in crude protein.

Treatment procedure will vary according to circumstances. In Zimbabwe, Smith et al. [22] found that 5% urea, in solution, added at a rate of at least 20%, weight for weight, solution to dry stover, followed by an incubation period of five weeks gave the greatest improvement. The stover had been rotor slashed before treatment. Although successful upgrading of whole stover is possible, reduction of particle size aids ensilage as well as the other advantages listed above.

Urea treatment is relatively easy to apply and is effective. However, its uptake at farm level has been slow. Cost is often cited as a reason for this. To overcome this the following should be considered:

(a) Offer large quantity of the stover, to allow selection of the most nutritious material (leaf) and then treat the refusals, thus reducing the volume of material to be treated. Intake of treated refusals has been found equal to that of the original material [23]. The stems resulting from leaf stripping [9] could also be chopped and treated.

(b) When ammonia treated straw (20% of straw intake) was fed as a supplement, the intake of untreated straw was increased [15]. In China, some farmers claimed that treating 25% of the wheat straw offered increased total straw intake.

(c) The use of urine as a substitute for urea [24]. Urine is a freely available resource which, if acceptable, is effective as an upgrading agent.

(d) Consideration of locally occurring alkalis. Magadi, which occurs naturally in parts of East Africa, improved the digestibility of straws and stover, albeit to a lesser extent than NaOH [25]. The efficacy of such local products must be set against their cost for a true evaluation to be made.

(e) Enzyme (cellulase and hemicellulase complexes) treatments to breakdown fibre are currently being tested. There have been mixed responses so far but Phipps et al. [26] have stressed that the potential for unlocking nutrients in fibrous tropical feeds is enormous.

2.5. Amount of roughage offered

The components of stovers and straws are leaf, sheaf and stem material. Owen and Aboud [6] suggested feeding excess straw to selective feeders, such as goats and sheep, the rejected material then being offered to comparative non-selectors including cattle. Smith et al. [22] offered increasing amounts of coarsely ground (14 mm screen) maize stover to lambs and steers. At the higher levels of offer, intake was increased more in lambs than steers, supporting the hypothesis [6] that sheep are more selective than cattle. This would result in a high stem: leaf ratio being a bigger constraint to intake with sheep and goats than with cattle. These two species also retain digesta in the rumen for less time than cattle, thus resulting in less efficient digestion than in cattle [27].

However, with milking cows intake increased when more stover was offered, to the extent that a small increase in milk yield was detected [28]. A similar pattern of responses has been observed with sorghum stover [20].

2.6. Other dry season feeding strategies

What else can the farmer do to ensure that his livestock survive the dry season in a condition appropriate to meet the production targets.

(a) Grazing stovers versus carrying and storing. The non-livestock owner will leave stovers *in situ,* to be grazed, by arrangement with neighbours, etc. In this way he ensures some manure on his field and can probably negotiate favourable terms for contract ploughing. Whilst removal increases the efficiency of use of a feed resource, its effects on the nutrient cycling within the crop/livestock system are not fully understood. As farmers become 'commercial', with an increased amount of produce being sold off the farm, the potential loss of nutrients from the system can be balanced by the purchase of animal feed and fertilizer [29]. This area of farming systems/nutrient cycling warrants investigation, especially where the cost of fertilizers prohibits adequate usage.

(b) The cycle of weight loss in the dry season followed by accelerated growth in the wet season is common in the tropics. However, the long term effects of dry season weight loss are not always appreciated. Smith and Manyuchi [30] found that, with indigenous cattle, no supplementation in two successive dry seasons reduced carcass weight by 27 kg after the final wet season and a 90 day pen feeding period immediately before slaughter. The supplemented groups received a cottonseed meal/maize meal/urea mix (10:9:1). As the onset of puberty is related to live weight, it is reasonable to assume that age at first calving will also be affected by prolonged periods of underfeeding, as is reconception. Prolonged calving intervals are often nutrition related [31, 32].

(c) Although supplements are often fed on a daily basis, they can be fed as infrequently as once per week. However, if adopting this strategy care must be taken with urea containing compounds, especially with group-fed animals [33].

(d) Stover quality is not a constant, but varies between cultivars. Smallholder livestock farmers often select dual purpose varieties, because of cost, availability and characteristics of the crop (e.g.: feeding quality of stover; brewing quality of grain; resistance to attack by birds). Research is addressing these issues [34, 35].

(e) Dry season feeding need not be restricted to grazing and crop residues. There is increasing interest in conservation of forage, by making silage from planted forage [36]. The silage is made in plastic bags. Because of the use of arable land and the cost of bags, the silage must be a component of a productive enterprise such as dairying.

3. CONCLUSIONS

- The effects of underfeeding in the dry season can affect both immediate production and lifetime performance of livestock.
- There are large quantities of crop residues available in Zambia (Simbaya, this proceedings) for livestock feeding.
- The nutritive value of residues can be improved by correct harvesting and storage, supplementation with N and physical and chemical treatment. Locally occurring sources of protein, such as tree pods should be fully investigated (J. Sikosana. Personal communication). Conservation of fodder, as silage, for milk production should also be investigated.
- Of the tools suggested here, a combination will probably be most effective. It is for the extension worker and farmer to decide on the options most appropriate for a given set of circumstances. Availability and costs of off-farm inputs, together with the perceived value (sales and outputs used within the household) will be the determining factors.
- The options presented here should not be seen as definitive. Further research is needed, particularly at the farm level. Closer collaboration between those in development within the Central/Southern Africa region is called for. A group of projects, funded by the Department for International Development (DFID, UK, managed by the livestock production programme of Natural Resources International, Ltd.) in Zimbabwe is addressing the potential to alleviate the dry season feed shortage [33]. However, because of the pivotal role of low protein/fibrous materials (crop residues and natural grazing) in dry season feeding, a modest improvement (5–10%) would substantially reduce the effects of underfeeding on both survivability and production.

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