Small ruminant production—the present situation and possible nutritional interventions for improvement

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Summary

IN TROPICAL AFRICA, sheep and goats are raised mainly by small farmers under a low-cost system. The productivity of small ruminants can be increased through better health care and feeding, involving simple modifications to the existing farming systems rather than drastic changes. The cost-effective interventions discussed in this paper include inexpensive prophylactic measures, the maximum use of waste products from small-scale processing, household wastes and crop residues, cut-and-carry feeding and the provision of water in pens, and reserving areas of bush for dry-season grazing only.

Introduction

Jahnke (1982) estimated that there are about 104 million sheep and 125 million goats in tropical Africa, kept predominantly within the small-farming sector. It is only in highland regions that sheep outnumber goats (Table 1). Throughout the continent there are many different breeds, ranging from small, trypanotolerant animals found in the humid zone of West Africa to long-legged, rangy animals found in most arid regions. Day length in the tropics shows little variation; females breed throughout the year and variations in birth patterns from month to month are related to the plane of nutrition at the time of conception.

Table 1. Ruminant livestock population by species and ecological zone in tropical Africa.

<table>
<thead>
<tr>
<th>Ecological zone</th>
<th>Cattle</th>
<th>Sheep</th>
<th>Goats</th>
<th>Livestock units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arid</td>
<td>31.5</td>
<td>37.1</td>
<td>48.3</td>
<td>41.7</td>
</tr>
<tr>
<td>Semi-arid</td>
<td>45.5</td>
<td>23.1</td>
<td>33.2</td>
<td>37.5</td>
</tr>
<tr>
<td>Subhumid</td>
<td>32.8</td>
<td>14.2</td>
<td>20.3</td>
<td>26.4</td>
</tr>
<tr>
<td>Humid</td>
<td>8.8</td>
<td>8.2</td>
<td>11.6</td>
<td>8.1</td>
</tr>
<tr>
<td>Highland</td>
<td>29.0</td>
<td>21.4</td>
<td>11.9</td>
<td>23.6</td>
</tr>
</tbody>
</table>

Mortality rates are usually high (25–40% per annum) and young stock are particularly at risk in the first 3 months post partum. Neonatal losses can be closely correlated with birth weight, which is itself a reflection of maternal nutrition during the last 2 months of gestation. The disease pattern varies from area to area and from season to season. At all times, animals that are undernourished are at high risk. Under-nutrition also lengthens kidding/lambing interval and decreases kidding/lambing percentage and growth rates, which, together with survival rate, are components of a productivity index:

Productivity index = KP x 365/KI x S x B W
Thus any strategy to increase the productivity of small ruminants must look closely at nutrition.

**Current situation**

Increases in food production in Africa are falling behind population growth and food shortages are becoming increasingly widespread. Ruminants have a distinct advantage over simple-stomached animals in being able to convert organic material unsuitable for human consumption into products of high nutritional value, while at the same time providing excellent fertilizer from undigested residues. Furthermore, in extensive farming systems, small ruminants, particularly goats, are complementary to cattle. Goats have catholic tastes and consume many more plant species than cattle. By preference, goats are browsers rather than grazers, while cattle are primarily grazers. Provided that an area is not overstocked, and in many areas of Africa that condition is unlikely to be fulfilled, goats and cattle together allow a higher carrying capacity than would be possible with either species alone.

The myth of the destructive goat should have been finally demolished by Staples et al (1942), who described the comparative effects of goats and cattle on fenced plots of semi-arid wooded grassland in central Tanzania. After 4 years of the trial, considerable modifications had been effected to the plots. Goats browsed all plants within reach, but did not browse any plant down to ground level, so that none were destroyed. Little bark damage was caused to trees, and young trees large enough to produce branches out of reach of the goats continued to grow. Thus a good ground cover was maintained at a stocking rate of approximately 1.4 LU/ha/year. In contrast, cattle at a slightly higher stocking density concentrated on the grasses and eventually produced open thicket with little ground cover. Carrying capacity was reduced and erosion accelerated. Environmental degradation was therefore more likely from cattle than from goats. It is realised, however, that when an area is overstocked with goats, as with any other livestock species, damage to vegetation will occur.

In areas of extensive farming where the soil is of low agricultural potential, animal productivity is also low. There is little competition for the land and extensive livestock systems are most appropriate to the conditions. In such areas, despite the fall in the nutritional value of maturing grasses, small ruminants are frequently better nourished than cattle because of their preference for browse (Zeeman et al, 1983; 1984). In East Africa, many browse species start to produce new growth before the onset of rains. This contributes to a rising plane of nutrition and is associated with a peak in conception rates (Walker, 1980; Reynolds, 1985). The flush of young grass that accompanies the early rains, although highly nutritious, does not result in the expected increase in production. A concurrent rise in levels of both internal and external parasites also occurs (Adeoye, 1985).

Forage availability during the dry season determines the overall carrying capacity of the land. On more fertile land the perceived needs of pastoralists and arable farmers clash. Throughout Africa population pressure is increasing; as a result former grazing areas are being used for arable farming, and the true pastoralist is restricted to a decreasing area. Although it may appear contradictory, this can be to the advantage of the pastoralist. In a symbiotic relationship, pastoralists can graze their animals on crop residues in the dry season and the settled farmers
benefit from the deposited manure. Putt et al. (1980) demonstrated that this can result in an increase in overall carrying capacity because the crop residues can support more animals than natural pasture during the critical dry period.

In areas of higher soil fertility and cropping intensity, local communities view wandering animals with disfavour and may demand that livestock be penned or tethered. Most localities, however, have areas unsuitable for cropping that can be set aside for communal grazing, but overstocking will be a hazard. Traditionally, livestock were herded by children, but with the spread of primary education, and in some places, compulsory school attendance, this source of free labour is decreasing and herders must be employed. One response to these combined pressures is stall or pen feeding, in which animals are not allowed out.

A continuum of management systems can be found between nomadic pastoralism and stall feeding. Where do small ruminants fit into these systems? In most parts of Africa, they are merely adjuncts to the farming system, although still important. It is only under special situations in moderate to high-rainfall areas, for example where tsetse flies combined with government directives exclude cattle, that small ruminants assume a dominant role. In such situations, infrastructural development is invariably poor. Farmers have difficulty marketing their animals because roads and transport to centres of population, and hence consumers, are lacking. Prices paid by itinerant buyers to farmers are low, and profits accrue to middlemen rather than to the farmers. At the other extreme, where demand for land is intense, there may be moves to exclude livestock completely.

**Scope for improvement**

Small ruminants are raised under a low-cost system, and farmers are less likely to buy feedstuffs or provide veterinary care for sheep and goats than for cattle. Interventions that call for expenditure are unlikely to be adopted widely, while those that are simple adaptations of existing systems could be more acceptable.

Productivity can be increased by two major routes with a degree of interdependency. The first involves improved health care, which reduces mortality. ILCA (1985) has shown that prophylactic health measures in southwest Nigeria allowed goat numbers to increase by 118% over a 2-year period, compared with a 24% increase in control villages. However, increasing flock size is a long-term recipe for disaster if insufficient forage is available. Are more animals needed or could higher productivity be achieved through better nutrition and health care while reducing the total population? If a reduction in numbers is to accompany health and nutrition interventions, this necessitates increased offtake and hence improved marketing arrangements.

Veterinary inputs for small ruminants are unlikely to be widely available in the foreseeable future. Any health intervention must be low-cost, and preferably within the resources of the farmers themselves. Can the management system be modified, bearing in mind the constraints imposed by the farming system as a whole, to limit the incidence of disease?

The second major route is through improved feeding. The type of nutritional intervention will depend on the overall farming system employed and on environmental conditions. Certain questions must be asked whatever the farming system. What can be found on the uncultivated land? What is available from crop residues? Is the farmer aware of the nutritional value of the potential feed resources? Will using that material as animal feed fit into the existing farming system? If not, what changes will be necessary?
It can be argued that extensive systems are the most difficult to assist given the necessity of minimal-cost interventions. The major feed resource in extensive systems is uncultivated browse and grasses. Goats in particular are able to select the most nutritious plants and parts of plants, obtaining a reasonably balanced diet throughout the year. It is rare to see extensively raised goats in poor condition unless carrying capacity is exceeded. Farmers may assist by lopping branches that would otherwise be out of the reach of livestock and by providing water to animals at night. This latter intervention is particularly beneficial to lactating females since 86% of milk is water. Shortage of water inhibits milk production (Little et al, 1976).

Bush improvement may be suitable for selected areas within cattle ranches, but is generally uneconomic for small farmers raising smallstock. Communal agreement to reserve an area for dry-season feeding can however be beneficial and has been successfully adopted in some areas. One such example is in west Mzimba, Malawi (Dwowela, 1980), where the reserved area was improved with *Stylosanthes guianensis* cv Cook.

A cost-effective approach is to check on mineral nutrition. Tissue and feed samples will show whether supplementation is necessary; if so, they can easily be incorporated into salt licks.

Use must be made of whatever crop residues are available. Crop residues left in the field will help to maintain soil structure through the provision of organic matter. Is it more beneficial to incorporate residues into the soil or to return manure from livestock as a byproduct of crop-residue feeding? The feeding value of a particular residue will be related to the overall feed situation. Where there is a shortage of forage, a residue of low nutritional value will assume a greater importance than when adequate feed is available. Under the latter conditions, quality rather than quantity becomes the major factor.

As human population density rises, the importance of crop-residue feeding increases relative to uncultivated forage. Livestock can have free access to arable fields after harvest in addition to whatever natural forage is available. Animals grazing maize stover always waste part of the feed by knocking it over. Contamination with soil, urine and faeces occurs, and the resultant mixture is unpalatable. A bimodal rainfall pattern limits access to first-season crop residues *in situ* because cultivation for the second crop closely follows the first harvest. Storage of first harvest maize is difficult in the absence of drying facilities, so it is often picked green. The remaining stems and leaves can be fed to animals. Farmers can carry forage to the animals each day during harvest, to feed in the pen at night. Any wastes can be composted to fertilize vegetable gardens or can be returned to the fields. Access to fields after the second harvest is less restricted and labour is more readily available for collection and transportation of residues to animal pens. In many areas, maintenance of soil fertility depends on the inclusion of fallow periods in the farming system. Regrowth during these periods can be made available to animals.

Alley farming—growing rows of leguminous trees such as *Leucaena leucocephala* and *Gliricidia sepium* with food crops between the rows—provides mulch and browse to the advantage of both crops (Table 2; Attah-Krah et al, 1986) and livestock (Table 3; Reynolds and Adeoye, 1985). The leguminous trees provide high-quality, cut-and-carry feed for confined animals. The trees are managed for maximum forage availability in the dry season. In addition, mulch nitrogen helps to maintain soil fertility (Kang et al, 1985) and reduces the need for a fallow period, so that a larger proportion of land can remain under cultivation. The resultant crop residues are important feed resources during the dry season.
Table 2. The effect of alley farming on the yield of maize cobs in southern Nigeria.

<table>
<thead>
<tr>
<th></th>
<th>Maize yield (t/ha)</th>
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<tbody>
<tr>
<td></td>
<td>1983 1st season</td>
</tr>
<tr>
<td>Continuous cropping (control)</td>
<td>2.19</td>
</tr>
<tr>
<td>Continuous alley Cropping</td>
<td>2.54 (1.16)</td>
</tr>
<tr>
<td>Alley grazing/cropping</td>
<td>–</td>
</tr>
<tr>
<td>Alley cropping/graazing</td>
<td>2.56 (1.16)</td>
</tr>
</tbody>
</table>

Values in parentheses indicate yields as proportions of control yields.

Table 3. The effects of supplementary leucaena and gliricidia, with ad libitum Panicum maximum, on the productivity of West African Dwarf sheep (means ± S.E.).

<table>
<thead>
<tr>
<th>Browse (g/day):</th>
<th>0</th>
<th>400</th>
<th>800</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parturition interval (days)</td>
<td>262</td>
<td>226</td>
<td>241</td>
</tr>
<tr>
<td>Litter size</td>
<td>1.26</td>
<td>1.19</td>
<td>1.17</td>
</tr>
<tr>
<td>Survival to 90 days</td>
<td>0.65</td>
<td>0.65</td>
<td>0.82</td>
</tr>
<tr>
<td>Birth weight (kg)</td>
<td>1.80</td>
<td>1.52</td>
<td>1.72</td>
</tr>
<tr>
<td>Daily liveweight gain to 90 days (g)</td>
<td>64.4</td>
<td>73.4</td>
<td>83.8</td>
</tr>
<tr>
<td>Productivity index</td>
<td>8.67</td>
<td>10.15</td>
<td>13.46</td>
</tr>
</tbody>
</table>

'Productivity index = kg lamb weaned/dam/year.

Household and small-scale food processing wastes such as maize bran and cassava peels may also be available. Maximum use must be made of these since they are energy sources and complement the high-protein browse. Less wastage of feed occurs in cut-and-carry systems, but the labour requirement is high.

In the Oume province of the Republic of Benin, where animals are confined and raised under a cut-and-carry system, forage is deliberately spread on the floor so that much of it becomes unpalatable. Food residues, mixed with urine and faeces, are composted in situ and the resultant fertilizer is highly valued. The animals are kept to provide fertilizer, with meat as the byproduct of the system (Attah-Krah, personal communication).

Where there is only a limited amount of supplements available, preferential feeding to animals in late pregnancy and lactation is advisable. This will ensure that animals under the greatest
nutritional stress will benefit. In intensive systems, the provision of extra rations prior to mating (steaming-up) has been demonstrated to increase litter size, particularly when breeding females are in poor to moderate body condition initially. Steaming-up would be difficult to implement in extensive systems with year-round breeding, but it could be used where animals are confined.

Within birth type classes there is a close inverse relationship between birth weight and mortality rate. Single offspring are heavier at birth than twins, which in turn are heavier than triplets. Neonatal deaths among offspring from multiple births are higher than among singles. Under-nutrition of the dam during the final 2 months of gestation, when foetal growth is greatest, will reduce birth weight. It is possible to select for twin-bearing females in order to increase the overall kidding percentage of the flock, but unless adequate nutrition is provided this may result in a higher mortality rate. Improvement of the genetic base must therefore be accompanied by good nutrition otherwise the additional potential, gained at such cost during selection over a number of years, cannot be realised.

Selection for increased growth rates to weaning is, in part at least, selection for higher milk production from the dam. Milk yield will depend on body condition, nutrient intake and number of offspring being suckled, as well as on genetic potential. When the CP level in grasses is low and lignin levels are high, as happens after flowering, digestibility is low. At this stage the provision of additional nitrogen, whether from browse or from urea, will increase rumen microbial growth rates and hence digestibility. This in turn will be matched by a higher feed intake because of faster passage of food through the gastrointestinal tract. Thus the nutrient intake of lactating females on poor-quality forage can be greatly increased by providing browse.

Milk production from small ruminants kept for meat has received little attention in Africa, and it may be useful to extrapolate from cattle data. Differences in response to supplementary feeding during lactation have been noticed between beef and dairy breeds. Incremental increases in the feed intake of dairy cows have most effect on total lactation milk production during the early lactation period, their effect declining thereafter (Broster et al, 1969). Hart et al (1975), in a matched-pair trial with beef and dairy cows, showed that beef cows gained weight but produced little milk, while dairy cows on the same level of feeding lost weight but had a high milk yield. Supplementary feeding at any stage of lactation to African small ruminants and to zebu cows produces a response comparable to that observed in temperate beef cattle. Genetic selection for high milk production has increased the importance of early lactation feeding, but in meat animals the timing of supplementation during lactation is less critical. Nevertheless, milk production is important, ensuring as it does a high pre-weaning growth rate. Zebu cows are sometimes expected to provide milk for humans as well as for the calf, often to the detriment of calf growth. Lambs and kids are less likely to be affected, since human consumption of sheep and goat milk is less widespread.

**Conclusion**

Small ruminant production by small farmers is at present a low-cost enterprise. Development agencies must take this fundamental point into account and look first for modifications of the existing farming systems before proposing drastic changes. Low-cost interventions might include provision of water in pens, maximum use of residues from small-scale food processing, household wastes and crop residues, and the reservation of areas of bush for dry-season use. The use of leguminous trees for browse should be considered.
References


