browse trees provide a flexible, easily managed fodder resource which appears to be particularly well suited to small-scale livestock production where more intensive technology is not applicable. Depending on the characteristics of the other farm enterprises, browse production might be integrated with cropping in a system such as alley farming, or browse trees might be grown in special feed production plots. ILCA is currently investigating the management and use of this kind of 'intensive feed garden' in eastern Nigeria where animal movement is commonly restricted, necessitating daily cut-and-carry feeding.

Alley farming addresses several important issues facing small farmers in the region, for whom fodder production is presently a minor farm concern. Alley farming, therefore, will be considered by these farmers for adaptation primarily as a crop production strategy, and only secondarily for its potential contribution to sheep and goat production. This realization should influence the way alley farming and browse feeding are portrayed by research and extension organizations. In our own on-farm research, for example, the browse trees are presented firstly for their considerable mulch and fertilizer value, and only secondly for their value as livestock feed.

Alley farming is an intensive production technique which has sufficient promise to be tested under a variety of conditions throughout the region. *Leucaena* and *Gliricidia* are the most widely used alley farming browse species, and although other potentially useful species are under investigation, ILCA's work will continue to focus on these two widely adapted, versatile species. It is hoped that our collection and evaluation of new *Gliricidia* germplasm will identify types that are more productive than the present materials, and better adapted to more arid environments (Sumberg, in press). In the coming years we will be interested in having these unique genetic resources evaluated under as wide a range of environmental and management conditions as possible.

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Small ruminant production under pressure: the example of goats in southeast Nigeria

S.D. MACK, J.E. SUMBERG and C. OKALI

Introduction

Goat husbandry in the humid zone of Nigeria is a low-input, minor farm enterprise offering potentially good but highly variable returns. The majority of rural owners are farmers involved in food and tree crop production, or women involved in food processing and marketing. Both groups of owners have relatively limited skills in livestock husbandry.

The traditional practice of permitting goats to roam freely around the village still predominates in southwest Nigeria (Matthewman, 1979). Specialized housing, systematic feeding and veterinary care are uncommon in this region. Goats depend on their ability to select an adequate diet from the naturally available vegetation. Household scraps are often available, but are probably of limited nutritional significance. The majority of goats appear to be in good condition. The mean weights of dams at 90 days post partum show no evidence of seasonality, which may indicate that they are able to obtain an adequate diet even during the dry season. However, growth rates of kids are low at 35 g/day, and the probability of kids surviving to 90 days is only 0.67 (Mack, 1983). The low levels of both of these parameters might be seen as indirect indications of nutritional stress.

The West African Dwarf goat is both fertile and prolific. Data from villages in southwest Nigeria indicate a mean litter size of 1.5 kids/litter and a mean parturition interval of 259 days (Mack, 1983). The traditional free-roaming system of management takes advantage of this reproductive potential through continuous and uncontrolled breeding. However,

early conception in immature females is a potential disadvantage of this strategy, and may contribute to high kid mortality.

In southeast Nigeria, traditional goat husbandry systems are being modified by high human population density and increasing pressure on agricultural land. Lagemann (1977) noted that both goats and sheep may be restricted, either in small stockades or by tethering, to protect crops during the growing season. He further noted that with increasing population pressure compound gardens become smaller and more intensively managed, while the number of goats kept per household increases. In such areas, it would appear that free-roaming animals pose an increasingly important threat of damage to growing crops. This would seem to explain the relatively recent introduction of local laws banning free-roaming animals in ILCA's two village sites in the southeast.

The consequences of such mandated restrictions on animal movement, are unclear, yet they surely demand major changes in goat management strategies. Housing, feed, water and breeding strategy become critical once animal movement is restricted. Restricted animals require a higher level of input and management than free-roaming animals, and in no area is this more clear than in the need for daily feeding.

This paper presents a preliminary analysis of some biological parameters of free-roaming and recently restricted animals. The objectives of this work are not so much to compare animal productivity under the two management systems as to describe the animals' and farmers' responses to forced changes in traditional livestock husbandry practices.

Materials and methods

Data for free-roaming goats have been extracted from a larger data set gathered from villages near Fasola, 60 km north of Ibadan in southwest Nigeria. Mgbakwu village in Anambra State and Okwe village in Imo State, southeast Nigeria, are used to assess the impact of restricted animal movement on management and productivity. Animal monitoring was initiated in August 1982 and February 1983 at Mgbakwu and Okwe respectively.

All animals entering the survey were identified by ear tags. Information on age, sex, dam and parity was collected for all animals entering the survey. Reasons for entry and exit were also recorded. All animals were weighed monthly. Some characteristics of the three survey areas are presented in Table 1.

Table 1. ***Some characteristics of three village survey sites.***

Location	Management	Number of households	Number of animals	Animals/ household	Breeding males: females
Fasola	free-roaming	15	68	4.5	1:4
Mgbakwu	restricted (tethered/confined)	105	284	2.7	1:2.6
Okwe	restricted (confined)	65	234	3.6	1:3.8

Results and discussion

Due to the relatively short monitoring periods at the two southeastern sites, only a preliminary analysis of animal performance is possible. In none of the locations are the data sufficient to construct a comprehensive productivity index; as an alternative, the various components which would normally be used to compile an index are presented.

Flock dynamics

The structure of the goat populations in each location at the beginning and end of the survey periods is given in Table 2. While the total number of goats in the free-roaming flocks at Fasola increased by 59%, goat populations decreased by 2 and 18% at Okwe and Mgbakwu respectively. In Mgbakwu 65% of households had smaller flocks at the end of the survey period than at the beginning, 14% abandoned goat keeping and 4% lost all their animals due to high mortality. In the village with free-roaming animals only 24% of households had smaller flocks at the end of the period, while none abandoned goat keeping or lost all their animals.

The ratios of males to females were similar at all locations and averaged 1:1.7. The ratio of breeding males (^{3} 6 months) to breeding females (^{3} 18 months) ranged from 1:2.6 in Mgbakwu to 1:4 in Fasola.

Table 2. ***Goat populations at three survey sites.***

Location	Date	Total goats	All females	Breeding females	All males	Breeding males
Fasola	30-4-82	68	57	29	11	2
	31-8-83	108	68	37	40	14
Mgbakwu	31-8-82	284	200	111	84	39
	31-8-83	234	166	100	68	41
Okwe	31-3-83	238	177	106	61	30
	31-8-83	235	172	114	63	28

Reproductive performance

Reproductive performance of does at the three locations is summarized in Table 3. The limited number of parturitions involved to date makes comparisons between sites or management systems difficult. In any case, as has been well illustrated by Upton (1985), changes in mortality (survival) of offspring have a far greater effect on productivity and potential profitability than changes in reproductive performance.

Table 3. ***Reproductive performance of goats at three locations.***

Location	Number of parturitions	Litter size[1] (kids/litter)	Parturition interval (days)	Kids/doe year[2]	% of breeding does kidding per month
Fasola	41	1.7a	271 (± 89)	2.3	8.1
Mgbakwu	109	1.5b	263 (± 42)	2.0	8.5
Okwe	57	1.3c	-	-	8.8

[1] Means within columns followed by the same letter are not significantly different at P = 0.05.

[2] $$\text{Kids / doe / year} = \frac{\text{mean litter size} \times 365}{\text{mean parturition interval}}$$

Growth

Estimated least square means for kid weights at 30 and 90 days, and growth rate between 30 and 90 days, are given in Table 4. Kids from free-roaming does at the Fasola site were significantly heavier at both 30 and 90 days than kids from restricted does at the southeastern sites. Since there was no difference in growth rates between the sites, these differences in kid weight can be assumed to be related to lighter birth weights at the southeastern sites.

Table 4. ***Estimated least square means for weights of 30- and 90-day kids and daily liveweight gains between 30 and 90 days.***

Location	Management system	Kid weight (kg) at:		Growth rate (g/day);
		30 days	90 days	30-90 days
Fasola	free-roaming	3.5a	5.7a	36.6a
Mgbakwu	restricted	2.5b	4.7b	36.6a
Okwe	restricted	2.4b	4.4b	33.3a

Means within columns followed by the same letter are not significantly different at P = 0.05.

The average body weight of free-roaming does at Fasola was 21% greater than that of restricted does in the southeast. Whether due to nutritional or genotypic causes, the difference in doe body weight probably accounts for the heavier kids at the Fasola site. The similar growth rates of kids at all sites might argue against significant nutritional effects, since nutritional stress strong enough to affect dam body weight would almost certainly affect milk output, and consequently kid growth.

Mortality

Mortality of free-roaming goats at Fasola (2.7% per month) was significantly lower than mortality at either Mgbakwu (4.5% per month) or Okwe (4.7% per month) (Table 5). Mortalities for each month of the survey period are depicted in Figure 1. Among free-roaming animals at Fasola, mortalities appeared more sporadic than at the southeastern sites. There was one confirmed outbreak of the disease *peste des petits ruminants* (PPR) at Fasola in September 1982.

Table 5. ***Mortalities at three locations.***

Location	Management	Average monthly mortality (%)	Aver. kid mortality from 0-90 days (%)
Fasola	free-roaming	2.6 ± 4.4	11.1
Mgbakwu	restricted	4.4 ± 1.8	24.8
Okwe	restricted	4.2 ± 2.5	18.6

Figure 1. Monthly mortality of goats at three locations in Nigeria.

Initial health and disease surveys in Mgbakwu and Okwe have been inconclusive, and the major causes of the high mortalities remain unknown. In southwest Nigeria vaccination against PPR reduced mortalities by approximately 75% (Adeoye, 1984; Opasina, 1984). Although PPR is said to be widespread in the southeast, and is identified by owners as a cause of mortality, there have been few confirmed cases of PPR at the two village sites. More intensive disease monitoring has been initiated at these sites in order to identify the causes of high mortality.

While 67% of all households at Fasola experienced some goat mortality during the survey period, most of these houses lost less than 15% of their animals, and none lost more than 50%. At Okwe, mortality occurred in only 43% of households, but a number of these lost over 30% of their animals, and 5% lost all their animals. Mortality was more widespread in households at Mgbakwu, with 80% experiencing some mortality. As at Okwe, many households lost over 30% of their animals, and 4% lost all their animals.

Differences in mortality between households may be indicative of important management variations between households, or may be the effect of some epidemiological characteristics of the primary diseases causing death. In the two southeastern villages where animal movement is restricted, differences in management of individual flocks are apparent in housing, feed quantity and quality, water availability and general concern for the animals' well-being. Without a clear understanding of the causes of morbidity and mortality at these sites, the importance of such management factors is difficult to assess.

Breeding strategies

Few decisions directly related to breeding strategy appear to be made when animal movement is unrestricted. Breeding is uncontrolled and depends on the presence of mature males in the free-roaming village flock. As young males are the principle disposable product of this production system, both sales and mortality can have important implications for the village-wide breeding situation. At Fasola, for example, the ratio of breeding males to breeding females varied from 1:15 at the beginning of the survey, with 2 breeding males in the village, to 1:3 at the end, with 14 breeding males available. Periods when no breeding males were present in village flocks have also been documented in southwestern Nigeria. The effects of these changes in the availability of breeding males on reproductive characteristics such as parturition interval are not yet known.

Breeding management takes on greater importance once animal movement is restricted. At Mgbakwu and Okwe the

major breeding options involve keeping a resident male or borrowing/ renting a breeding male when required. At Mgbakwu there is a small number of free-roaming males associated with a local religious shrine. These bucks are relied upon by some goat owners who make receptive does accessible to them. In the two villages studied, approximately 50% of households do not keep a breeding male; the vast majority of the flocks in these villages are single-animal flocks.

Concern over transfer of disease has been cited at both southeastern villages in relation to hesitation to either borrow or lend males for breeding. Both borrowing and renting of males are common, however, with males apparently being transferred for short periods of 2 to 5 days. Although cash payment for breeding services has been reported, some borrowers report that the service of feeding the buck for the borrowed period is considered sufficient payment. This situation illustrates the perceived burden of cut-and-carry feeding at these sites.

The free-roaming management system in southwest Nigeria can be described as a low-level, equilibrium system offering potentially good returns with a minimum of capital, labour or management inputs. Returns from this system are highly variable, however, since the disease PPR can cause significant loss of stock and has been known to destroy whole flocks. The risk of PPR is thought to limit animal populations by discouraging flock expansion.

PPR can be effectively and economically controlled by annual vaccination with tissue culture rinderpest vaccine (TCRV). While the effects of PPR control on the various components of the free-roaming management system are not known, it seems likely that increased numbers, resulting directly from reduced mortality and indirectly from a reduction in perceived risk, will put significant pressure on available feed resources. Once a form of feed production is introduced, it is not unlikely that some level of restriction of animal movement will follow. PPR will probably cause major shifts in goat management in the region. Some of these changes will be similar to those observed in southeastern Nigeria, where animal movement is being restricted by law.

At the two village sites in southeast Nigeria, both the production environment and the management systems are in dynamic states. Relatively recent legislation mandating restriction of animal movement has forced owners either to confine or tether their animals. These restrictions on animal movement have created the need for immediate changes in housing, feeding and breeding strategies.

The extremely high mortality observed at these sites, averaging over 50% per year, clearly indicates that there are major outstanding issues in the production system which have not yet been addressed successfully. Mortality does not appear uniformly in all flocks, indicating that there may be some important management considerations which are not fully appreciated. Great differences in housing and feeding strategies certainly exist, but the importance of these cannot be assessed until the major causes of mortality are identified.

There can be little doubt that if the current level of mortality continues, more households will be forced to abandon goat keeping altogether. Other owners, unwilling to invest the additional labour required by cut-and-carry feeding, will choose to participate in different economic activities. While both of these situations have been observed in the southeastern villages, it is also evident that some owners willingly invest the additional time and labour in goat keeping, and are, in fact, expanding their flocks.

It is evident that restriction of animal movement is a common and important aspect of the small ruminant production environment in southeast Nigeria. A recent survey of 26 Local Government Areas (LGAs) in four southeastern states indicates that restriction of animal movement is encountered where open, derived savanna vegetation predominates, but is less common in heavily forested areas (Table 6). In 15 LGAs in Anambra and Imo States, for example, 86% of households restricted movement of their animals either during the whole year or at least during the cropping season. In contrast, only 16% of households in Rivers and Bendel States restricted animal movement at any time in the year.

It would appear from these data that restriction of animal movement is directly related to the intensity of agricultural land use. Small ruminants can cause serious damage to growing crops, particularly in areas characterized by open vegetation. Restriction of animal movement can then be seen as a forced response to changes in larger farming and land-use patterns. As is typical of minor farm enterprises in general, and of particular livestock enterprises, the character of the goat production system is determined largely by outside forces. In other words, goat production cannot be usefully discussed in terms of 'optimization' and 'maximization', but rather in terms of its complementarity - lending some measure of additional stability to the overall farming system.

Table 6. ***Prevalence of restriction of goat movement in four southeastern states, Nigeria.***

	% of households in:			
	Anambra	**Imo**	**Rivers**	**Bendel**
Restricted year-round	65	48	11	9
Restricted, farming season only	27	42	0	12
Free-roaming	8	20	89	79
Number of LGAs	6	9	5	5
Number of households	239	321	244	236
% households without goats	7	7	15	5

It seems likely, nonetheless, that goat production will evolve from a low-input, minor farm enterprise to a more intensive and specialized enterprise. Thus, successful management will be within the reach of a more limited number of persons. This may be particularly true as specialized food production systems are introduced. There is also a strong interest in the introduction and use of exotic breeding stock in the southeast, and this kind of activity might further stimulate specialization.

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