ADAPTATION AND INTEGRATION OF SMALL RUMINANTS IN AFRICAN SYSTEMS OF PRODUCTION

UTILIZATON OF RESOURCES

Any degree of utilization of the natural vegetation involves modifications to its composition. Such modifications are often referred to as degradation. Where such degradation occurs there is often a gradual change in the combination of domestic ruminant species in favour of small ruminants and in particular the goat. This is one of the. main reasons why goats are blamed for desertification. Small ruminants compete with other domestic species for the resources available. They are however complementary to other species with regard to forage resources consumed and the height at which the forage is found. For this reason higher total biomasses of domestic livestock can be maintained, resulting in higher incomes from livestock production for owners. The production of more than one species of domestic animal enables maximum utilization to be made of grass and browse cover across and within years. An illustration of the complementarity of the two major feed strata in the Sahel zone is given in Figure 9. The browse layer, such as *Boscia Senegalensis,* is consumed by goats (87 per cent of feeding time being spent on the browse layer) and camels, whilst sheep (59 per cent of grazing time) and cattle graze on the annual grass *Schoenefeldia gracilis.* In this system in the southern Sahel, crop residues supplement the total forage resources and cattle spend 43 per cent of their annual grazing time on stubbles, with goats and sheep spending1 per cent and 2 per cent of their time respectively. Crop residues are available from January onwards, during the dry season, when the quantity and quality of natural feed resources are mediocre.

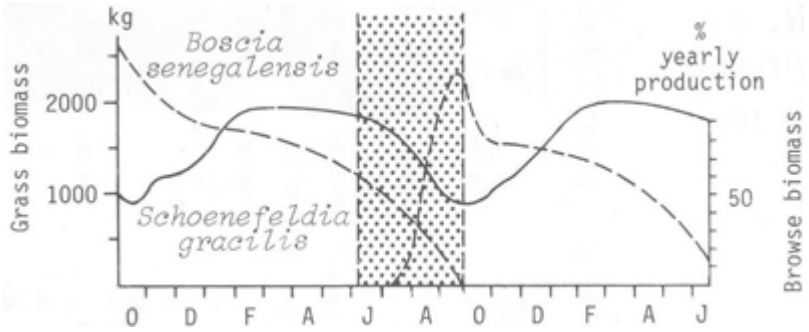

Figure 9 Complementarity of biomass production curves in fodder species in the browse and field layers

Table 11 Contribution of different fodder sourees (per cent) to the diet of domestic herbivores in Kenya

Species	Field layer	Dwarf shrubs	Browse layer
Camels	3	56	34
Cattle	96	4	0
Goats	38	21	18
Sheep	58	25	2
Donkeys	71	22	0

Recent surveys carried out in kenya further demonstrate the complementarity of domestic species with regard to the utilization of forage resources. The time spent by each of five categories of livestock on three elements of the rangeland resource are given in Table 11 (Schwartz & Said, 1986). Data provided by a related survey (Figure 10) indicate the feeding height of camels, goats and sheep.

A mixture of species on semi-arid rangelands, for example, makes it possible to reduce the stocking rate of 26 hectares per tropical livestock unit (a TLU is equivalent to 250 kilograms live weight) for cattle alone to 13 hectares per TLU when cattle and goats are reared together and to 10 hectares per TLU when camels are included (Schwartz, 1983). In order to maintain these stocking rates, the ratio of one species to the other in terms of TLU should be 1.0:1.0:0.3.

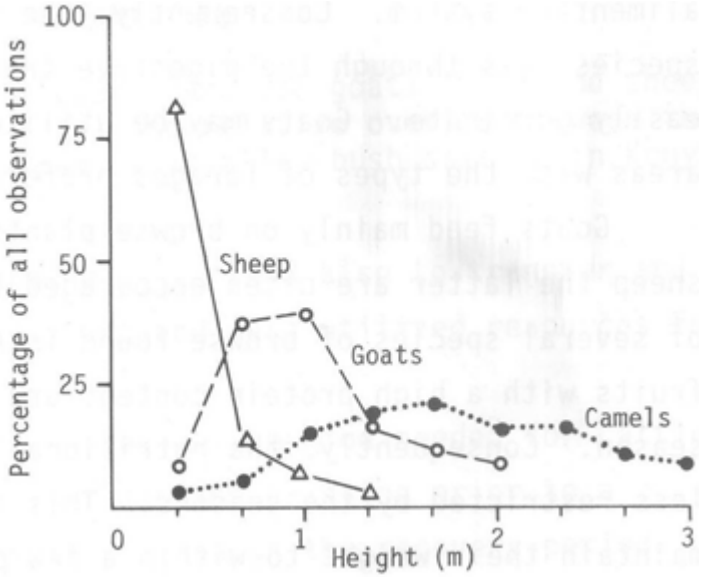

Figure 10 Feeding times at different heights above ground level by three domestic ruminant species

Goats walk long distances in search of food and feed on a wider range of vegetation types than do other domestic animals living in the same environment (Table 11). Even when they graze at the same height as sheep and cattle, the overlap of species eaten is not very great (Figure 11 and Figure 12). When feeding, goats nibble rather than bite due to the anatomy of their muzzles and jaws. They are selective feeders, eating mainly leaves, flowers and fruits as opposed to stems and other permanent parts of plants. For this reason they cause little damage to the plant structure unless the vegetative biomass is already greatly reduced. Goats ruminate less effectively than sheep or cattle and food passes faster through their alimentary system. Consequently, the seeds of their preferred plant species pass through the digestive tract more or less intact and can easily germinate. Goats may be utilized in this way to seed denuded areas with the types of forages preferred.

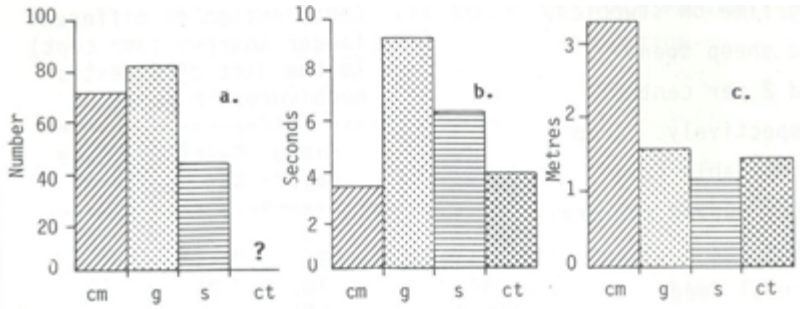

Figure 11 Feeding behaviour of four domestic animal species in Kenya in relation to: a. number of species in diet; b. time spent at each feeding station; and c. feeding height

Goats feed mainly on browse plants and when herded together with sheep the latter are often encouraged to do likewise. The phenology of several species of browse found in Africa is such that leaves and fruits with a high protein content are available during the dry season. Consequently, the nutritional needs of small ruminants are less restricted by the seasons. This is reflected in their ability to maintain their weight to within a few per cent of their annual average as compared to cattle (Figure 13). Seasonality of breeding is also less marked than for cattle, this probably also being related to nutritional status.

In zones in which agriculture is an important part of the system, the feeding habits of goats are an additional advantage. They spend less than 30 per cent of the time spent by sheep and only 5 per cent of the time spent by cattle feeding off crop residues (Table 12; Wilson, de Leeuw & de Haan, 1983). This therefore enables cattle to benefit directly from the farming system and also to transfer and convert, through their manure, distant and less utilized resources for the benefit of man.

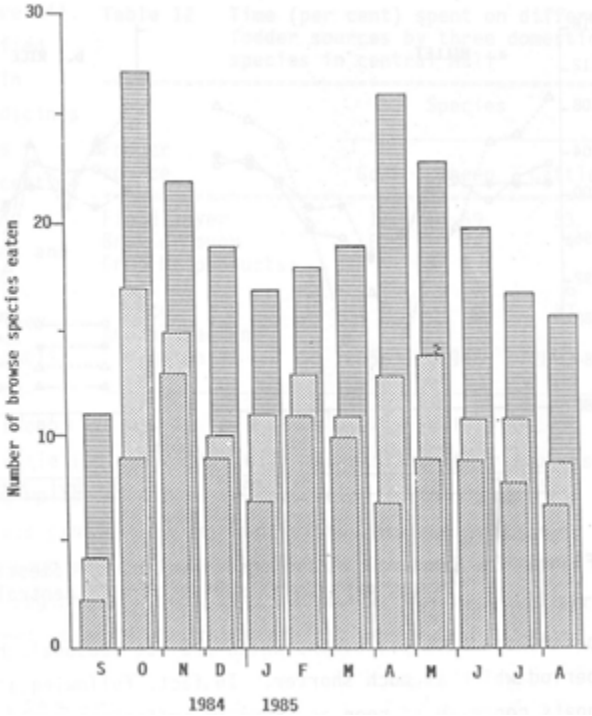

Figure 12 Dietary range of goats (?) and sheep (?) and relative overlap between the species in a low-bush savanna in Kenya

It has been estimated that the recovery period needed for cattle to attain the number and level of production existing prior to a drought could be as long as 40 years (although the recovery period following the notorious 1968-1973 drought in the Sahel was less than 10 years in most cases). Small ruminants, due to their lower mortality rate, their shorter gestation period, reduced generation period and multiple births which are not seasonal, have a recovery period which is much shorter. In fact, following a severe drought, goats conceive as soon as there is sufficient humidity for the growth of leaves on browse plants, kid five months later, and consequently produce milk for human consumption at a very early phase of the recovery cycle. In numerous instances, they are a source of food before cereals are ripe for harvesting.

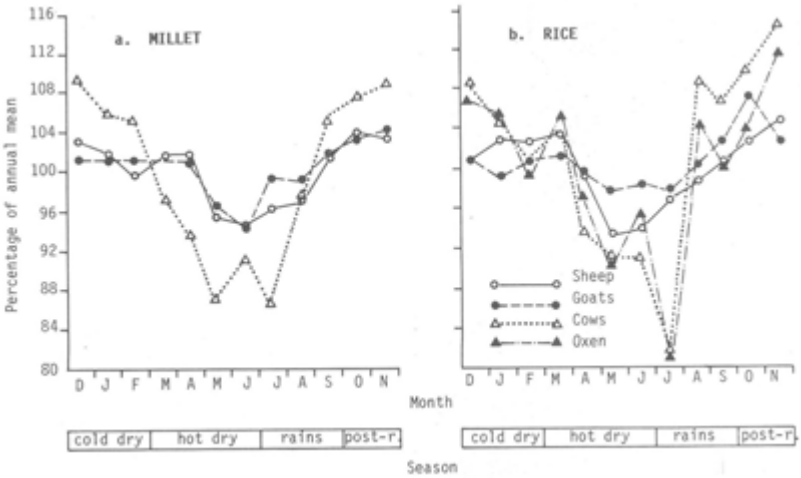

Figure 13 Seasonal variations in weight of domestic ruminants in two agro-pastoral sub-systems in central Mali

CONTRIBUTION TO MAN'S WELL BEING

Small ruminants are not only advantageous to man during periods of cyclical and unpredictable food shortages. They are also adapted to balancing the energy and protein supply during normal variations occurring over the years as well as between different seasons.

In Mali, goats provide about half the total quantity of meat sold to consumers living in the towns, the greater part of this being available towards the end of the dry season when there is little beef on the market (Figure 14). In Kenya in a modified traditional system in which veterinary medicines were provided, goats contributed 18 per cent of the minimum calorific requirements (in meat and milk combined) of the human population. They were surpassed by camels (27 per cent) but contributed more than sheep(12 per cent) and cattle (16 per cent), with cereals and other sources (27 per cent) making up the remainder of the diet. In this same Rendille system, goats provided 33 per cent of the minimum protein requirements even though protein availability was in excess of that required. In other regions of Kenya, goats accounted for about 75 per cent of the total meat consumption in pastoralist households (Figure 15 ; Schwartz, 1985).

Table 12 Time (per cent) spent on different fodder sources by three domestic species in central Mali

Fodder source	Species		
	Goat	Sheep	Cattle
Field layer	11	59	53
Browse cover	87	34	4
Crop by-products:			
millet	2	7	6
rice	0	0	37
Annual feeding time (hr)	2051	1948	2883

Small ruminants produce lower absolute quantities of milk than do cattle. Taking into account body weight or metabolic weight, however, their milk yield is higher than other species, with perhaps the exception of the camel. These minor supplies are, when all else fail, available during the most difficult periods of the year as is shown in Figure 16 for the Sudan and Table 13 (Coppock et al, 1982) for Kenya.

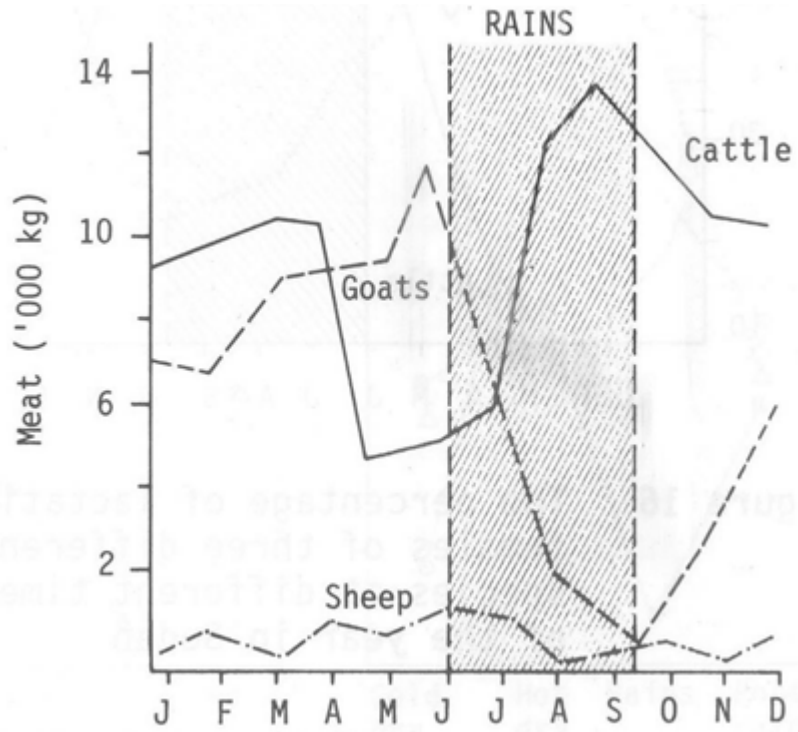

Figure 14 Contribution of domestic ruminant species to the meat supply of a central Mali town

At the beginning of the 1970s, the publicity given to the drought in the Sahel focused international attention on the fragility of the food supply system in Africa. The droughts of the early 1980s, which mainly affected Ethiopia but which also affected the Sahel as well as Sudan, have again resulted in famine situations. During both periods, 80 per cent or more of cattle were lost, according to reports, while small ruminant losses did not exceed 50 per cent.

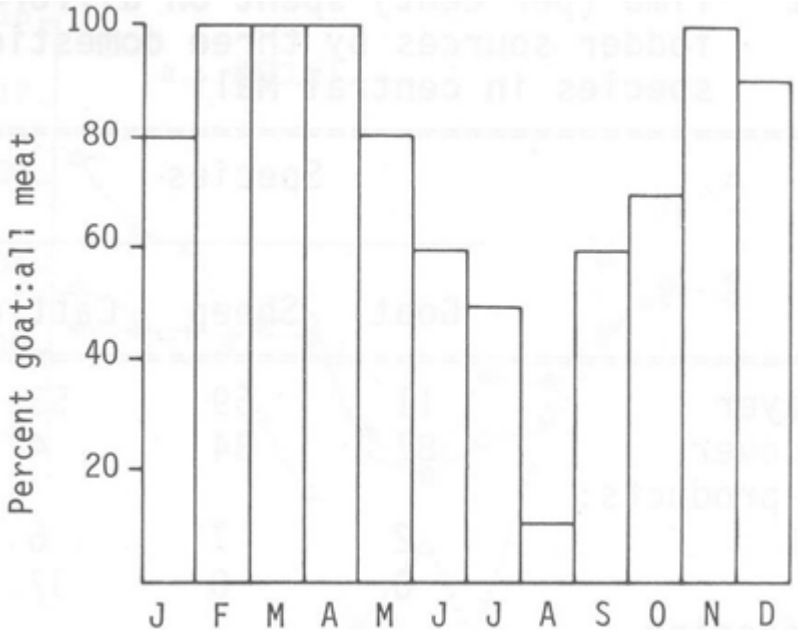

Figure 15 Proportion of goat meat to all meat eaten in 60 Kenya pastoral households

The products obtained from an animal may be expressed as a productivity index. Some generally accepted indices are the live weight of young produced by a breeding female per year, per kg of breeding female per year and per kg metabolic weight of breeding female per year. Some calculated productivity indices are given in Table 14 for Mali for four species of domestic ruminants. These figures, collected over a six year period between 1978 and 1983, clearly demonstrate the relative effectiveness of the short term utilization of each of these species in this environment. The annual and seasonal responses are different for each species, however, and in general seem to complement each other (Figure 17, Table 15). It is evident that fluctuation in productivity is considerably reduced when the livestock holding consists of several rather than of a single species.

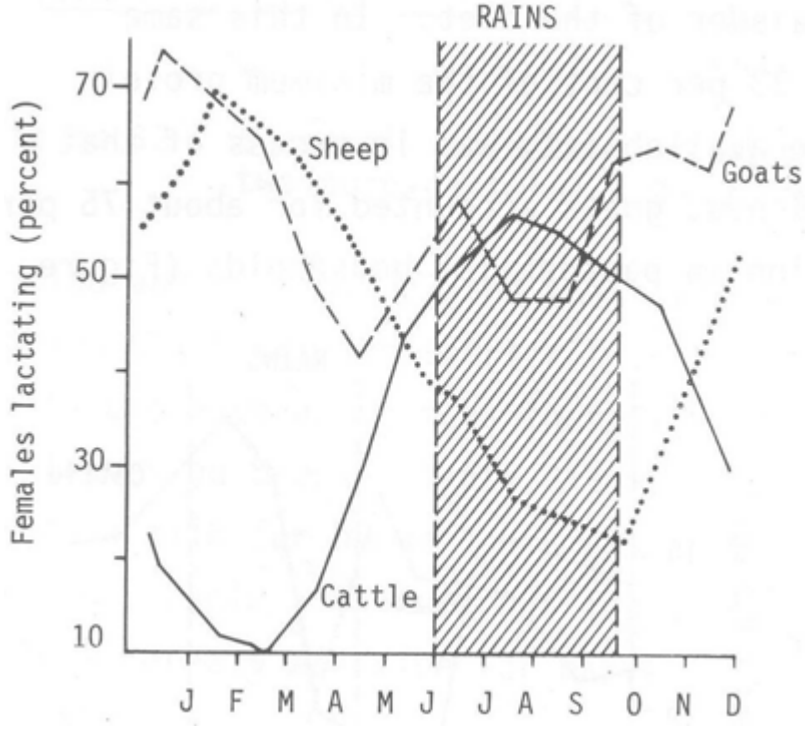

Figure 16 The percentage of lactating females of three different species at different times of the year in Sudan

Table 13 Seasonal contribution to human milk supply (per cent) by different livestock species in Turkana, northern Kenya

Species	Wet season	Dry season
Camels	45	70
Cattle	12	10
Goats + Sheep	43	20

The major advantages of including small ruminants in mixed species guilds are evident during a prolonged period of drought. The two species of small ruminants appear to withstand drought better than cattle although there exist regional and breed variations with regard to the ability of sheep and goats to do so. Table 16 (Campbell, 1978) provides the figures for cattle, sheep and goats in the region inhabited by the Masai in Kenya following the drought of the mid 1970s. Although the Masai are generally considered to

be cattle breeders, the importance of goats and sheep is clearly emphasized by the number of people who keep them. The resumption of breeding by these two species following a drought guarantees food in the form of milk even before cereals can be harvested. In more general terms, the role of goats and sheep as a continuous source of protein during and immediately following a period of drought is demonstrated in Table 17. The overall demand for meat in four West African countries remained constant throughout the drought period but the relative and overall contribution of goats and sheep increased.

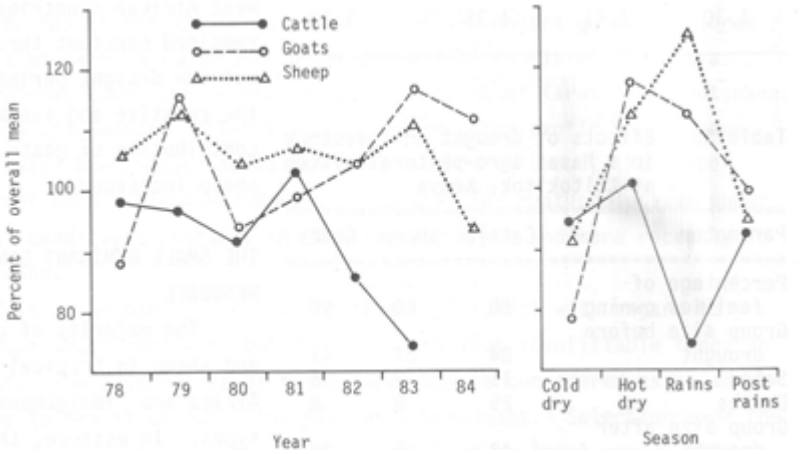

Figure 17 Comparative annual and seasonal productivity indices for cattle, goats and sheep in central Mali

Table 14 Productivity indices for different livestock species in Mali

Species	Annual index		
	per breeding female	per kg of breeding female	per $kg^{0.73}$ of breeding female
Goats	18.7	565	1.47
Sheep	29.5	888	2.31
Cattle	41.2	173	0.76
Camels	43.6	125	0.61

Table 15 Ratios of variation (maximum: minimum) of productivity indices for three domestic species in Mali

Cattle	Goats	Sheep	Overall
Year (1978-1983)			
1.29	1.54	1.14	1.16
Season			
1.30	1.41	1.35	1.13

Table 16 Effects of drought on livestock in a Masai agro-pastoral system at Loitokitok, Kenya

Parameter	Cattle	Sheep	Goats
Percentage of families owning	60	80	90
Group size before drought	84	27	41
sales	11	2	5
Deaths	25	9	8
Group size after drought	48	16	28
Per cent of animals after drought	57	59	68

The majority of goats and sheep in tropical Africa are "indigenous" types. In essence, this means that they have been naturalized for several thousands of years, although both species were originally domesticated in Asia (Epstein, 1971).

Table 17 Contribution of sheep and goats ('000 head) to recorded slaughter in four Sahel countries before and after a drought (per cent of total TLUs)

Country	1973			1976		
	Sheep	Goats	Sheep and Goats	Sheep	Goats	Sheep and Goats
Mauritania	21	4	16	10	3	23
Mali	80	23	22	90	38	30
Niger	62	79	56	33	89	73
Chad	56	10	15	55	13	19
Total	219	116	35	188	143	43

Recent importations -- in the last 150 years -- of specialized types of small ruminants have been mainly for modern commercial operations. The Republic of South Africa has been foremost in this movement but there are large populations of Merino sheep in Kenya and Zimbabwe and of Karakul sheep in Namibia. Merinos are also important in Lesotho in the small-scale sector, as are Angora goats. Angoras are also gaining importance under commercial conditions in Kenya. Elsewhere, there are relatively small numbers of Karakuls in Botswana, Angola and Rwanda. Attempts to introduce other exotic breeds have generally been unsuccessful but a new composite breed, the Dorper (Dorset Horn x Blackhead Persian), is used for meat production under local conditions, notably in Zimbabwe and Kenya and more recently in Botswana.

It is probably incorrect to talk of "breeds" with regard to African small ruminants but it is evident that identifiable types do exist. The development of these types may be considered as an adaptation to the stresses of the African environment. Selection over the centuries has been on their ability to adapt to local ecological conditions and to meet the production requirements of their owners.

Until recently, blood grouping and chromosome mapping have been little studied but increased interest is currently being shown in this field and it is certain that in the near future some light will be thrown on the relationships between one type of sheep and another.

Figure 18 A castrated West African Long-legged goat in Burkina Faso

Goats

Indigenous goats have been classified into two main groups, the long-eared and short-eared (Mason & Maule, 1960). This is not a particularly useful system and a more appropriate one ascribes goats to large, small and dwarf types (Devendra & Burns, 1983). Large types, which may also have disproportionately long legs (Figure 18) are found along the southern fringe of the Sahara and also in southern Africa; the small types are mainly distributed in eastern Africa; and the dwarf types, which are also to some extent tolerant of trypanosomiasis, are found mainly in humid West Africa (Figure 19). Dwarf types are usually more prolific than the small and large types.

The normal regional distribution and major production aptitudes of some goat types are shown in Table 18. Variation in the productive efficiency of goats is due not only to animal type but also to the environment and management.

Other than meat, skins and milk are the two major products of goat production. Constant attempts have been made to improve indigenous goats by outcrossing to non-African breeds for the production of milk, meat or fibre. These have in general failed except in cases where artificial conditions have been created for the purely exotic types and the progeny of the crossbreeding. Possibilities for improving milk or meat production exist by the utilization of some indigenous breeds such as the Boran or Galla of northern Kenya or the Boer of southern Africa.

Figure 19 Distribution of major goat types in tropical Africa

Table 18 Areas of distribution and production aptitudes of some African goat types

Type	Country:Zone	Production
Sudan Desert/Sahel	Senegal-Sudan: arid, semi-arid	Meat, milk
Maradi/Red Sokoto	Niger/Nigeria: southern semi-arid	Skins, milk and meat
Nubian	Sudan: riverain, urban	Milk
Afar	Ethiopia: arid, semi-arid	Milk
Small East African	Kenya: highlands	Milk, meat
Mubende	Uganda: highlands	Skins, meat
Boer, Boran	Kenya: highlands	Meat, crossing
Angora	Lesotho, Kenya: mountains, highlands	Mohair

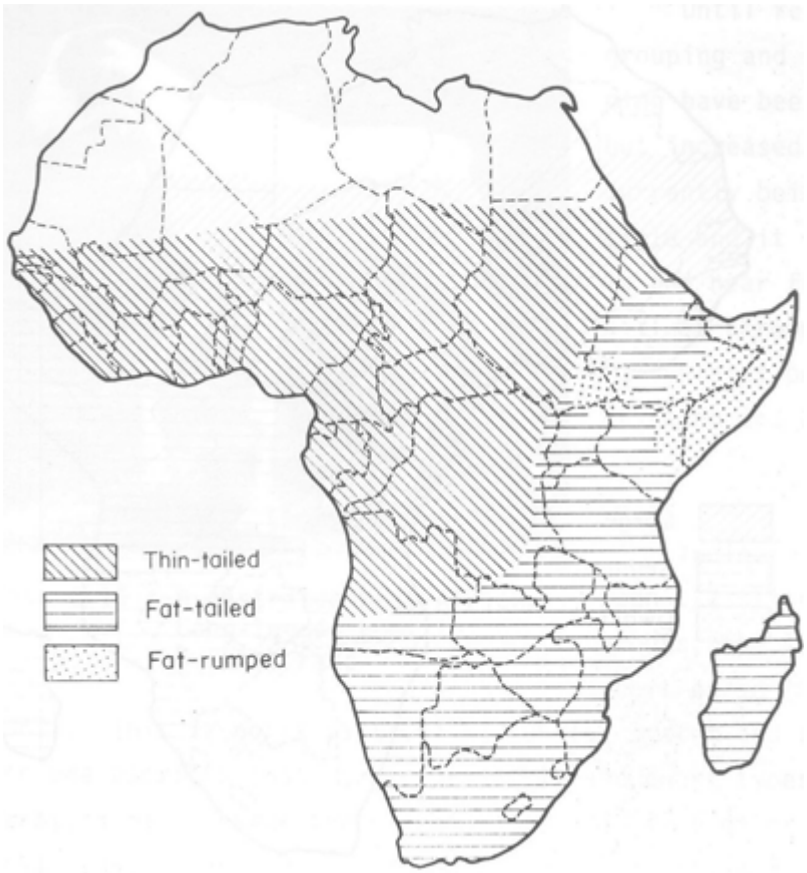

Figure 20 Distribution of major sheep types in tropical Africa

Table 19 Areas of distribution and production aptitudes of some African sheep types

Type	Country:Zone	Production
Black Maure/Zhagawa	Mauritania-Sudan: arid	Meat, hair
Sudan Desert	Sudan: desert fringe	Meat, milk
Sahel	Senegal-Chad: semi-arid	Meat, (skins)
Macina	Mali: inundation zone	Wool, meat
Afar	Ethiopia: semi-arid	Milk, (meat)
Masai	Kenya: semi-arid highlands	Fat meat (skins)
Djalionké	West Africa: sub-humid, humid (trypanotolerant)	Meat
Sahel x Forest/Nilotic	Mali/West Africa:	Meat-supplemented
	semi-arid, sub-humid	
Blackhead Persian	Kenya: semi-arid	Meat, crossing
Karakul	Botswana: arid	Pelts

Sheep

African sheep are usually described as thin-tailed, fat-tailed or fat-rumped (Mason & Maule, 1960) and thin-tailed are sometimes further segregated into hairy or woolled types (Epstein, 1971). Thin-tailed sheep are

commonest in the northern dry tropics where they are usually of large size or in the western humid areas where they are smaller and often referred to as dwarf or forest sheep. Fat-tailed types predominate in eastern Africa as far south as Mozambique. Fat-rumped types are commonest in traditional systems in north-east Africa, but have spread in commercial systems to Zimbabwe and other countries of the southern region (Figure 20).

The major production aptitudes of African sheep and the general type of environment in which they are found are given in Table 19.

There appears to be little reason at present in Africa to attempt an improvement of sheep by utilizing non-African breeds. In areas of favourable climate, however, as in the East African highlands and Zimbabwe, such an improvement may be justified. An example is the crossing of the Dorset Horn with the fat-rumped Blackhead Persian in order to increase the prolificacy and the growth rate of the latter. Under ideal climatic or management conditions, a direct introduction of exotic sheep could be considered.