Small Ruminant Production in Western Nigeria.

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EXPLANATORY NOTE

The present paper formed part of a report presented by the Small Ruminant Programme of the International Livestock Centre for Africa (ILCA) in 1981. Although the results reported refer mainly to southwestern Nigeria, the climate, poor soils, and farming structure of the zone are not only typical of the humid zone of West and Central Africa but also of monsoon Asia, the Caribic Islands, and the Atlantic Coast of Latin America.

INTRODUCTION

The countries of the humid zone of West and Central Africa have traditionally imported slaughter animals from the Sahel zone. Following the drought of the last few years they have had to turn to the international market. Even after recovering from the drought the Sahel countries will play a diminishing role as exporters; according to OECD projections by the end of the century their entire production will be required to meet their own needs (Montgolfier-Kouevi and Vlavanou, 1981).

The humid zone of Africa is heavily infested with tsetse flies and will remain so for some time as the control methods which have given good results in the dry savannas (chemicals) are not applicable in forest areas and other techniques are still under development (FAO, 1980). Drug treatment against the blood

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parasite, *Trypanosomas* spp., is costly and ineffective over a long period due to the development of resistant trypanosome strains (Ruchel, 1975). The International Research Centre on Animal Diseases, Nairobi, is developing a vaccine but it is estimated that results will take anytime between 5 and 20 years and it is expected to be most effective in animals with a degree of natural tolerance.

Sheep and goats of the dwarf trypanotolerant breeds outnumber trypanotolerant cattle throughout the zone and are an alternative for increasing the meat output in the zone if the possible population growth rates of the various species are compared.

In 1978, ILCA established a research programme on small ruminant production in the humid zone based at Ibadan, Nigeria. The programme was established following the recommendations of an initial analysis made on the basis of a literature review and field surveys. The results of this study are summarized in ILCA's System Study No. 3 (ILCA, 1979).

The programme has a village study site and a station in both the forest belt and the drier derived savanna belt. In the villages, the present system of production is studied and improvements are tried on farmer's plots and animals. At the stations, research on more advanced systems of production is carried out. In 1981, work at the original forest belt research station was discontinued and work was transferred into IITA's Ibadan campus to facilitate interaction with the work of the International Institute for Tropical Agriculture (IITA) on crop production.

The programme covers aspects of animal management, health and nutrition, socio-economics, and forage production studied in cooperation with researchers and officers of IITA, the Universities of Ibadan and Ife, the Federal Livestock Department of Nigeria, and the Oyo State Ministry of Agriculture. An outreach programme on health is being carried out at Kumasi, Ghana, in cooperation with the Ghanaian Ministry of Agriculture.

PRODUCTION SYSTEMS IN THE HUMID ZONE

The humid zone in considered to be one of high rainfall, high humidity, and high temperatures although considerable climatic variations are to be found. While rainfall is high and year round in some areas (Liberia, Eastern Nigeria, and in the Congo basin), rainfall in the northern limits of the derived savanna is no more than 1200 mm and the dry season approaches six months.

The farming systems within the region are affected by the rural population densities which vary from less than twenty to more than one thousand per km^2 and by the economic development within and between countries.

Cattle are absent from most of the area (ILCA, 1979b), but goats and sheep of the dwarf trypanotolerant type are commonly kept in small household flocks. The relative importance of the three species in the zone is shown in Table 1.

Table 1. Livestock population in the humid zone in thousands and as percentage of the total in some countries of West Africa

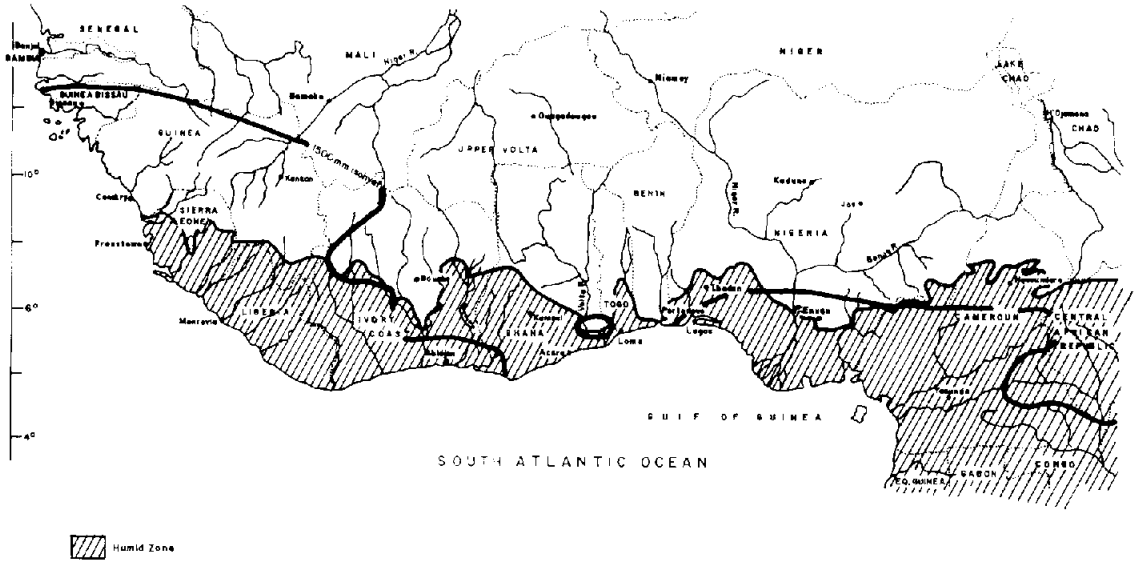
	Cattle		Sheep		Goats	
	n	o/o	n	o/o	n	o/o
Ivory Coast	111	24	572	79	430	76
Ghana	39	5	335	37	242	31
Togo	47	22	356	45	314	43
Benin	109	15	352	40	365	43
Nigeria	494	6	7000	39	7406	32

Source: ILCA, 1979[b].

THE FOREST

The forest zone occurs in a 150-200 km wide belt along most of the coast from Sierra Leone eastwards to Zaire except for a gap from eastern Ghana to Benin (Figure 1). The mean annual rainfall is never less than 1150 mm; there are no more

Figure 1 The humid zone of West and Central Africa



Source: ILCA 1979 a

than two or rarely three months with less than 25 mm of rain. The mean monthly minimum temperature lies between 18-24°C; the mean monthly maximum between 29-35°C.

The main cash crops are perennial tree crops (cocoa, oil palm, rubber, cola nut), while annual crops are planted mostly for subsistence though production for sale is increasing rapidly. Most of these annual crops are low yielding; in the case of cereals and pulses, lack of sun (less than two hours of sunshine at the height of the wet season) and high humidity result in poor growth, high disease incidence, and difficulties in ripening.

THE DERIVED SAVANNA

The derived savanna is a man-made savanna which stretches in a band along the north of the forest zone but reaching the coast between Benin and eastern Ghana.

In western Nigeria the dry season in the south of the zone lasts from October to early March while in the north it occurs between early October and early April. Twenty years of records indicate that the annual rainfall decreases from 1350 to 1120 mm between the limits of the forest in the south and those of the Guinea savanna in the north.

The ODM (1976) study of the derived savanna of the former Western State of Nigeria classified the soils as follows:

- Land over basement complex, granite and other acidic parent material 2,700,000 ha or 93o/o of the total.
- Land over sedimentary rocks 200,000 ha or 7o/o of the total.

In the basement complex, only about 25o/o were classified as good or fair soils with slopes of less than 4o/o suitable for rainfed agriculture: semi-mechanised in the case of cereals and grain legumes, and hand cultivated in the case of cassava and yams.

Tree crops are of minor importance in the derived savanna. Mechanised agriculture is expanding and with it the tendency to intensively cultivate destumped land with road access.

LAND USE

Farm sizes are small throughout the humid zone. A study carried out by the Ministry of Agriculture and Natural Resources (MANR) for the former Western State of Nigeria in 1971 found the average size to range from 5.7 to 3.6 ha. Larger farms were found in the cocoa belt and smaller ones in the derived savanna and coastal areas (Table 2).

Table 2. Average farm size in the three ecological zones of the Western State of Nigeria.

Zone	Land Use		FARM CATEGORY Small	Medium	Large	Average
Derived Savanna	Tree crops	ha	1.4	2.7	5.9	1.9
	Annual crops	ha	1.6	3.9	8.0	2.3
	o/o of farms		76o/o	18o/o	6o/o	
Cocoa Belt	Tree crops	ha	1.8	5.3	12.9	3.2
	Annual crops	ha	2.4	3.0	3.8	2.5
	o/o of farms		73o/o	19.9o/o	7.1o/o	
Coastal Forest	Tree crops	ha	1.2	2.3	3.6	1.8
	Annual crops	ha	1.1	2.4	3.7	1.8
	o/o of farms		56o/o	35.8o/o	8.2o/o	

Source: Nigeria, Ministry of Agric. and Nat. Resources, 1971.

The overall pattern of land use in the two ILCA study sites is shown in Table 3. Tree crops dominate land use in the forest belt site although some of the smaller food crop plots cannot be detected because of the scale of the aerial photographs used for the mapping.

In Nigeria, Bachmann and Winch (1979) as well as Lagemann (1977) found an inverse relation between farm size and population density (Table 4).

Flinn and Zuckerman (1979) found the average area under annual crops to be 1.70 and 1.63 ha in two villages in the cocoa

Table 3. Patterns of land use in the two ILCA research sites near Ibadan.

	Forest Zone o/o	Derived Savanna o/o
Annual crops	2.1	5.8
Fallow	12.8	57.0[a]
Perennial tree crops	61.5	5.6
Secondary forest	5.4	10.7
High forest	11.6	8.0
Gallery forest	3.8	8.9
Villages, roads	2.8	4.0
Area mapped in ha	7520	6060

[a]Grass-bush savanna.

Source: Akinsanmi, Internal Report 1980, ILCA Ibadan.

Table 4. Variations in farm size according to population density in the humid zone.

	Derived Savanna			Forest		
	A	B	C	A	B	C
Area cultivated (ha)	.8	1.1	3.0	.23	.27	.40
Total farm (ha)	1.1	2.6	8.0	—	—	—
No. of plots cultivated	6.6	8.0	5.4	6.6	4.4	4.4
Population/km^2	560	270	105	1200	500	250

Source: Derived Savanna—Bachmann, E. and Winch F.E., 1979. Forest—Lagemann, J., 1977.

belt and derived savanna respectively. In the two villages less than 50o/o of the families cropped more than two-thirds of the land.

The small size of the farms is further complicated by their being split up into plots often distant from each other and from the village. Okali (1979) found in her survey of

ILCA's cooperating farmers that 17.5o/o of the plots of 96 farmers interviewed in both forest and derived savanna zones were five and more km distant from the village. The average number of plots under annual crops was 1.9 in the derived savanna and 2.8 in the forest zone. The clearings are often larger as 2, 3, or more farmers may have adjacent plots.

FARMING SYSTEMS

Traditionally land was cropped for 2-3 years and fallowed for 6-12 years to restore soil fertility to adequate levels. As follow periods shorten the amounts of phosphorus and potasium added in the ash decline, and less organic matter is accumulated during the fallow period.

Under savanna there is usually a shortage of nitrogen even in the year of cropping, though not usually of phosphorus, unless the fallow is less than six years. Soil erosion usually accompanies cultivation after bush fallow in the savanna because hoeing is required to remove the grasses and mounding or ridging is necessary for drainage.

Mechanized farming with high fertilizer inputs can sustain relatively high yields for five to seven years but still results in degraded and eroded soils. Decline in soil biomass activity, soil compaction and manganese toxicity due to soil acidification are among the important growth-limiting factors that cannot be remedied simply through fertilization (Juo, 1981). Moreover, erosion losses are greater with mechanized farming than with traditional agriculture (Lal, 1981).

Tree crops maintain both soil structure and nutrient levels by keeping a permanent canopy over the soil and a permanent root system within it so that soil conditions and nutrient cycles approximate those under the natural forest which the planted species have replaced.

The seasonal peaks in labour demand for clearing and weeding limit the area cropped in peasant agriculture. Increased cropping frequencies result in increased weed growth so that the labour requirement for clearing and weeding rises or yields fall further from the losses caused by the decrease in fertility. To hire more labour the small farmer has to have credit which

he can only obtain on hard terms. Hence, small farmers suffer most under conditions of land shortage (Flinn and Zuckermann, 1979).

Alley cropping, a system in which arable crops are grown in the spaces between rows of planted woody shrubs or trees, *(Leucaena leucocephala* and/or *Gliricidia sepium).* is being tried as an alternative to bush fallow cultivation and the results so far indicate that a longer cropping period can be maintained (Hartmans, 1981). The trees are allowed to grow during the off season, but are periodically pruned during the cropping season to prevent shading and provide green mulch.

This new technique is an attempt to deal with the fundamental problems of tropical agriculture in a situation where bush fallow is no longer possible and mechanized agriculture is not effective. Furthermore, the integration of livestock raising and crop production can be achieved with alley croopping.

SYSTEMS OF SMALL RUMINANT PRODUCTION

In general, small ruminants are not integrated into the farming operation but are free to roam in and around the villages, grazing and browsing the natural vegetation. Kitchen residues and by-products of the local food processing industry are fed as supplements.

In the derived savanna a ring of bush can be observed around the villages, the width of which marks the distance the animals graze/browse. Beyond this ring are the farmers' plots. In the forest zone cocoa or cola plantations fulfill the function of the bush.

In the very densely populated areas of eastern Nigeria, a more intensive system has developed, where the animals are tethered, cut and carry fed, and the manure is used to fertilise the plots close to the house. In the Ivory Coast the government has introduced daytime communal herding of the village animals by a paid herdsman.

The number of animals per farmer remains low in all cases; five to six in the Ivory Coast, and three to four in Nigeria.

Larger sheep flocks can be found in Ghana where some farmers keep a hundred or more animals.

The actual contribution from small ruminants to the farm income is small. While ILCA's work on this aspect is still in a data collection phase, some figures are available from other parts of the humid zone. In eastern Nigeria, Lagemann (1977) found small ruminants contributed between 4 and 13o/o of the farm income and between 2-3o/o and 3-8o/o of the total income (Table 5). On the other hand, they represent a readily available source of cash whenever there is a need.

Table 5. Sources of income for small farms of eastern Nigeria.

	Okwe	Umuokile	Owerri-Ebeiri
Population/km^2	250	500	1200
Average farm income ₦/year	458	318	239
Average non-farm income ₦/year	300	347	721
Avg. income from arable crops o/o (a)	47.00	21.0	10.0
Avg. income from tree crops o/o (a)	49.00	71.0	77.0
Avg. income livestock o/o (a)	4.0	8.0	13.0
Avg. income from livestock o/o (b)	2.3	3.8	3.2

(a) o/o of farm income.
(b) o/o of total income.
₦ ≅ $1.50
Source: Lagemann, 1977.

ILCA's SMALL RUMINANT PROGRAMME

RESEARCH ACTIVITIES

The programme is based on results of the analysis of village conditions, the testing of innovations and farmers' reactions to them. Research at the stations on more innovative systems of production is reshaped according to the findings in the villages. Innovations at village level are aimed primarily at improving the productivity of the present system of small scale production by providing veterinary care and introducing fodder production. In the stations the main thrust is the study of the possibilities and problems of new systems of production characterized by much larger flocks than presently owned and by fodder pro-

duction (grass/browse) for them. These systems require access to enough land to justify the overheads for fencing, provision of water, etc., and could be implemented by larger farmers or cooperative groups.

The broad aspects covered by the programme are:

- Studies on farming systems including a baseline survey (ILCA, 1979), socio-economic survey of the cooperating farmers (Okali, 1979) and an in-depth study being carried out at present with 30 farmers.

- Studies on livestock productively at village level by monitoring all aspects of animal production on some 1900 small ruminants during a 14-month period.

- Studies on the nutrition of small ruminants at village level, including sources of feed, feeding habits, quantitative and qualitative analysis of the food resources and status of mineral nutrition.

- Marketing.

- Test of a simple health package for farmer's animals.

- Research on control of pests of small ruminants (PPR).

- Studies on the integration of livestock into the cropping cycle and of grazing systems.

RESEARCH RESULTS

Study of the productivity of village animals

ILCA's initial studies on the productivity of village animals were conducted in two rural areas, Egbeda in the forest and Ibarapa in the derived savanna. The animals of the cooperating farmers were neck-tagged, weighed, and approximately aged from their dentition. Resident field assistants recorded births, deaths, ailments, purchases, sales, and other transfers. A team of animal scientists and a veterinarian paid regular visits to supervise the field personnel and assist in the recording. Whenever possible dead animals were given postmortem examinations to

establish the cause(s) of death. The survey was initiated in October 1978 and lasted 18 months.

In April, 1980 a simple health package consisting of annual vaccination against PPR and monthly dipping to control ecto-parasites was introduced into the same villages. The recording of animal performance was continued to determine if there were measurable improvements in animal productivity. Simultaneous studies on socio-economics of the farming system, and health and nutrition of animals were conducted.

Detailed reports have been prepared, and only the main findings are presented below (Okali, 1979; Carew, 1981 a and b; Mosi et al., 1981).

Animal Productivity

In the forest and derived savanna zones respectively, 73o/o and 80o/o of 461 and 231 households interviewed owned small ruminants. The average number of animals per owner was 3.2 and 4.0 (Okali, 1979). These figures are within the range found elsewhere in the humid zone of west Africa (ILCA, 1979a).

The age structure of the population at the beginning of the survey shows that females grossly outnumber males in post-weaning age groups (4-12 and 12+ months). This can be taken as an indication of the high demand for the animals either for household consumption or for sale (Table 6).

Table 6. Age structure in small ruminant flocks in Nigeria.

Months	Sheep			Goats					
	Forest			Forest			Derived Savanna		
	Male %	Female %	Total n	Male %	Female %	Total n	Male %	Female %	Total n
0 – 3	58.6	41.4	29	44.4	55.6	63	42.4	57.6	118
4 – 12	35.7	64.3	28	20.3	79.7	74	30.7	69.3	189
12+	11.5	88.5	78	4.9	95.1	164	1.9	98.1	264

It is possible that for periods of 2-3 months every few years there is no sexually mature male present in a village flock.

In Table 7 the information obtained on production and reproduction before commencement of preventive veterinary treatments is summarized.

Table 7. Production traits of west African Dwarf sheep and goats at the village level.

Description	Sheep			Goats		
	n	$\bar{x}$	s	n	$\bar{x}$	s
Offspring/parturition	160	1.29	—	563	1.60	—
o/o mortality: 0 — 3 months	158	9.60	—	707	23.60	—
4 — 12 months	148	14.40	—	699	22.60	—
12+ months	138	14.50	—	576	18.10	—
Birthweight (1)	259	1.70	.46	325	1.30	.24
Weaning weight (2)	634	9.00	1.70	2407	4.80	.90
300 days weight (2)	428	17.30	3.60	1894	8.90	2.40
Age of first parturition (days)	38	531	193	181	545	152
Breeding interval (days)	94	287	44	249	278	10

(1) Results from ILCA's stations.
(2) n is the number of observations used to plot the regressions from which the weights were obtained.

Nutrition of village animals

Small ruminants run free in and around the villages grazing and browsing on natural vegetation and scavenging on the garbage heaps. Kitchen leftovers and by-products of the local food processing industry, mainly cassava peels and maize chaff, supplement the diet.

The present feed supply appears to be one of the main factors constraining the development of the small ruminant industry, (a) by limiting the full expression of the animal's genetic potential, and (b) by limiting the number of animals which can be kept.

Some information of the feeding habits of small ruminants is presented in Table 8. The time spent grazing and browsing is much less than the 6-11 hours observed in the majority of studies of small ruminant behaviour. Even if an allowance is made for night grazing (which is only important in the dry season) the total time would clearly not be enough for proper feeding.

Table 8. Time spent grazing by small ruminants in percentage of the day (7:00-19:00).

Species	Area	Seasons			
		Late dry	Early wet	Late wet	Early dı
Goats	Forest	5.7	5.6	5.4	6.7
	D. Savanna	13.9	17.4	20.6	16.4
Sheep	Forest	16.6	23.2	19.8	19.8
	D. Savanna	18.7	17.9	28.0	29.0

Source: Carew, (1981b).

During the cropping season sheep are often tethered because they tend to walk longer distances than goats while foraging and are thus generally considered a greater threat to crops. This threat causes sheep or sometimes goats or both species to be banned from an area. Some of the accidents mentioned in Table 10 are actually caused by farmers chasing the animals from their plots.

As previously stated, supplements in the form of peeling and leftovers from the kitchen or from food processing industries are fed. Maize chaff is sold by the women engaged in food processing within the village and dried cassava peels are also sold. The importance of supplements appears to have been overstressed in the past. Carew (1981a) estimated that on a dry matter basis they do not meet over 15o/o of the daily requirements of a 15 kg live weight animal (Table 9).

Health

Health is the second major constraint on village flock productivity. The main causes of morbidity are shown in Table 10. The main causes of mortality among goats are PPR, mange, pneumonia, helminthiasis, and accidents; among sheep, helminthiasis, trap wounds, and pneumonias.

Table 9. Level of supplements in small ruminant feeding in g dry matter/animal/day.

Zone	Season			
	Jan-March	April-June	July-Sept.	Oct.-Dec.
Derived Savanna	56	90	60	47
Forest	84	62	133	53

(Average of 24 animals observed in each zone).
Source: Carew, (1981a).

Table 10. Main causes of morbidity in village small ruminants (o/o of observed cases).

	Sheep	Goats	
	Forest %	Forest %	Derived Savanna %
PPR	—	13.5	17.6
Pneumonia	3.1	7.6	5.0
Foot Rot	7.0	0.4	0.6
Helminthiasis	16.4	6.7	2.8
Mange	13.3	37.5	60.7
Ectoparasites	26.6	8.6	2.3
Accidents	18.9	13.9	4.7
Other	4.7	11.8	6.3

The main difficulties in reducing these disease problems are the farmers' lack of knowledge and the unreliable availability of veterinary drugs. Based on the information obtained from the first 18 months of the survey a simple health package was developed and its efficiency is now under test.

Tables 11 and 12 show the effect of the health package on mortality. Presently, the package is annual vaccination against PPR (Peste des Petites Ruminants) with TCRV (Tissue Culture Rinderpest vaccine) and monthly dipping against ectoparasites.

The vaccination against PPR was included because of the heavy losses among the farmers' animals which the outbreaks cause every 2-4 years (Table 13). No PPR has been observed since commencement of the vaccination programme in both the stations and in the survey villages.

Table 11. Mortalities before and after commencement of vaccination against PPR and dipping of village goats.

Age Group-Months	Sex	Baseline (1)		With Vet. Care (2)	
		Population (3) n	o/o Dead	Population (3) n	o/o Dead
0 — 3	Male	328	25.9	228	6.6
	Female	379	21.6	273	6.6
4 — 12	Male	285	20.0	226	8.9
	Female	414	24.4	321	8.4
12+	Male	116	7.8	132	4.6
	Female	460	20.7	510	4.9

(1) 18 months observations.
(2) 12 months observations.
(3) Includes all animals which entered the group.

Table 12. Mortality before and after commencement of vaccination aganist PPR and dipping of village sheep.

Age Group-Months	Sex	Baseline (1)		With Vet. Care (2)	
		Population (3) n	o/o Dead	Population (3) n	o/o Dead
0 — 3	Male	82	7.3	55	14.5
	Female	76	11.8	59	10.2
4 — 12	Male	68	14.7	48	8.3
	Female	80	13.7	83	7.2
12+	Male	30	6.7	16	—
	Female	108	16.7	113	5.3

(1) 18 months observations.
(2) 12 months observation.
(3) Includes all animals which entered the group.

Table 13. Results of three PPR outbreaks among goats in the survey area

Age group-months	Forest Zone			Derived Savanna Zone		
	Pop.	Morbidity (o/o)	Mortality (o/o)	Pop.	Morbidity (o/o)	Mortality (o/o)
0 — 3	28	50.0	39.3	20	10.0	5.0
4 — 8	25	72.0	60.0	9	56.1	56.1
9 — 12	25	52.0	36.0	30	50.0	33.3
12+	86	34.9	25.6	38	36.8	18.4
TOTAL	164	45.7	34.8	97	37.1	23.7

While some cases of helminth infestation were found, the general level of clinical parasitism was considered not sufficient to warrant treatment. The veterinary package also affected offtake (sales, slaughters, and gifts), Table 14. In the age group 0-3 months there was a reduction. Considering that a proportion of offtake is a salvage operation, improved health might be expected to result in a reduction in offtake of young animals. Among older animals offtake rates increased but so did the stock inventories (Table 16).

Table 14. Offtake before and after commencement of vaccination against PPR and dipping of village goats.

Age Group, Months	Sex	Baseline (1)		With Vet. Care (2)	
		Population n	Offtake o/o	Population n	Offtake o/o
0 — 3	Male	328	6.1a	228	0.9a
	Female	379	4.5	273	2.9
4 — 12	Male	285	27.4	226	31.4
	Female	414	15.2	321	11.8
12+	Male	116	32.8b	132	50.0b
	Female	460	2.6c	510	6.3c

(1) 18 months observation.
(2) 12 months observation.
a,b,c. Different letters indicate significant ($P < 0.01$) differences in offtake.

Table. 15. Offtake before and after commencement of vaccination against PPR and dipping of village sheep.

Age group, Months	Sex	Baseline (1) Population[3] n	Baseline (1) o/o Offtake	Witn Vet. Care (2) Population[3] n	Witn Vet. Care (2) o/o Offtake
0 – 3	Male	82	7.3	55	5.4
	Female	76	1.3	59	–
4 – 12	Male	68	44.1	48	52.1
	Female	80	25.0	83	15.7
12+	Male	30	60.0	16	18.7
	Female	108	15.9	113	14.2

(1) 18 months observation.
(2) 12 months observation.
(3) Includes all animals which entered the group.

Table 16. Average of monthly inventories of village sheep and goats over 12 months before and after commencement of vaccination and dipping.

Sex	Sheep Forest			Goats Forest			Goats D. Savanna		
	Base-line n	Vet. Care n	o/o In-crease	Base-line n	Vet. Care n	o/o In-crease	Base-line n	Vet. Care n	o/o In-crease
Male	9	10	11.1	20	35	75.0	11.5	54.5	230.3
Female	72	77	6.9	141	180.5	21.9	137.5	189	37.5

Results from the stations.

At the stations research has focused on the constraints, requirements and productivity of small ruminants under grazing. Objectives were to develop livestock raising activities for (a) the use of fallow land within a crop/grass rotation, and (b) the use (for permanent grazing) of the large areas of non-arable land in the derived savanna.

The stocking of animals for the stations was initiated in April, 1979 and was completed by the end of the same year

(164 sheep and 188 goats were bought in total). The delay was due to the unwillingness of the farmers to sell healthy breeding stock and the bad health of most animals on offer in markets. PPR was the main problem encountered with the purchased animals. The other major problems were pneumonia and diarrhoea, which can be related to the stress of transport to and the new environment and feed regime at the stations.

Initially, animals were vaccinated against PPR in the 8th day of quarantine if normal temperature had been previously observed. However, reactions to the vaccine were observed and were often followed by clinical signs of PPR. The use of inmune serum before vaccination solved the problem. Since then, animals under settled conditions in the station and in the villages have been vaccinated without prior use of serum and without problems.

Table 17. Morbidity and mortality during quarantine.

	Morbidity		Mortality	
	Sheep	Goats	Sheep	Goats
Animals purchased	164	188	164	188
PPR o/o	19.5	21.3	3.7	9.6
Pneumonia o/o	17.6	—	7.9	1.1
Diarrhoea o/o	10.4	—	—	—

The following data on the productivity of small ruminants under grazing must be regarded as of a tentative nature because (a) most females had their first parturition at the station and fertility is known to improve up to the 4th parturition (Mosi et al., 1981), and (b) initial inadequate housing and lack of fodder in the dry season affected mortality and growth rate.

Livestock productivity

Two years of data are now available on livestock productivity. Productivity has been affected by various factors such as:—

— Initial stress due to the change in environment and feeding,
— deficiencies in the housing which have been at least partially solved since late 1980,
— lack of fodder and overgrazing in the dry seasons 1979/80 and 1980/81. Browse *(Gliricidia)* was planted in 1980 but was not available until the dry season 1981/82.

The breeding interval of the two species did not differ significantly between the two stations. They are (in days): ewes 239.2 ± 68.7 and 225.5 ± 46.7, and for does 286.2 ± 99.6 and 264.2 ± 71.5 at the derived savanna and forest station respectively. Similarly, the differences found in the interval between first & second, second & third, and third & fourth births were not significant. The average breeding interval of 233.2 days for sheep and 277.5 days for goats would mean that per year 1.57 and 1.32 parturitions can be expected of a dam. Results are shown in Table 18.

Table 18. Average breeding interval at the stations (in days), Parturtions 1-4.

	Sheep			Goats		
	D. savanna	Forest	Total	D. Savanna	Forest	Total
n	57	45	102	41	27	68
$\bar{x}$	239.2	225.6	233.2	286.2	264.2	277.5
s	68.7	46.7	60.1	99.6	71.5	90.0
Part./year	1.53	1.62	1.57	1.28	1.38	1.32

A small increase was found in the number of offspring per parturition with successive parturitions. The low total number available for analysis might have been the reason for the lack of significance in the differences. In Peru, with Anglo Nubian goats, the largest increase was found between the 3rd and 4th parturition (Vélez, 1984). The results for the stations are shown in Table 19. Of interest, although unexplained as of yet, is the differences in ewe fertility between the two stations.

Birthweight was not influenced by type of birth as much as by sex, although more of the differences were significant (Table 20). The average birth weights of kids and lambs was 1.3 ± .2 and 1.7 ± .2 respectively.

Table 19. Litter size by age of dam, estimated least square means.

Age of Dam (months)	Goats (kids/litter)			Sheep (lambs/litter)		
	n	$\bar{x}$	S.e.	n	$\bar{x}$	S.e
< 20	159	1.20	0.04	40	1.13	0.08
21 — 30	179	1.38	0.04	41	1.24	0.08
31 — 40	180	1.55	0.04	34	1.24	0.09
> 40	372	1.80	0.03	133	1.41	0.04

Source: Sumberg and Mack, 1985.

Table 20. Average birthweight, in kg, of offspring at the stations.

	Lambs					Kids				
	D. Savanna		Forest			D. Savanna		Forest		
	M	F	M	F	All	M	F	M	F	All
n	68	73	51	67	259	89	103	73	60	325
x	1.9^a	1.9^a	1.4^b	1.5^b	1.7	1.4^a	1.3^a	1.2^b	1.1^b	1.3
s	.2	.2	.2	.2	.2	.2	.2	.3	.2	.2

a,b.- Within station means with the same letters do not differ significantly ($P < 0.01$).

Of the kids and lambs born 39.3 and 18.6o/o respectively died before 90 days of age. Mortalities were higher at Ikenne where the environment is harsher during the rainy season. Differences between sexes were not consistent but in both stations kids and lambs born as twins or triplets had lower survival rates (Table 21).

Survival rates beyond 90 days of age have not been calculated as sales and slaughter have reduced the number of animals below the number required for a meaningful evaluation. Growth rates are given in Table 22.

Observations on grazing

A pasture mixture of *Panicum maximum. Stylosanthes gracilis, S. hamata,* and *Centrocesma pubescens* was planted at the derived savanna station. The mixture has proven to be

Table 21. Mortality rate of kids and lambs, 0-90 days.

Parturition type	Lambs				Kid			
	D. Savanna		Forest		D. Savanna		Forest	
	born n	dead o/o	born n	dead o/o	born n	dead o/o	born n	dead o/o
Single	110	16.4	74	13.5	65	21.5	36	30.6
Twin	16	25.0	37	32.4	69	47.8	74	43.2
Triplet	—	—	—	—	—	—	18	72.2
All	126	17.5	111	19.8	134	35.1	128	43.8

Table 22. Growth rates of small ruminants at the stations, in kg.

Age interval days		Sheep				Goats			
		D. Savanna		Forest		D. Savanna		Forest	
		Male	Female	Male	Female	Male	Female	Male	Female
0—90	n	49	50	37	42	50	43	37	25
	$\bar{x}$	97.4	88.9	70.9	65.5	41.1	38.1	27.9	29.9
	s	37.5	20.6	31.6	24.8	13.9	13.3	11.8	16.3
91—180	n	29	35	29	29	29	32	11	12
	$\bar{x}$	61.7	54.3	52.9	51.3	31.6	24.4	23.6	18.9
	s	26.3	25.0	26.5	19.5	17.7	16.1	8.9	11.7
181—270	n	19	—	18	—	14	—	8	—
	$\bar{x}$	46.6	—	38.8	—	22.9	—	25.9	—
	s	33.2	—	30.4	—	12.3	—	13.7	—

satisfactory although a shorter growing grass might be better, especially for goats, which do not like entering tall, wet grass. At IITA paddocks were established with *Brachiaria decumbens.*

Grass/legume mixtures have also been shown to be deficient in quality during the dry season. The high bulk of growth during the rainy season matures to a material of very low quality. Furthermore, if the grass/legume mixtures are to be grazed at a stage of good nutritional value, stocking rates have to be high.

The traditional answer of the nomadic pastoralists has been to burn the savanna to obtain fresh regrowth. Research

stations which keep small ruminants revert to the use of supplements during the dry season if spare paddocks are not available.

If cattle are seasonally bred, calving can be scheduled at the beginning of the rains to adjust nutritional requirements to the low level of nutrients available during the dry season. However, if the best use is to be made of the short breeding interval of small ruminants, they should be allowed to breed freely throughout the year, which requires a constantly high level of nutrition. Of the possible solutions, hay-making had to be discarded due to the high humidity and lack of sun during the harvesting season. Silage making is beyond the present skills and capital available to most farmers.

A fourth alternative and the one the Programme is following is to establish browse plants as a major component of the pasture. Carew (1981) lists 102 species of native trees, 73 of shrubs, and 125 of herbs which are eaten by the small ruminants in the villages of ILCA's study areas. Some of them are actually harvested and fed to the animals.

The following advantages make research into browse appear promising:—

1. Some browse plants are already lopped and fed to animals.
2. Trees and shrubs are capable of high yields of edible dry matter in the dry season.
3. Some species produce material of high protein content and high digestibility.
4. Some of the trees which are suitable for the alley cropping system being developed at IITA are of proven value as fodder and the integration of livestock production into the cropping cycle thus appears feasible.

At present the Programme is concentrating on the two naturalized browse species, *Gliricidia sepium* and *Leucaena leucocephala*, which grow actively in the dry season, can sustain repeated cutting and are known to be of high feeding value (Table 23).

One disadvantage is that under the conditions in the region two rainy seasons (that is 1.5 years) are required before the

Table 23. Chemical composition and digestibility of Gliricidia *sepium* and *Leucaena leucocephala*.

	Dry Matter o/o	Ether Extract o/o DM	Crude Protein o/o DM	Crude Fiber o/o DM	Ash o/o DM	Digestibility[3] o/o DM
Leucaena[1]	34.5	6.5	12.5	14.5	8.3	71.4
Gliricidia[2]	—	3.2	25.9	14.1	7.4	66.0

(1) Leucaena: Jones, 1979.
(2) Gliricidia: ILCA results.
(3) Leucaena in vivo, Gliricidia in vitro.

trees are well established and a significant harvest can be obtained. In the case of *Gliricidia*, vegetative reproduction, with cuttings at least 1.2 m in length allows planting in a paddock which is already being grazed as the upper shoots will grow out of reach of the small stock.

Leucaena has the disadvantage of slow initial growth and high palatability which makes establishment in a stocked pasture difficult. *Gliricidia* sheds its leaves and flowers during the dry season but a severe pruning shortly before the end of the rainy season forces the plant into active vegetative growth during the dry season and appears to be a means for overcoming the normal growth pattern.

Initial data on yields of 18 month-old *Gliricidia* trees is presented in Table 24. Treatment A (cut at the beginning and end of the dry season) yielded more dry matter at the end of the dry season than either treatment B (cut at the middle of the dry season) or treatment C (cut at the end of the dry season) where the *Gliricidia* (both B and C) had gone undisturbed into the dry season and had flowered.

At present, trials are under way to study the following:—

— browse planting spacings for grass/browse ratios which will ensure balanced pasture production,

— best harvest system,

Table 24. Average yield of browse species in the dry season, 1980/81 (g dry matter/plant).

Species	Treatment A			Treatment B	Treatment C
	Early Dry (December)	Late Dry (March)	Total	Mid Dry (January)	Late Dry (March)
Gliricidia	400	348	748	93	209
Cajanus	300	108	408	55	106
Flamingia	150	104	254	35	82

Treatment A: Two harvests of the same tree.
Treatment B and C: One harvest.

- local trees/shrubs suitable for browse under intensive use, and
- integration of livestock into an alley cropping system using browse species.

Because of their high production of dry matter for mulch and their high nitrogen content, it will be an advantage to establish the browse required by livestock during the prior cropping phase of the land use cycle. *Gliricidia* and *Leucaena* are presently the most promising species identified by IITA scientists for alley cropping. The system can also be envisaged for a cut and carry enterprise in which the material grown in the alleys is fed to the animals and the manure returned. The animals could be allowed to graze on the crop residues during the off (dry) season.

Experiences in housing

In the village environment, small ruminants have access to shelter under protruding roofs or even inside the owner's house in case of bad weather. Even so, losses from pneumonia among kids and lambs are heavy especially during the rainy season. Under grazing conditions at the stations shelter is considered indispensable although this may not be true for dry, weaned sheep.

Temperature ranges of 15°C and more are prevalent during the harmattan period of the dry season (1-2 months).

In the rainy season temperatures are not extreme, with average daily maxima of 26-28°C, and daily minima of 20-22°C, but high humidity, rain, draught and dew, cause young animals' temperatures to easily drop below normal. A long 'A' frame design with both of the narrow ends and the lower of the two long sides open was tried initially, but the draught was excessive. Therefore, the design has been changed to a single pitch roof sloping backwards from the front, walls of laterite or planks up to 1.20 m on three sides having an opening of 50-80 cm to the roof, and with the front open. This has proven to be better suited to our needs though improvements on the floor are still needed. A slatted floor of bamboos will be built as an alternative to the rammed laterite used at present. The space allocated per animal has been increased from 1 to approximately $2m^2$.

DISCUSSION

While the programme is still far from having answers to all the problems livestock production encounters in the zone, the results obtained so far have provided several insights into the constraints of small ruminant production.

THE NEED FOR A VIGOROUS LIVESTOCK INDUSTRY IN THE HUMID ZONE

Even to sustain the present low level animal protein consumption of 17g/person/day, a big effort will have to be made to develop a livestock industry in the zone. Montgolfier-Kouevi and Vlavonou (1981) show that, with a yearly increase of 3.3o/o in the demand for livestock products in the Sahel, in 20 years time the exportable surplus will be near zero. This means that the humid region will have to produce what is presently consumed plus the increase in demand of around 5.8o/o p.a., a compound of population growth of 3o/o and an increase caused by economic development. The alternative is to import from outside the continent. This figure of required increase in production contrasts sharply with estimated increase in total animal production of 2.4o/o p.a. in the zone for the period 1963-1975, which is a rate below that of population growth.

The demand for crop products will also increase, putting an additional strain on soil resources, which in countries like

Nigeria, are already reaching the limits of productivity under the bush fallow system. Changes in the farming system that incorporate the introduction of livestock grazing as a farm activity are less likely to meet resistance if done with small ruminants, as farmers in the humid zone are traditionally the owners of these stock whereas cattle (where present at all) are traditionally owned by different ethnic groups.

DEVELOPMENT OPTIONS

At the present stage of knowledge, development options proposed for small ruminant production in the humid zone have to be of a tentative nature. Increased knowledge from ILCA and national government research may well cause changes in the details of present proposals, though not in the general approach.

Livestock development for meat production in the humid zone tends to be directed towards the development of large scale ranching operations, often forgetting that the main component, the trypanotolerant cattle, on which it has to be based are not available or only at great expense. In Nigeria for example, the import of only 9000 Ndama heifers had to be spread over 4-5 years.

However, we contend that the main thrust of development effort should be towards the small farm where the management experience and small stock are presently found. Nevertheless, even for larger schemes, sheep appear as a viable alternative to cattle.

A division of the humid zone is required when considering the development options. The forest zone is the area of tree crops (cocoa, rubber, oil palm, coconuts, etc.) which may provide an economic alternative for permanent land use rather than livestock raising which would complement cropping activities. In the derived savanna zone livestock raising can compete economically with forestry for the use of non-agricultural land as well as being integrated with crop production.

Development at village level

ILCA's trial of the health package in the village research sites has awakened the interest of the farmers in their animals.

Their initialy laissez-faire attitude toward goats and sheep mentioned by other workers (e.g. Oyenuga, 1967) could be attributed to their knowledge that in a normal year 20-30o/o of their flock would die and every 3-4 years an epidemic could wipe it out entirely.

The package may still require improvement to include other vaccinations (e.g. against orf, pox, and blue tongue) and the training of the villagers to dip their own stock and to give minor treatments.

At the village level, productivity increases due to improved health will soon reach the limit of what food there is available. Feed was mentioned as among the main contraints seen by the farmers to an increase in their flock (Okali, 1979). The amount of supplements fed depends rather on the size and food consumption of the farmer's family than on the needs of his animals. Moreover, an uncontrolled increase in the foraging activity of the small ruminants would increase the damage done to crops.

For small units, the solution for the feed problem may be cut and carry, as the overhead for fencing small areas is too high. A mixture of Elephant grass *(Pennisetum purpureum)* or Guatemala grass *(Tripsacum laxum)* with trees like *Leucaena* and *Gliricidia*, having total yields of at least 5 t DM/ha, can be expected to support sheep or goats at a ratio of about 600m^2 per adult animal.

Alternatively a cut and carry system could be based on the trees of alley cropping fields. Although yield trials with mature trees are still underway, the figures of Table 24 indicate that some 7-10 animals can be kept per hectare. It may be possible on small farms to tether sheep and goats on planted pasture.

In the derived savanna, where land is not taken up by tree crops, larger areas could be brought under alley cropping, so that fencing might be feasible. With alley cropping there would be alternatives depending on the ultimate length of the cropping season (e.g.: pasture grazing or cut and carry of the pruning during the rainy season, and grazing of the alley crop residues and browse loppings in the dry season) as compared with crop/grassland rotations. In some areas in the forest belt where indi-

viduals have small plots within large communal clearings, a scheme similar to the first alternative, but based on cooperative flock managment, can be envisaged.

Some anticipated problems are water supply for the animals in paddocks and theft. Especially in the forest zone stealing may present a problem if the paddocks are hidden by secondary forest or tree-crops and a shepherd is not employed.

The long term consequences on land ownership of planting tree lines for alley cropping still have to be studied as crop land is traditionally allocated by the head of the village for the duration of the crop cycle, whereas whoever plants a tree, because he owns it therefore controls the site.

Development of larger units of small ruminants

Larger flocks of small ruminants, especially of sheep but also mixed flocks, may be an alternative to cattle for the use of grassland in the savanna. Stocking rates of 10-15 ewes or 15-20 does/na may be possible on grass/browse mixtures and mortality rates as low as 10o/o can be achieved. The high figures quoted for ILCA's station at Fasola are influenced by the losses in the first year when management and feeding practices were still being developed.

A physical separation of the areas planted with grass and with browse might be better than alleys, as shading of the grasses would be avoided. Browse trees could then be planted every 25cm in rows 2m apart.

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