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VOLUME 1 · GENERAL STUDY

UNDERTAKEN BY
INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
UNITED NATIONS ENVIRONMENT PROGRAMME

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ILCA MONOGRAPH 2

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ABSTRACT

Trypanotolerant cattle, sheep and goats are reviewed in the 18 countries of West and Central Africa where they are found. Classification, distribution, description, performance and productivity are considered. The productivity of trypanotolerant livestock relative to other indigenous types in Africa may well be higher than previously assumed, thus recommendations and possible locations are presented for cooperative programmes to evaluate their potential and further utilization and to ensure the conservation of endangered breeds.

KEY WORDS

Trypanotolerant, cattle, sheep, goats, West Africa, Central Africa.

PREFACE

This joint study on trypanotolerant livestock was initiated by the Food and Agriculture Organization (FAO), the International Livestock Centre for Africa (ILCA) and the United Nations Environment Programme (UNEP). Preparatory research was carried out in early 1977 by R Queval (ILCA Consultant) and I Reh (ILCA). Eighteen countries of West and Central Africa were visited between September 1977 and June 1978 by Ph Lhoste (joint FAO/ILCA Consultant), Y J Wissocq, C H Hoste and I Reh with coordination by J C M Trail (all ILCA).

Grateful acknowledgement is made to the governments of the 18 countries visited for the welcome given and assistance provided to the various team members on their missions. The interest taken in this study and the assistance provided to the team by veterinary and animal production services and research stations have greatly contributed to its completion. Thanks are also due to staff members of FAO, UNDP, commercial firms and other organizations, without whose assistance the study could not have been undertaken. Grateful acknowledgement is made to S Westley for editing and G Maloba and R Ndonyo for typing the report.

The two-volume report was written at the ILCA office in Nairobi, Kenya by the trypanotolerance team, J C M Trail, C H Hoste and Y J Wissocq, and Ph Lhoste in collaboration with I L Mason.

PREFACE

This joint study on transcontinental livestock was initiated by the Food and Agriculture Organization (FAO), the International Livestock Centre for Africa (ILCA) and the United Nations Environment Programme (UNEP). Preparatory research was carried out in early 1977 by R Ghevat (ILCA Consultant) and I Roh (ILCA). Eighteen countries of West and Central Africa were visited between September 1977 and June 1978 by Dr Ilonka (Joint FAO/ILCA Consultant), Y J Wissocq, G H Jones and I Roh with coordination by J C M Trail (all ILCA).

Grateful acknowledgment is made to the governments of the 18 countries visited for the welcome given and assistance provided to the various team members on their missions. The interest taken in this study and the assistance rendered to the team by veterinary and animal production services and research institutes were greatly contributed to the completion. Thanks are also due to staff members of FAO, UNEP, commercial firms and other organizations, without whose assistance the study could not have been undertaken. Grateful acknowledgement is made to a Working for editing and C Sandbe and R Ndonyo for typing the report.

The two-volume report was written at the ILCA office in Addis Ababa, Ethiopia by the principal team, J C M Trail, G H Jones and Y J Wissocq, and Dr Ilonka in collaboration with I L Mason.

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CHAPTER 1

INTRODUCTION

The origin and characteristics of African livestock, and of West African cattle in particular, have long been a subject of study and speculation. The first account of West African livestock was published by Pierre in 1906. The title *L'elevage dans l'Afrique Occidentale Francaise* clearly restricts it to only half the territories in the region. However, it is important to note that Pierre was one of the first to record the ability of certain cattle to survive in tsetse-infested areas. This ability was later described as 'trypanotolerance' and applied to all livestock species. Curson and Thornton (1936) attempted to classify cattle types for the whole continent, but their personal experience was limited to the southern region. These two works still remain the basis of current nomenclature and classification, the first brought up-to-date by Doutressoulle (1947) using the same title as Pierre, and the second by Epstein (1971) in his monumental *The Origin of the Domestic Animals of Africa.*

In the meantime, Stewart (1937, 1938) in his papers on the cattle of the Gold Coast emphasized the importance of the trypanotolerance which they exhibited and coined the term 'West African Shorthorn' to describe them. Reports continued to appear from francophone and anglophone countries, but Mason (1951) was the first who tried to bring together an account of all the livestock of both groups of territories (including Cameroon). The language subdivision continued with Faulkner and Epstein's *The Indigenous Cattle of the British Dependent Territories in Africa (1957)*, but Pagot et al (1972) and Pagot (1974) went some way to bridge the gap.

By the 1970s, the emphasis was changing, from the view of humpless cattle in West Africa as a historic relic and their trypanotolerance as a biological oddity to a consideration of their economic possibilities in tsetse-infested environments where other breeds can only be maintained under high levels of management based on chemoprophylaxis and therapy. In such areas, the trypanotolerant breeds may represent the only practicable approach to the introduction or significant expansion of livestock production. Interest in these breeds gained momentum

when they were introduced into parts of Central Africa where tsetse had prevented the introduction of Zebu or Sanga cattle from surrounding areas. Trypanotolerant cattle from West Africa were first imported into Zaire in 1904 and much more recently into the Central African Republic, Gabon and Congo. In all these countries they have flourished and have opened the possibility not only for commercial beef production in tsetse areas, but for a transformation of the life of the local farmers.

At the same time, research on trypanosomiasis and tsetse control and its practical application was so successful that FAO, with the support of the World Food Conference, launched a Programme for the Control of African Animal Trypanosomiasis in 1974. Since 'effective techniques for tsetse control in the moist savanna and forest gallery areas are not yet readily available' this programme envisaged the rearing of trypanotolerant cattle as the best approach for these zones. The same emphasis was placed on trypanotolerant cattle at several other international meetings on trypanosomiasis in the 1970s, such as:

Interregional FAO/WHO Seminar on African Trypanosomiasis, Kinshasa, 1972 (see Pagot et al, 1972);

Specialist Discussion on Trypanosomiasis and Tsetse Control, Hamburg, 1973 (see Huhn, 1973);

OIE/IEMVT Discussion: Control Programmes for Trypanosomes and Their Vectors, Paris, 1974 (see Pagot, 1974);

Programme for the Control of African Animal Trypanosomiasis, Rome, 1974 (FAO, 1974a);

Consultation on the FAO Programme for the Control of African Animal Trypanosomiasis, Accra, 1975 (FAO, 1975);

First FAO Expert Consultation on Research on Trypanotolerance and Breeding of Trypanotolerant Animals, Rome, 1976 (FAO, 1976).

In spite of these meetings, first-hand accounts of the status and records of the productivity (especially comparative productivity) of trypanotolerant livestock have been rare. ILCA (1977a) and IEMVT (1977) undertook literature reviews which included descriptions of the productivity traits of trypanotolerant livestock, but only isolated pieces of information were available. Most of the reports presented at the meetings listed here referred back to authorities whose work was carried out in the past. They indicated that, notwithstanding the successful introduction of trypanotolerant cattle in Central Africa, the Shorthorns in West Africa were under pressure from the N'Dama and these in turn were under pressure from the Zebu, through selection and cross breeding. As a result, the Dwarf West African Shorthorn appeared to be nearly extinct in several countries and rapidly declining in others. This situation dictated the need for positive efforts to conserve the genetic characteristics of these breeds. Because of this conservation aspect and the interest in a non-chemical (and therefore non-polluting) approach to trypanosomiasis control, UNEP became interested in trypanotolerant livestock

and decided in 1973 to launch a Pilot Project on Conservation of Animal Genetic Resources in cooperation with FAO. The report from this project (FAO/UNEP, 1974) included a list of livestock breeds in danger of extinction and one of its recommendations for follow-up action was a study of the trypanotolerant cattle of West and Central Africa, with particular attention to the Dwarf Shorthorn, as part of a series of surveys of selected breeds. A study of trypanotolerant cattle was also recommended by the FAO Adhoc Consultation on Breed Evaluation and Crossbreeding (EAAP, 1975). As a result, the FAO/UNEP Project on Conservation of Animal Genetic Resources, initiated in 1976, included such a study.

Also in 1976, ILCA decided to incorporate research on trypanotolerant cattle into its programme. At the beginning of 1977, both FAO and ILCA were looking for a consultant to undertake an on-the-spot study of the trypanotolerant livestock of West Africa. Sheep and goats were to be included as well as cattle because, apart from some isolated research in Ivory Coast, Nigeria and Cameroon, very little was known about small ruminants in the region. The two organizations decided to work together: the scope of the enquiry was extended in response to ILCA's interests in sheep and goats and in the countries of Central Africa (i.e. West Equatorial Africa), and the joint programme was named the FAO/ILCA/UNEP Study on Trypanotolerant Livestock. The terms of reference included 'surveying the present status of the trypanotolerant livestock of West and Central Africa and appraising existing data and information on productivity of trypanotolerant livestock especially when these are maintained under conditions allowing legitimate comparisons'.

The study was coordinated by ILCA, with close ties maintained throughout between ILCA and FAO and contacts made at regular intervals with UNEP and several interested multilateral and bilateral agencies. This study involved preparatory cataloguing of information on trypanotolerant livestock (ILCA, 1977a), visits to the 18 countries involved, regular evaluation meetings, assessment of data and information obtained and production of a comprehensive report.

The preparation of a catalogue of information on trypanotolerant livestock for each country to be visited was based on a literature review (ILCA, 1977a) carried out by a consultant and ILCA staff. This catalogue entailed visits by an ILCA scientist to the documentation sections of institutes such as the Commonwealth Bureau of Animal Breeding and Genetics, the Centre for Tropical Veterinary Medicine at Edinburgh, the University of Stuttgart-Hohenheim, IEMVT in Maisons Alfort and FAO in Rome. Each country catalogue covered an outline of available information, a checklist of gaps in the information to assist during the country visit, recommendations on places and people to visit and a bibliography. Questionnaires in French and English were prepared to facilitate the collection of information on breeding and multiplication activities, research work and development programmes.

In preparation for the country visits, FAO headquarters staff prepared letters to the FAO Country Representative or the UNDP Resident Representative in each of the 18 countries involved, asking that the necessary arrangements be made

with the authorities concerned. In certain cases, assistance with transport was also provided. All countries were visited between September 1977 and June 1978, with an average of 17 days, including travel time, spent in each.

Major evaluation meetings were held in Bouaké, Ivory Coast in November 1977 and Nairobi, Kenya in February and August 1978. In February 1978, in order to obtain recommendations for possible future technical studies, ILCA brought together three consultants who worked closely for one week with the scientists who had carried out the missions to the first seven countries. Based on these sessions, the consultants produced a report and recommendations for further work on the use and potential of trypanotolerant livestock (ILCA, 1978a). This report forms the basis of section 5.4.1 of the present document. Representatives of FAO, ILRAD, UNEP, IBAR and GTZ were then brought together in Nairobi for two days to review the suggested programme and its relation to their own operations (ILCA, 1978b).

The analysis of the information obtained during the country visits and the production of the report were carried out at the ILCA office in Nairobi between August 1978 and March 1979. In Volume 1 of this report, the available information is integrated for the entire study area. In Chapter 2, the environment of the region is described, the human and livestock populations indicated, the trypanotolerant cattle, sheep and goats classified into their various groups, and research and development activities listed. In Chapter 3, the different groups of trypanotolerant cattle, sheep and goats are described in more detail. In Chapter 4, the productivity of trypanotolerant livestock is assessed and compared with that of non-trypanotolerant livestock or crosses found in the study area. In Chapter 5, the productivity of trypanotolerant livestock is examined relative to that of other groups in Africa using all currently available information. This chapter also suggests how productivity levels and the trypanosomiasis situation can best be evaluated together, and the requirements and possible locations of conservation measures and evaluation of potential utilization are discussed. Detailed studies of each of the 18 countries are presented in Volume 2.

CHAPTER 2

THE STUDY AREA AND ITS LIVESTOCK

The West and Central African countries included in this study are all the coastal countries from Senegal to Zaire plus three land-locked countries, Mali, Upper Volta and Central African Republic. These 18 countries are, from west to east, Senegal, The Gambia, Guinea Bissau, Guinea, Sierra Leone, Liberia, Mali, Upper Volta, Ivory Coast, Ghana, Togo, Benin, Nigeria, Cameroon, Central African Republic, Gabon, Congo and Zaire.

Parts of some countries have not been included where virtually no indigenous or introduced trypanotolerant livestock are found. Either they are outside the tsetse belt - such as the northern areas of Senegal, Mali, Upper Volta and Nigeria - or they are practically tsetse free from a livestock breeding point of view, such as parts of the Adamawa Plateau in Cameroon or the highlands of eastern Zaire, where only non-trypanotolerant cattle breeds are found and where trypanosomiasis is non-existent or is a marginal problem. The distribution of cattle breeds was a stronger factor in making decisions about areas to be included in this study than the distribution of small ruminant breeds, since, for the latter, transition zones between trypanotolerant and non-trypanotolerant breeds are more widely extended and less clear. The Zebu limit illustrated in Figure 2.3 approximately delineates the study area, while the individual country maps in Volume 2 indicate the precise limits.

The study zone lies approximately between latitude 14°N and 8°S and between longitude 17°W and 28°E, covering a total area of 4 673 000 km^2 or about 60% of the total area of 7 894 000 km^2 represented by the 18 countries. This chapter gives a brief overall description of the study area and its livestock; more detailed information on individual countries and livestock types is presented in Volume 2.

2.1 ENVIRONMENT

2.1.1 RELIEF AND HYDROGRAPHY

Most of the countries belong to the great inland basins which correspond to depressed sections of the ancient African platform, with an altitude of less than 500 m (Jeune Afrique, 1973). A few massifs rise between the coastal regions and the basins of the Niger, Western Congo (Zaire) and Lake Chad. The small highland areas are the Fouta Djallon highlands (average altitude 1 000, maximum altitude 1 537 m), the Guinea Dorsal (a.a. 600 m, m.a. 1 752 m), the Togolese Mountains (a.a. 600 m, m.a. 920 m), the Jos Plateau in Nigeria (a.a. 800 m, m.a. 1 690 m), the Adamawa Mountains in Cameroon and Central African Republic (a.a. 900 m, m.a. 3 008 m) and the Crystal Mountains in Gabon (a.a. 600 m, m.a. 1 000 m). Most of these elevated areas, along with the eastern Zaire highlands lying around the Congo (Zaire) basin, have affected the distribution of tsetse and trypanotolerant livestock breeds. The basins are characterized by a dense network of temporary and permanent rivers; they are generally covered by dense rain forest.

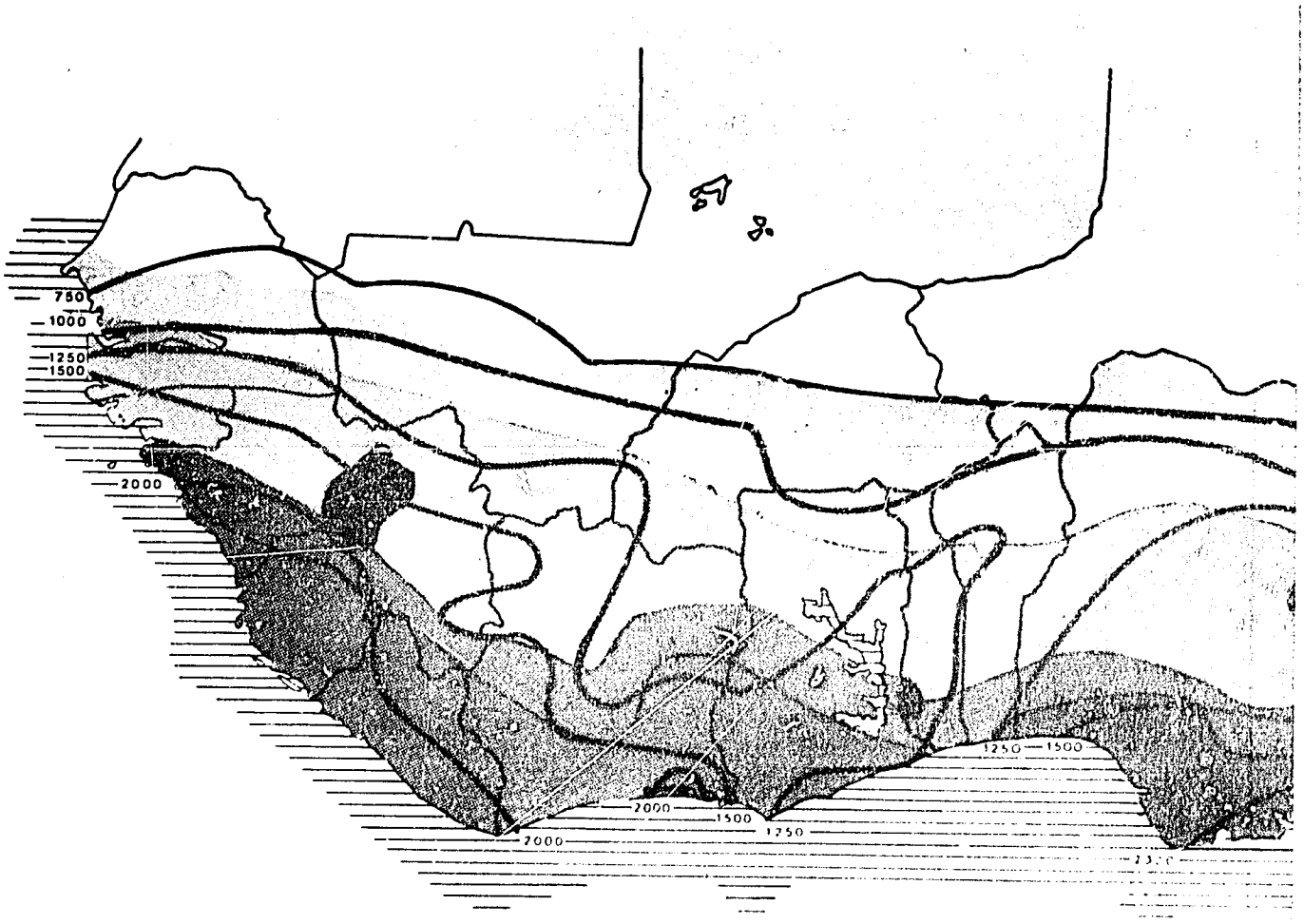
2.1.2 CLIMATE AND VEGETATION

From a climatic point of view, the northern limit of the area under study can be considered the 750 mm isohyet. Above this isohyet is the dry Sahelian zone. Between the 750 and 1 500 mm isohyets a transition climate is found which can be divided in terms of rainfall and vegetation into a Sahelo-Sudanian zone up to approximately 1 250 mm and a Sudano-Guinean zone from 1 250 to 1 500 mm. Over 1 500 mm, the humid tropical climate can be subdivided, mainly in terms of vegetation, into the Guinean savanna and the forest.

These ecological zones reflect not only total annual rainfall, but also rainfall distribution. The Sudanian zone is characterized by a single rainy season and an extended dry season, with the result that forested areas are limited to riverine galleries. The Guinean zone north of the Equator has two rainy seasons, with a principal dry season around February and a shorter dry period in August. These seasons are reversed south of the Equator. The extent of forested areas depends on rainfall, as well as edaphic factors and human activities.

Figure 2.1 indicates the five ecological zones and the main isohyet curves (750, 1 000, 1 250, 1 500 and 2 000). It also shows the high-altitude zones with their accompanying climatic variations which influence the distribution of tsetse and trypanotolerant livestock.

Figure 2.1. Climatic zones.



Sahelo-Sudanian

Sudano-Guinean

Guinean

Forest

High-altitude zones

Isohyets

Source: Prepared from Jeune Afrique, 1973; SEDES, 1975; and information from country visits.

Figure 2.1. Climatic zones.

2.1.3 TSETSE DISTRIBUTION

Tsetse distribution is closely related to relief, hydrography, climate and vegetation. Most of the region is tsetse infested, with trypanosomiasis acting as one of the major constraints on livestock production. Figure 2.2 presents the distribution of the three tsetse groups *(morsitans, fusca, palpalis)* according to a map prepared for OAU/STRC (1977). This map will serve as the basic reference document for the tsetse-infested zones throughout the study. In the country studies, whenever a more recent survey or additional data are available they are presented and discussed in relation to the OAU/STRC map.

2.2 HUMAN AND LIVESTOCK POPULATIONS

The most recent and reliable statistics on total area, human populations and livestock populations and densities are presented in Table 2.1 for each country included in the study. In this table, separate figures are given for the area under study if it is not the whole country and a distinction is made within cattle populations between total and trypanotolerant numbers. By trypanotolerant cattle are meant N'Dama, West African Shorthorn and their crossbreeds with Zebus, and by trypanotolerant sheep and goats are meant the small Djallonké or Guinean breeds. In the density columns, the figures in brackets indicate each country's ranking from high to low.

2.2.1 HUMAN POPULATION

The total human population in the 18 countries is about 165 million, which represents 40% of the total African population living in a region covering 26% of the continent (average density of 20.9 inhabitants/km^2 versus 13.6 for the whole of Africa). In the study area, the human population density is higher still (23.3 inhabitants/km^2), indicating that this region is particularly heavily populated and emphasizing the importance of meat production to meet human nutritional needs. Human population density in the study area ranges from 95.6 inhabitants/km^2 in Nigeria to 2 inhabitants/km^2 in Gabon.

2.2.2 CATTLE POPULATION

The country with the largest number of trypanotolerant cattle is Guinea and the one with the smallest number is Gabon. In terms of cattle densities, the smallest country, The Gambia, has the highest concentration of 26.2 head/km^2.

Figure 2.3 shows the total cattle population and the proportion of trypanotolerant cattle in each country. This map indicates the northern limit of tsetse distribution (from OAU/STRC, 1977) without distinguishing between the tsetse species. It also shows the zones with a preponderance of Zebu, humpless or crossbred cattle, based on observations in the field. These zones are only indicative, but clearly show that the Zebu zone extends far below the northern limit of

Table 2.1 Human and livestock numbers and densities.

Country	Size ('000 km²)	Inhabitants[a] ('000)	Livestock Numbers ('000): Cattle[b] total	Cattle[b] trypanotolerant	Sheep[b]	Goats[b]	Livestock Density in Study Area: Cattle (hd/km²)	Small Ruminants (hd/km²)	Liveweight[c] (kg/inhab)
Senegal	196.2	5 135	2 440		2 660[f]				
Study Area	111.5	1 700[d]	1 310	1 152	1 639		11.7 (2)	9.3 (6)	141.2 (1)
Gambia	11.3	540	296	296	113	187	25.2 (1)	26.5 (5)	102.9 (3)
Guinea Bissau	36.1	530	166	166	25	75	4.6 (8)	2.8 (12)	56.1 (7)
Guinea	245.9	5 685	1 215	1 215	540	535	4.9 (7)	4.4 (10)	39.6 (9)
Sierra Leone	72.3	3 053	207	207	47	112	2.9 (11)	2.2 (13)	12.4 (13)
Liberia	111.4	1 600	25.5	25.5	65	120	0.2 (16)	1.7 (14)	5.1 (17)
Mali	1 240	5 840	3 915		8 (500)[f]				
Study area	220	3 500[d]	1 810	987	1 300		8.2 (3)	7.3 (8)	95.7 (4)
Upper Volta	274.2	6 170	2 550		1 800	2 600			
Study area	203	5 000	1 534	1 024	1 000	1 800	7.6 (4)	13.8 (5)	62.8 (6)
Ivory Coast	322.5	7 028	516	356	722	586	1.6 (12)	4.0 (11)	16.2 (12)
Ghana	238.5	10 500[e]	777	755	905	780	3.3 (10)	7.1 (9)	16.5 (11)
Togo	56.8	2 280	214	210	792	730	3.8 (9)	26.8 (1)	20.5 (10)
Benin	112.6	3 200	726	595	881	848	6.4 (5)	15.4 (4)	49.2 (8)
Nigeria	913.1	77 000	6 235		18 099	23 146			
Study area	400	44 000[d]	766	300	1 900[g]	5 520[g]	1.9 (13)	18.5 (3)	6.4 (16)
Cameroon	475.4	7 606	2 917	8	3 653[fg]		6.1 (6)	7.7 (7)	73.9 (5)
Central African Empire	623	1 827	1 115	18	64	650	1.8 (12)	1.1 (16)	109.9 (2)
Gabon	267.7	544	3.2	3	47	52	0.01 (18)	0.4 (17)	4.5 (18)
Congo	342	1 360	43.3	43.3	42	84	0.1 (17)	0.4 (17)	7.2 (12)
Zaire	2 345	25 389	1 079		762	2 216			
Study area	753	9 500[d]	281	274	171[g]	818[g]	0.4 (15)	1.3 (15)	7.1 (15)
Total	7 884	164 787	26 440		24 904[h]	32 703[h]			
					71 920[i]				
Study area	4 613	105 953	13 922.8	7 634.8	7 314[h]	12 879[h]	3.0	5.7	26.4
					26 485[i]				

Sources and notes:

a. From OAU, 1978.

b. From national census. See country studies (Vol. 2).

c. 1 head of cattle = 0.66 TLU.
1 small ruminant = 0.08 TLU.
1 TLU (Tropical Livestock Unit) = 250 kg liveweight.

d. Estimate.

e. National and FAO 1978 estimate.

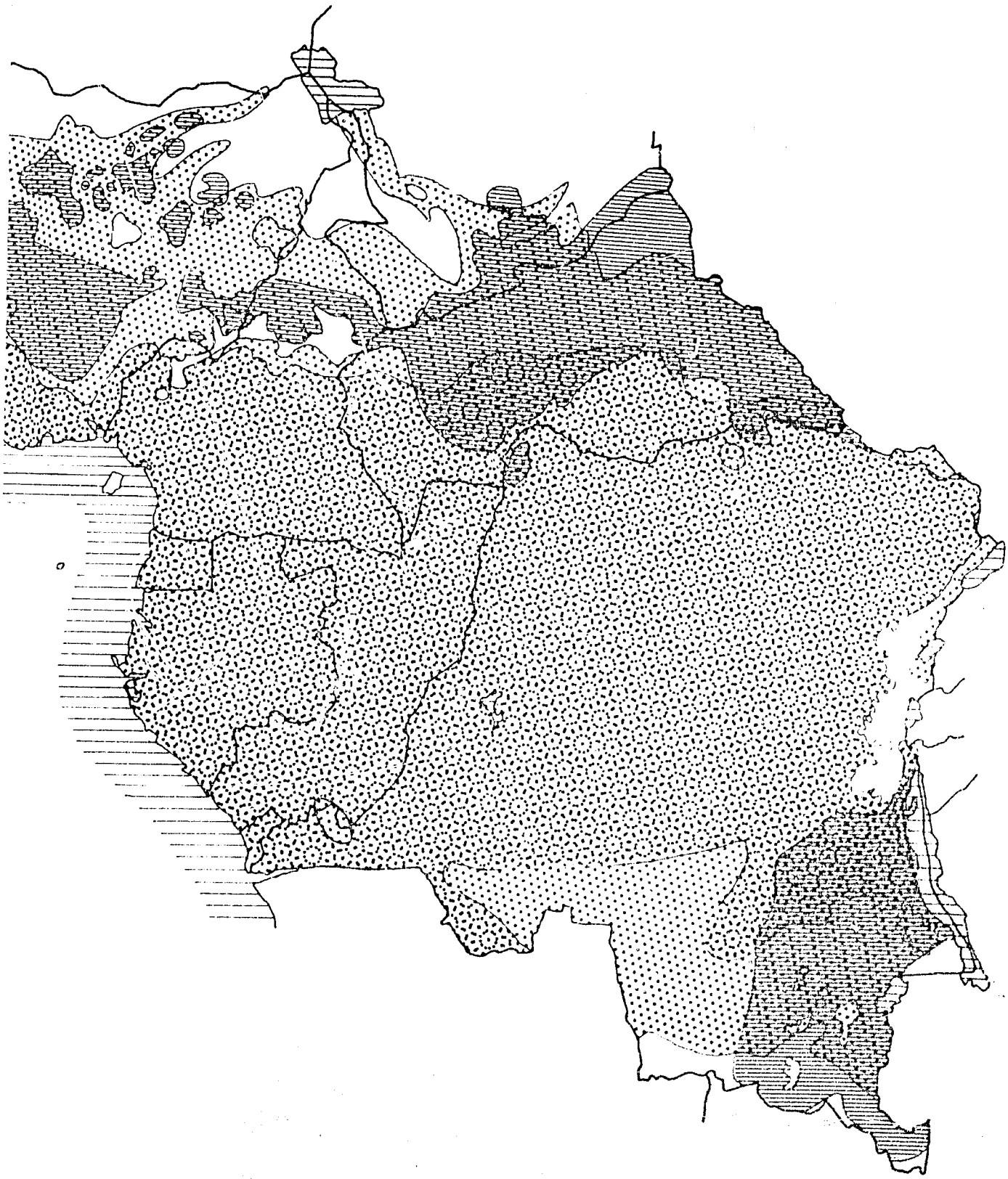
f. FAO (1978) indicates ('000) Senegal: 2655 total, 1760 sheep, 895 goats
Mali: 8494 total, 4437 sheep, 4057 goats
Cameroon: 3653 total, 2100 sheep, 1553 goats.

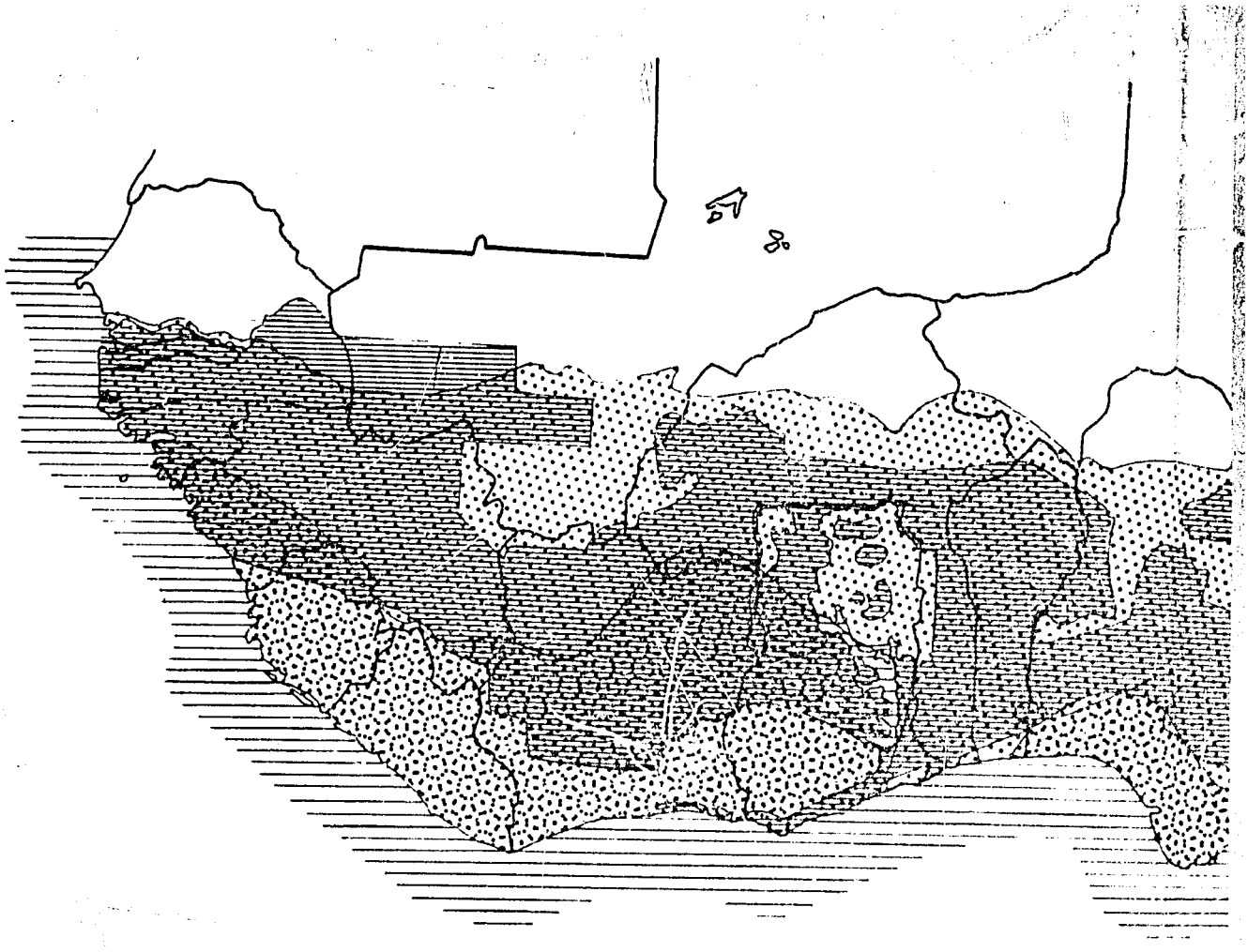
g. Trypanotolerant small stock ('000)
Nigeria: 3000 sheep, 6000 goats
Cameroon: 853 sheep and goats
Zaire: 610 sheep, 1773 goats

h. Total except Senegal, Mali and Cameroon.

i. Total sheep plus goats.

Figure 2.2. Distribution of tsetse flies.





Palpalis group

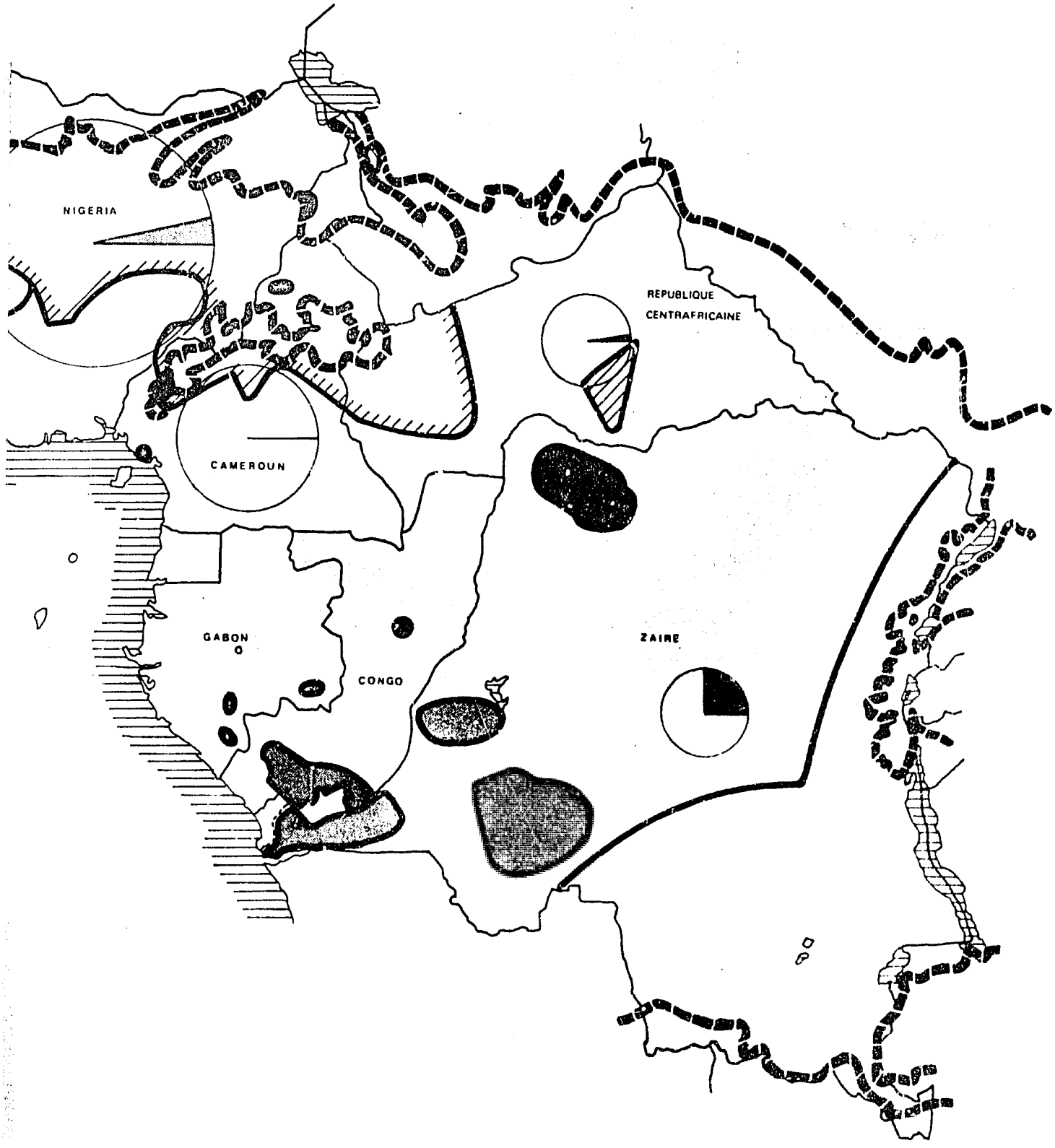
Fusca group

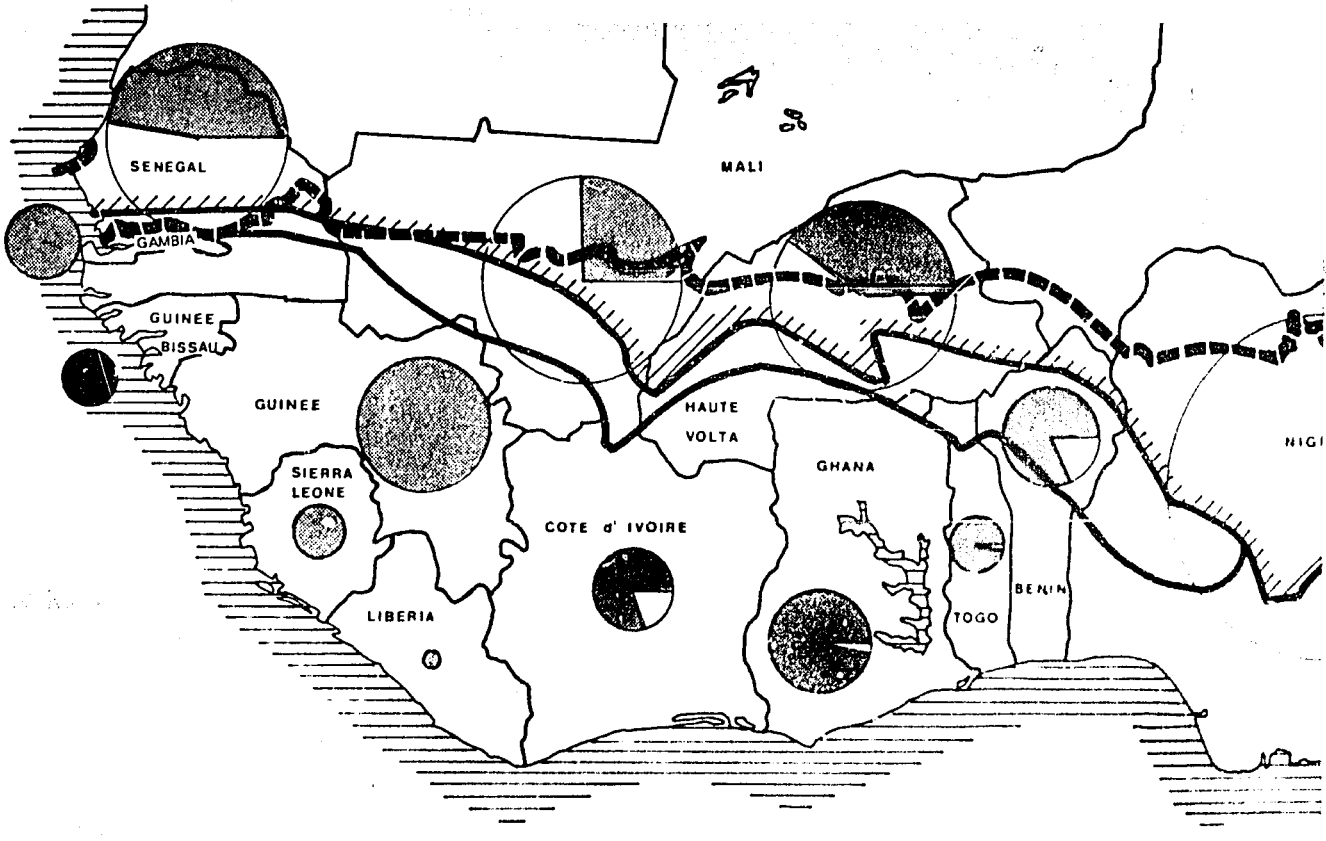
Morsitans group

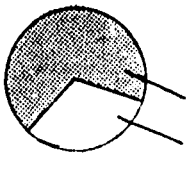
Source: OAU/STRC, 1977.

Figure 2.2. Distribution of tsetse flies.

Figure 2.3. Total and trypanotolerant cattle populations.







n.b. A circle this size represents 1 million head of cattle.

Trypanotolerant

Non-trypanotolerant

Boundary of tsetse-infested zone

Zebu predominate

Crossbred cattle predominate between this line and Zebu area

Concentration of cattle in Central Africa

Source: Constructed from information obtained during country visits.

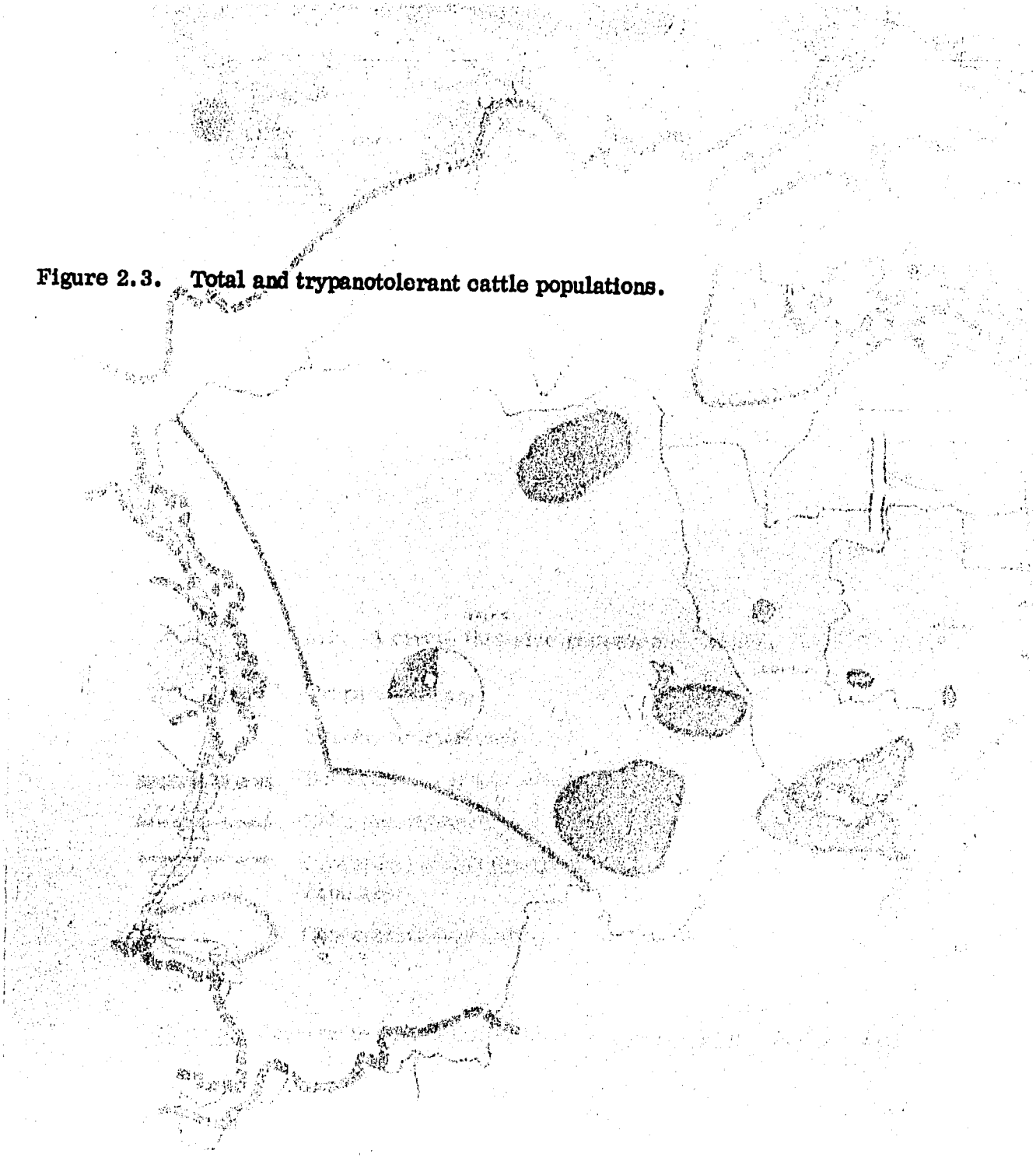


Figure 2.3. Total and trypanotolerant cattle populations.

tsetse infestation. This situation is also illustrated in Table 2.1. The total cattle population in the study area is estimated at 13.9 million head, with only 7.6 million (i.e. 55%) considered trypanotolerant. Deducting the Cameroon and part of the Central African Republic populations, which are almost entirely pure Zebu under negligible tsetse challenge (see country studies in Volume 2), about 73% of the remaining cattle populations is trypanotolerant. The other 27% consists of Zebu, transhuming into the study area, kept in small tsetse-free pockets or maintained under chemoprophylaxis and careful management.

2.2.3 SHEEP AND GOAT POPULATION

Few reliable statistics on small ruminants are available. It is difficult to find even approximate numbers for sheep and goats populations treated separately, and in some countries even estimates for all small ruminants are not available. Consequently, the distinction between trypanotolerant and non-trypanotolerant sheep and goats is based on estimates made during the field visits. Nigeria seems to have the larger number of trypanotolerant sheep and goats and Gabon the smallest. Nigeria also has the densest sheep and goats populations, while the least dense populations are found in Congo and Gabon.

Figure 2.4 shows the total small-ruminant population in each country, and indicates the ratio of sheep to goats, if this is known, and the proportion of trypanotolerant animals. The northern limit of tsetse distribution is repeated on this map and a tentative northern limit for trypanotolerant sheep and goats has been included. Trypanotolerant small ruminants tend to be kept further north than trypanotolerant cattle.

2.3 TRYPANOTOLERANT LIVESTOCK GROUPS

2.3.1 CATTLE GROUPS

Following the general classification of Mason (1951) based on the hump, three groups of cattle can be distinguished in West and Central Africa: the humpless (or taurine), the humped (or Zebu) and crosses between the two groups. The humped cattle are generally considered susceptible to trypanosomiasis and for this reason are not included in this study. They are briefly mentioned when they are found in the study area, but no detailed information is provided. In addition, the humpless group includes the giant-horned Kuri cattle of Lake Chad who live outside the tsetse area and consequently are not considered.

Trypanotolerant cattle can be divided into two main groups, the N'Dama (with long horns) and the West African Shorthorns. The latter group can be subdivided in terms of overall size into Dwarf Shorthorn and Savanna Shorthorn. Among the humped x humpless crosses, a distinction can be made between crosses of West African Zebu with N'Dama and crosses of Zebu with West African Shorthorn. Different breeds can be found in each of these categories. The general classification of the different breeds or

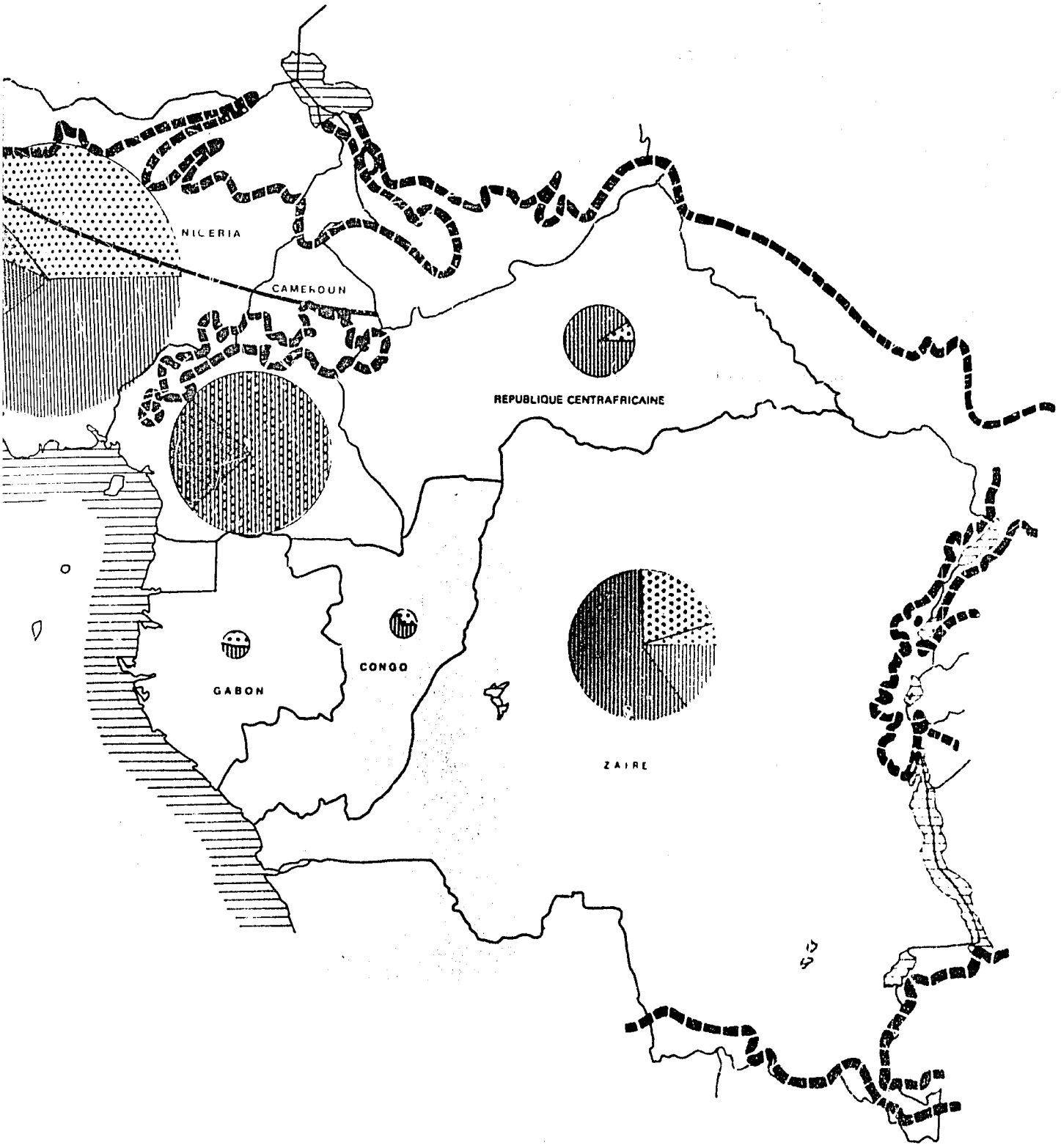
types under each heading is presented in Table 2.2. Additional names for each breed are also noted with the countries where they are used. Some breeds mentioned in past literature could not be found during the field visits and these not given in the Table but are discussed in Volume 2.

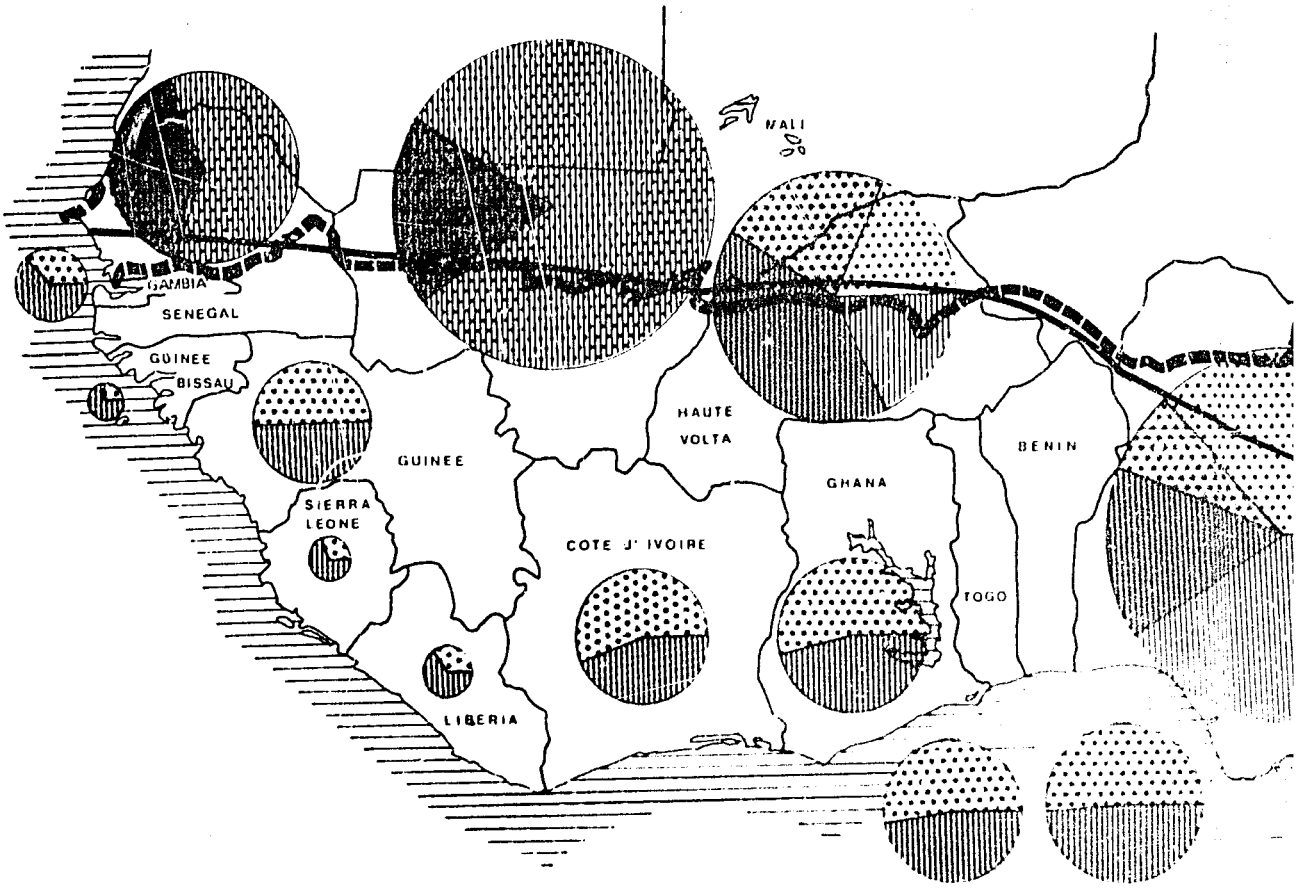
Table 2.2. Classification of trypanotolerant cattle.

Group	Breed	Varieties or Local Synonyms	Relevant Figures
N'DAMA	N'Dama	Boenca, N'Gabou (Guinea Bissau), Gambian cattle (The Gambia), N'Dama Petite and N'Dama Grande (Senegal)	3.1. - 3.26
WEST AFRICAN SHORTHORN = MUTURU (=PAGAN)			
- Dwarf West African Shorthorn			
	Lagune	Lagunaire (Benin, Togo), Lagoon cattle (Ghana), Dahomey (Zaire)	3.27 - 3.32
	Forest Muturu	Nigerian Dwarf Shorthorn	
	Liberian Dwarf		
- Savanna West African Shorthorn			
	Baoulé	Lobi	3.33, 3.36, 3.37, 3.46, 3.48
	Ghana Shorthorn	Gold Coast Shorthorn	3.45, 3.47
	Somba	Atacora (Benin), Mango (Togo)	3.34, 3.44
	Savanna Muturu		3.35, 3.39, 3.40
	Doayo	Namshi, Namji, Poli	3.42
	Bakosi	Bakwiri, Kozi	3.43
	Kapsiki	Kirdi	3.41
ZEBU X HUMPLESS = MERE			
- West African Zebu x N'Dama			
	Djakoré	Race du Sine	3.49, 3.53, 3.54
	Bambara		3.55, 3.56
- West African Zebu x West African Shorthorn			
	Ghanaian Sanga		3.57
	Borgou		3.50, 3.58
	Keteku		3.51 - 3.59

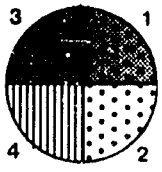
Source: Compiled by authors.

Figure 2.4. Total and trypanotolerant sheep and goat populations.





A circle this size represents 1 million head of sheep and goats (except for Nigeria where it represents 4.1 million).



1. Trypanotolerant sheep
2. Non-trypanotolerant sheep
3. Trypanotolerant goats
4. Non-trypanotolerant goats

Boundary of tsetse-infested zone

Approximate boundary of zone where non-trypanotolerant sheep and goats predominate

Source: Constructed from information obtained during country visits.

Figure 2.4. Total and trypanotolerant sheep and goat populations.

2.3.2 CATTLE NUMBERS

Table 2.3 indicates for individual countries the numbers of animals and percentages of the national cattle population accounted for by each trypanotolerant group. Most of these data are constructed from official statistics collected on field visits.

The N'Dama is the largest group, with 3.4 million head or 45% of all trypanotolerant cattle in West and Central Africa. The West African Shorthorn is next in importance, with 1.7 million Savanna type and 0.1 million Dwarf type, or 23% of all trypanotolerant cattle. The Dwarf Shorthorn is the smallest of these groups and would appear to be in danger of extinction or absorption. Crossbreds make up the remainder, with 1.0 million Zebu x N'Dama and 1.4 million Zebu x Shorthorn, representing 13% and 19% of all trypanotolerant cattle respectively, plus a small number of N'Dama x Shorthorn crosses.

2.3.3 CATTLE DISTRIBUTION

Figure 2.5 indicates the zones in which each of the five cattle types predominates. A further distinction can be made between indigenous and imported animals. In the Central African countries included in the study, cattle breeding was unknown until the beginning of this century. Trypanotolerant cattle were first introduced around this time, first into Zaire and later into Congo, Gabon and Central African Republic.

2.3.4 SHEEP AND GOAT GROUPS

Woolless thin-tailed sheep in West Africa can be roughly divided into a Sahelian type and a tropical Forest or Savanna type. The Sahelian type is typically tall, more than 60 cm at withers, while the typical Forest or Savanna type does not exceed 60 cm and may fall considerably short of this, warranting the term 'dwarf' (Epstein, 1971). The only sheep breed recognized as trypanotolerant is the small West African sheep called Djallonké or Fouta Djallon sheep or Southern sheep or Guinean (see Figures 3.70, 3.71, 3.73). It is found over the whole of West Africa south of the 14th parallel, and is the only breed of sheep in the coastal areas. Mason (1951) notes that, within such a wide geographic range, there are undoubtedly considerable variations of type, but there has been no successful attempt to subdivide them systematically. In this report, however, the trypanotolerant sheep have been divided into a larger Savanna type (mainly in the north) and a smaller Dwarf Forest type. In the northern part of the study area, some crosses between the trypanotolerant sheep and the Sahelian breeds (mainly Maure, Tuareg and Fulani) can be found (see Figure 3.77).

Goats within the study area vary in size from the Dwarf variety at the coast to the large animals kept in the semi-desert areas (Mason, 1951). Like the sheep, they are somewhat arbitrarily divided in this report into a large breed north of the 14th parallel and a small breed south of it. The Dwarf goat, also called Fouta Djallon goat or Guinean Dwarf or Southern goat, corresponds very closely in name,

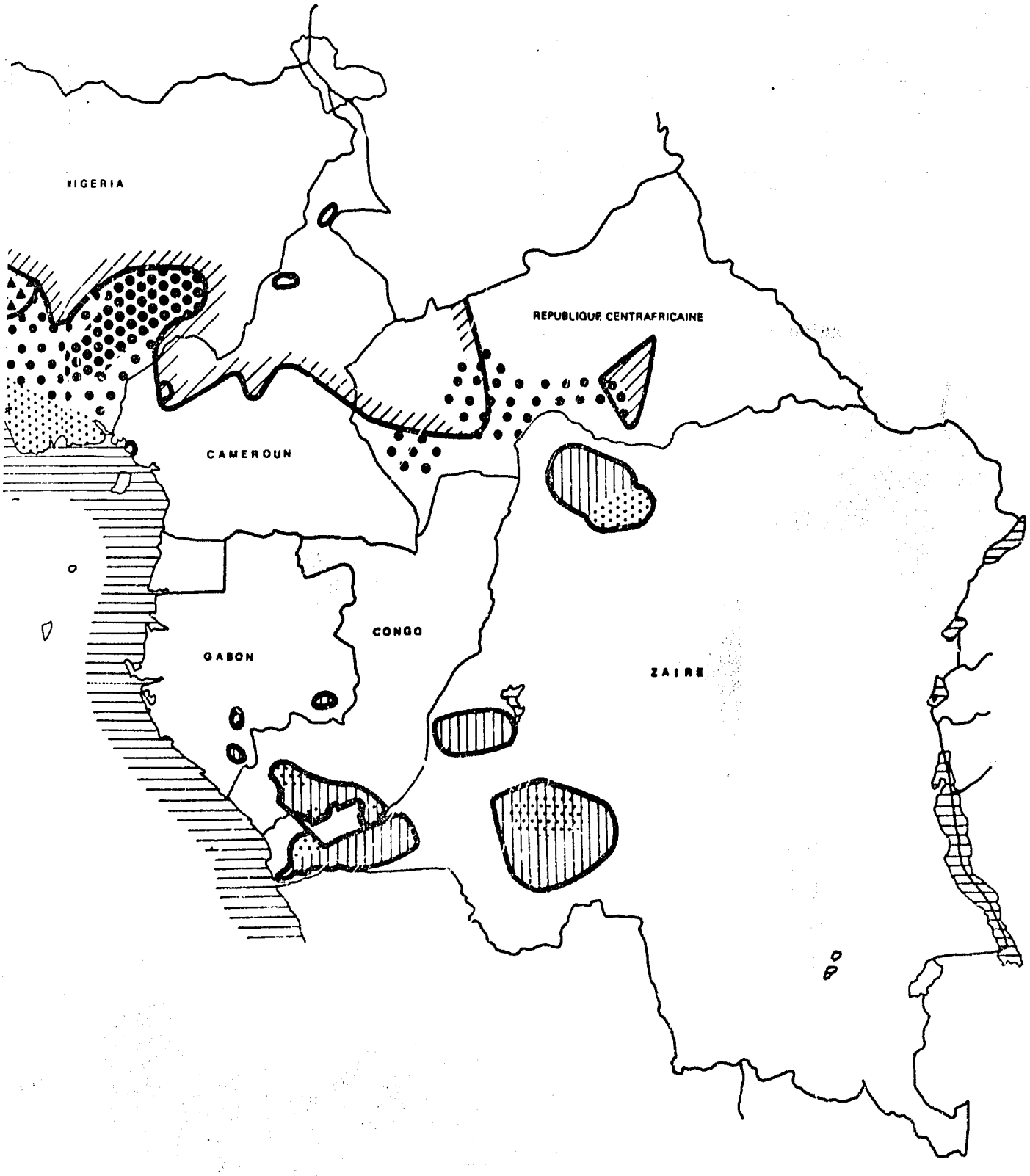
Table 2.3. Cattle numbers by classification group and country ('000).

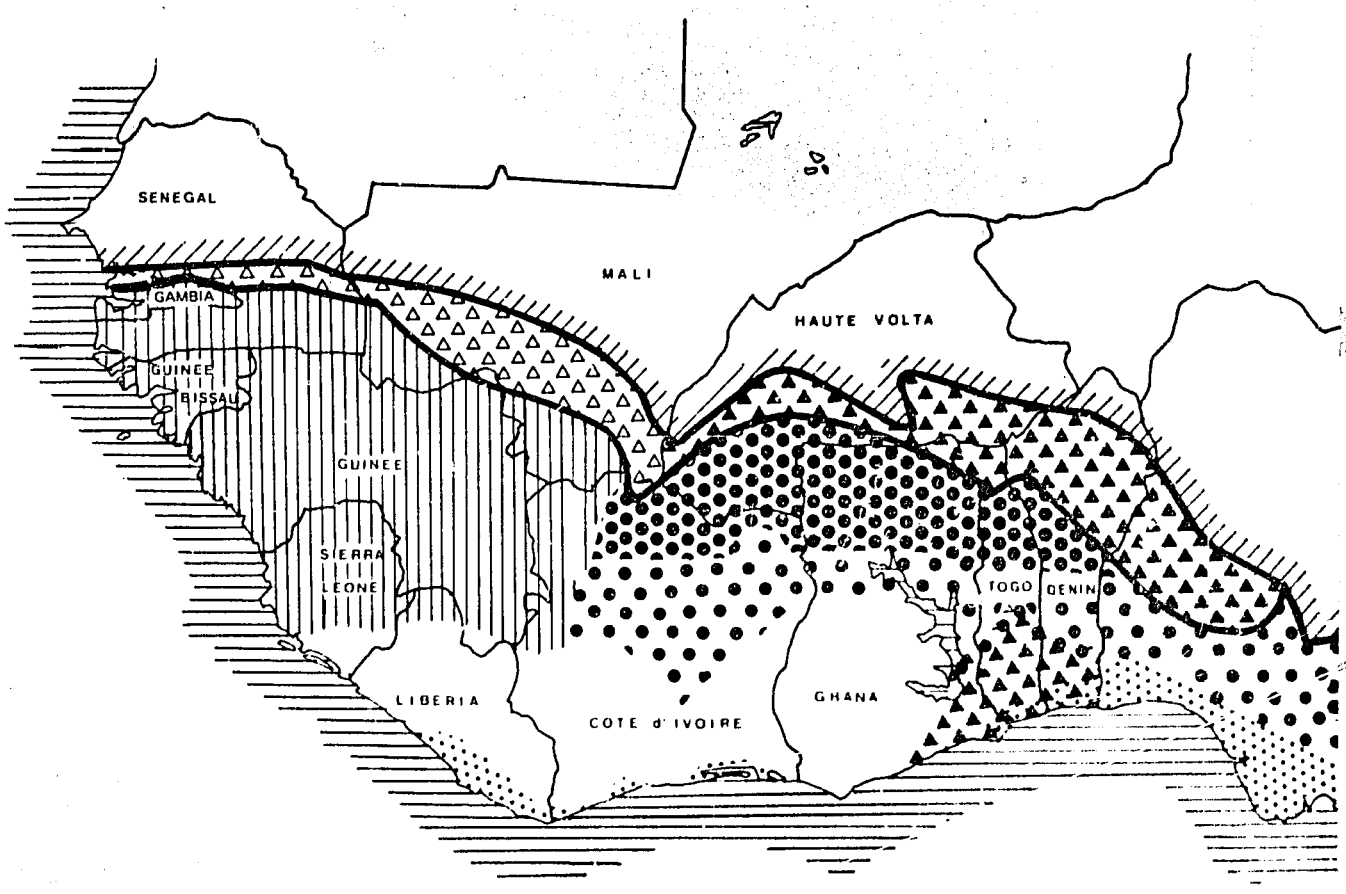
Country	N'Dama		Dwarf West African Shorthorn		Savanna West African Shorthorn		Zebu x N'Dama		Zebu x West African Shorthorn	
	No.	%	No.	%	No.	%	No.	%	No.	%
Senegal	746	21.8	-	-	-		406[i]	40.1		
The Gambia	296	8.7	-	-	-		**			
Guinea Bissau	166	4.9	-		-		-			
Guinea	1 154	33.7	-		-		61[j]	6.0		
Sierra Leone	207	6.1	-		-		-			
Liberia	10.5	0.3	15[a]	15.4	-		-			
Mali	465	13.6	-		**		522[k]	51.6	**	
Upper Volta	*		-		484[d]	28.9	*		540[j]	37.8
Ivory Coast	70	2.0	*		250[d]	15.0	**		36[j]	2.5
Ghana	17	0.5	*		616[e]	36.8	*		122[n]	8.6
Togo	*		*		144[f]	8.6	-		66[o]	4.6
Benin	*		20[b]	20.4	75[f]	4.5	-		500[p]	35.0
Nigeria	15	0.4	38[c]	38.8	82[g]	4.9	*		165[q]	11.5
Cameroon	1		*		7[h]	0.4				
Central African Empire	1	0.1	*		15[d]	0.9	2[l]	0.2	*	
Gabon	1.9		1.2[b]	1.1	-		-		-	
Congo	32.5	0.9	10.8[b]	11.0	-		-		-	
Zaire	240	7.0	13.0[b]	13.3	-		21[m]	2.1	-	
Total	3 422.9	100	97.9	100	1 673	100	1 012	100	1 429	100
Percentage of total Trypanotolerant population	45%		1%		22%		13%		19%	

* Less than 1 000 animals. ** More than 1 000, but actual number unknown.
a. Liberian Dwarf. b. Lagune c. Forest Muturu. d. Baoulé. e. Ghana Shorthorn. f. Somba. g. Savanna Muturu. h. 1 000 Bakosi plus Doaya and Kapsiki.
i. Djakoré. j. Méré (local name). k. Bambara. l. Mbororo Zebu x N'Dama. m. 17 000 N'Dama x Mateba plus 4 000 N'Dama x Angola or Africander.
n. Ghanaian Sanga. o. Borgou. p. Borgou and Borgou crosses. q. Keteku.

Source: Information from country visit.

Figure 2.5. Distribution of trypanotolerant cattle groups.





Dwarf West African Shorthorn

Savanna West African Shorthorn

West African Zebu x West African Shorthorn

N'Dama

West African Zebu x N'Dama

Boundary of zone where Zebu predominate

Boundary of zone where crossbred cattle predominate

Concentration of cattle in Central Africa

Source: Constructed from information obtained during country visits.

Figure 2.5. Distribution of trypanotolerant cattle groups.

size and distribution to the Dwarf sheep (see Figures 3.78 - 3.85). It is smaller in the south (the true dwarf) and larger in the north of its range (Mason, 1951). Great variability also exists within the breed, and different types are described in the country reports in Volume 2. In the northern part of the study zone there are some crosses between the Dwarf goat and the Sahelian breeds (Maure, Tuareg and Fulani).

2.3.5 SHEEP AND GOAT NUMBERS AND DISTRIBUTION

Total sheep and goat numbers and numbers of trypanotolerant sheep and goats were presented in Table 2.1. The information available does not allow subdivision of the West African sheep and goats into specific groups, as was possible with cattle, so they cannot be classified in any greater detail. Similarly, it is not possible to draw exact boundaries between the Dwarf, the Savanna, the crosses and the Sahel types. An attempt to estimate the northern limit of the distribution of trypanotolerant sheep and goats is presented in Figure 2.4.

2.4 RESEARCH AND DEVELOPMENT ACTIVITIES

A list of all activities in research, multiplication and development is presented for each country in Volume 2, covering livestock in the study area, and more precisely concerned with or closely related to trypanotolerance and trypanotolerant livestock. The research centres listed in this volume are those which are important at the national level and which are working or could easily work with trypanotolerant livestock. Different symbols are used to distinguish laboratories working on trypanotolerance and/or trypanosomiasis, university farms with trypanotolerant livestock, and centres or stations whose main activity is trypanotolerant livestock, those with a more general scope (agricultural research centres) with trypanotolerant livestock as a subsidiary activity, and those located in the study area but focussing on non-trypanotolerant livestock.

The multiplication activities described here are also those which are important at the national or regional level and which involve trypanotolerant livestock. A distinction is made between government and private commercial herds.

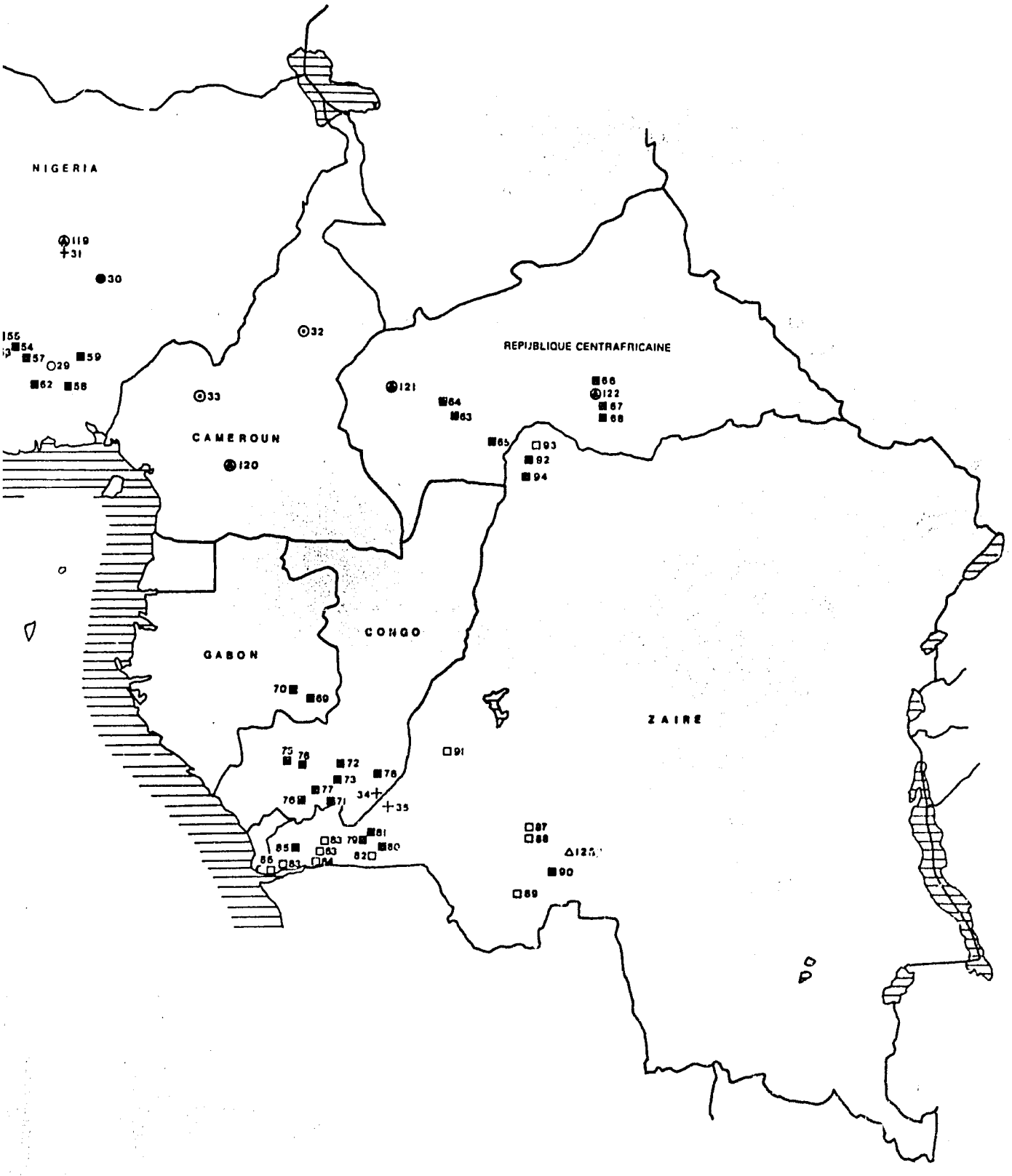
The same selection criteria were used in considering development projects. Only those currently in progress are mentioned here, but development projects planned for the near future with apparently good chances of implementation are mentioned in the country reports. A distinction is made between integrated development projects with a livestock component and livestock development projects per se.

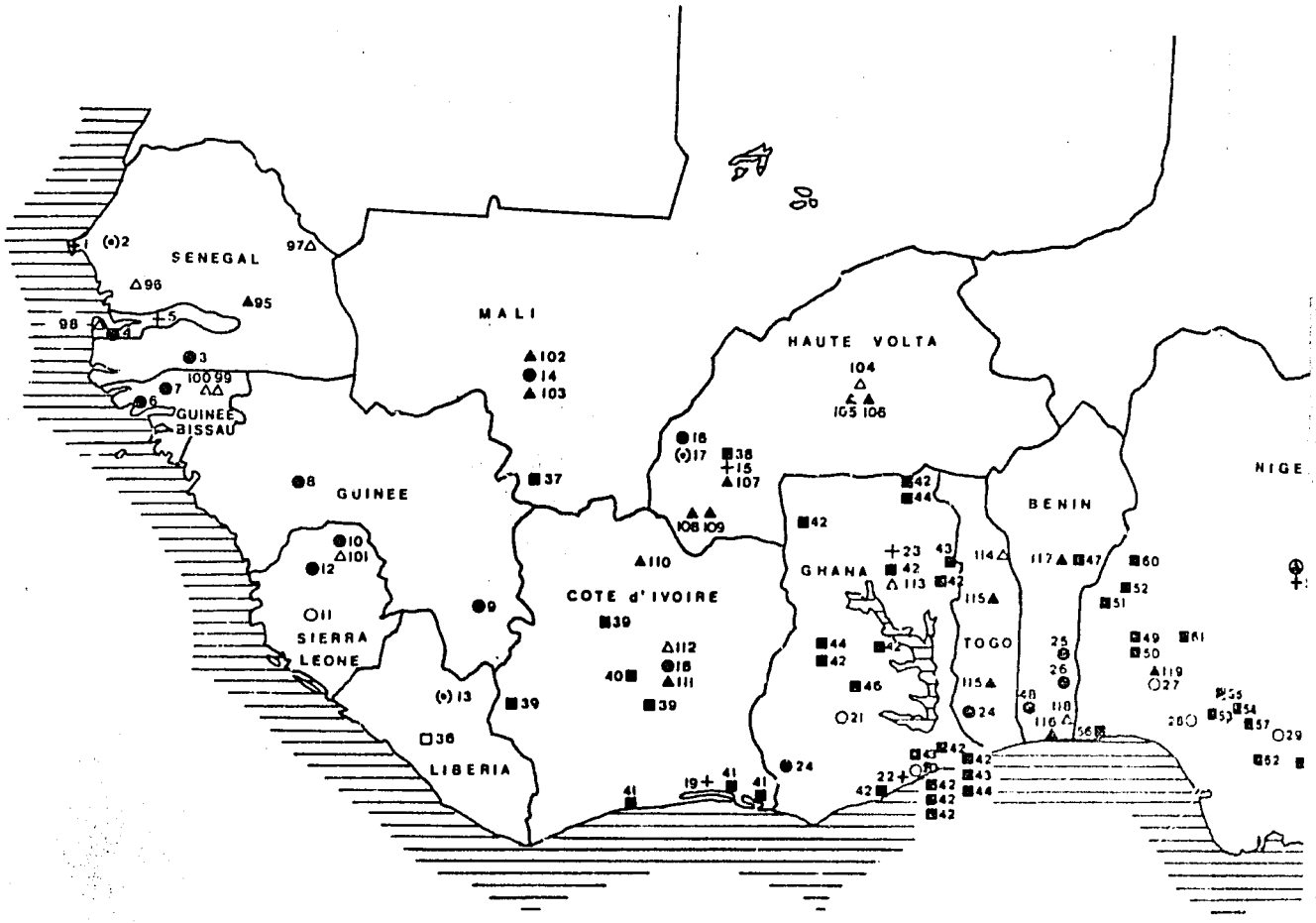
Figure 2.6 indicates the locations of research centres, multiplication herds and development project headquarters, using different symbols for each category. The number alongside each symbol refers to the information presented in Table 2.4. This table lists under each country the name and the location of all activities shown on the map. More detailed descriptions are found in Volume 2. These

activities are listed in numerical order from west to east under their respective countries. Research centres are listed from 1 to 35, multiplication herds from 36 to 94 and development projects from 95 to 123.

Figure 2.6 and Table 2.4 indicate that research centres are more numerous in West than in Central Africa. The two major research centres working with trypanotolerant livestock are the Centre de Recherche sur les Trypanosomiases Animales in Bobo-Dioulasso, Upper Volta and the Centre d'Elevage et de Recherche sur la Trypanosomiase et la Trypanotolérance in Avetonou, Togo. Similarly, development projects which cover some aspect of trypanotolerant livestock, commonly the improvement of veterinary services and the selection and multiplication of breeding stock, are more numerous in West African countries. In the case of multiplication herds, the picture is rather different, as many more exist in Central African countries than in West Africa. Overall, there appears to be considerable interest in establishing additional multiplication herds, both for livestock improvement within individual countries and for export.

Figure 2.6. Location of research centres, multiplication herds and development projects.





Research centres

- ✚ Laboratory working on trypanotolerance and/or trypanosomiasis
- ● Centre with trypanotolerant livestock as main activity
- (●) Agricultural centre with trypanotolerant livestock as subsidiary activity
- ○ University farm with trypanotolerant livestock
- ◉ Centre with non-trypanotolerant livestock as main activity

Multiplication herds

- ■ Governmental farm or ranch with trypanotolerant livestock
- □ Private farm or ranch with trypanotolerant livestock

Development projects

- ▲ Livestock project focussing on trypanotolerant breeds
- △ Agricultural project with trypanotolerant livestock component
- ⑃ Livestock project focussing on non-trypanotolerant breeds

Source: Constructed from information obtained during country visits.

Figure 2.6. Location of research centres, multiplication herds and development projects.

Table 2.4. Research, multiplication herd and development activities.

Country	Research Centres		Multiplication Herds		Development Projects (HQ)	
	No. & symbol	Name	No. & symbol	Name	No. & symbol	Name
Senegal	1 +	Laboratoire National de l'Elevage et de Recherches Vétérinaires de Dakar-Hann			95 ▲	Projet de Développement de l'Elevage au Sénégal Oriental (Tambacounda)
	2 ◐	Centre National de Recherches Agronomiques de Bambey			96 △	Projet de Développement de l'Agriculture au Siné Saloum (Kaolack)
	3 ◐	Centre de Recherches Zootechniques de Kolda			97 △	Amélioration de l'Elevage et des Pâturages dans le Département de Bakel (Bakel)
The Gambia	4 ●	Yundum Experimental Station			98 △	Rural Development Project (Banjul)
	5 +	Trypanosomiasis Research in The Gambia (Keneba)				
Guinea Bissau	6 ●	Bissau Station			99 △	Integrated Development Project - Rice and Cotton (Bafata)
	7 ●	Bissora Station			100 △	Development Project-Groundnuts (Bafata)
Guinea	8 ●	Ferme d'Etat de Ditinn (Dalaba)				
	9 ◐	Ferme d'Etat de Famoyla (Beyla)				
Sierra Leone	10 ●	Musala Stock Farm (Kabala)			101 △	Koinadugu Integrated Agricultural Development Project (Kabala)
	11 ○	Njala University College (Moyamba)				
	12 ●	Teko Station (near Makeni)				
Liberia	13 (●)	Central Agricultural Experimental Station of Suakoko (Gbarnga)	36 □	Liberian Agricultural Company (near Buchanan)		
Mali	14 ●	Centre National de Recherches Zootechniques de Sotuba (Bamako)	37 ■	Opération N'Dama Yanfolila	102 ▲	Mali Livestock I et II (Bamako)
					103 ▲	Développement de l'Elevage dans le Sud du Mali (Bamako)
Upper Volta	15 +	Centre de Recherche sur les Trypanosomiases Animales (Bobo-Dioulasso). Also the headquarters of the Ecole de Lutte Anti-Tsétsé and of the Office Central de Controle des Grandes Epizooties, the Muraz Centre and a mission of the Office de la Recherche Scientifique et Technique Outre-Mer (Bobo-Dioulasso)	38 ■	Centre de Formation de Matourkou (near Bobo-Dioulasso)	104 △	Aménagement des Vallées des Voltas (Ouagadougou)
					105 ▲	Assistance à la Culture Attelée (Ouagadougou)
					106 ▲	Elevage Villageois (Ouagadougou)
					107 ▲	Projet de Développement de l'Elevage en Ouest-Volta (Bobo-Dioulasso)
	16 ●	Station de Samandeni (near Bobo-Dioulasso)			108 △	Feedlot de Banfora (Banfora)
					109 ▲	Amélioration de l'Elevage traditionnel dans l'ORD de Banfora (Banfora)
	17 (●)	Station de Farako-Ba (near Bobo-Dioulasso)				

Table 2.4, cont.

Country	- Research Centres -		- Multiplication Herds -		- Development Projects (HQ) -	
	No. & symbol	Name	No. & symbol	Name	No. & symbol	Name
Ivory Coast	18 ●	Centre de Recherches Zootechniques de Minankro (Bouaké)	39 ■	Ranches of the Société de Développement de la Production Animale - Ranch d'Abokouamekro - Ranch de Sipilou - Ranch de la Marahoué	110 ▲	Opération d'Encadrement de l'Elevage Sédentaire en Nord Côte d'Ivoire. (SODEPRA - Nord) (Korhogo)
	19 +	Laboratoire de Pathologie Animale de Bingerville (near Abidjan)			111 ▲	Projet de Promotion des Fermes d'Elevage en Région Centre (SODEPRA-Centre) (Bouaké)
			40 ■	Centre National Ovin (Béoumi)		
			41 ■	Programme de Développement Bovin de la Société de Développement du Palmier à Huile - 3 main plantations (Littoral)	112 △	Encadrement de la Culture Attelée dans la Zone Cottonière (Compagnie Ivoirienne des Textiles) (Bouaké)
Ghana	20 ○	University of Ghana - Agricultural Research Station Legon - Agricultural Research Station Kpong - Agricultural Research Station Kade	42 ■	Animal Husbandry Stock Farms (12)	113 △	Ghanaian-German Fertilizing (Tamale)
			43 ■	State Farms (3) - Damon Ranch (Northern Region) - Ohawu-Akatsi Ranch (Volta Region) - Kwamoso State Farm (Eastern Region)		
	21 ○	University of Kumasi				
	22 +	Achimota Animal Research Institute (near Accra)	44 ■	Ghana Livestock Company - 3 ranches		
	23 +	Laboratory of Pong Tamale (Tamale)	45 □	Shai Hills Ranch (Greater Accra Region)		
			46 ■	Sheep and Goat Production Development Project - Ejura Farm (Ashanti Region)		
Togo	24 ●	Centre d'Elevage et de Recherche sur la Trypanosomiase et la Trypanotolérance (Avetonou)			114 △	'Togo-Nord' Programme d'Aménagement du Nord Togo (Lama Kara)
					115 ▲	Développement de l'Elevage Bovin par la Culture Attelée (Sokodé - Atakpamé)
Benin	25 ●	Station de M'Bétécoucou	47 ■	Centre d'Elevage de l'Okpara (near Parakou)	116 ▲	Amélioration et Développement de la Production Animale (Cotonou)
	26 ●	Station de Samiondji	48 ■	Ferme de Kpinnou		
					117 ▲	Projet de Développement de l'Elevage dans le Sud Borgou (Parakou)
					118 △	Société de Développement du Palmier à Huile - 21 coopératives (Southern Region, Porto-Novo)
Nigeria	27 ○	University of Ibadan - University Farm	49 ■	Upper Ogun Ranch (Oyo State)	119 ▲	Livestock Development Project Unit (Kaduna)
	28 ○	University of Ife - University Farm	50 ■	Fashola Stock Farm (Oyo State)	119 ▲	Western Livestock Company (Ibadan)
	29 ○	University of Nsukka - University Farm	51 ■	Shaki Livestock Station (Oyo State)		
	30 ●	Nigerian Institute of Trypanosomiasis Research Sub-Station (Vom, Plateau State)	52 ■	Ogbore Station (Oyo State)		
			53 ■	Ado-Ekiti Livestock Investigation Centre (Ondo State)		
	31 +	Tsetse and Trypanosomiasis Division, Federal Livestock Department (Kaduna)	54 ■	Akunu Cattle Ranch (Ondo State)		

Table 2.4, cont.

Country	Research Centres		Multiplication Herds		Development Projects (HQ)	
	No. & symbol	Name	No. & symbol	Name	No. & symbol	Name
Nigeria (cont.)			55 ■	Oke-Ako Cattle Ranch (Ondo State)		
			56 ■	Pota Cattle Ranch (Lagos State)		
			57 ■	Igarra Cattle Ranch (Bendel State)		
			58 ■	Ezillo-Nkalagu State Farm (Anambra State)		
			59 ■	Raav-Livestock Investigation and Breeding Centre (Benue State)		
			60 ■	Kalama Livestock Ration (Kwara State)		
			61 ■	Shao Livestock Station (Kwara State)		
			62 ■	Ubiadja Goat Farm (Bendel State)		
Cameroon	32 ●	Station de Wakwa (Ngaoundere)			120 ◐	Société de Développement des Productions Animales (Yaoundé)
	33 ●	Station de Bambui (Bamenda)				
Central African Republic			63 ■	Station de Bossembélé (Préfecture d'Ombella, Mpoko)	121 ●	Renforcement des Services de Santé Animale dans la Zone Occidentale (Bouar)
			64 ■	Station de Doumie (Préfecture d'Ombella, Mpoko)	122 ●	Assainissement et Aménagement d'une Zone d'Elevage dans la Région de Bambari (Bambari)
			65 ■	Ranch de Boali (Préfecture d'Ombella, Mpoko)		
			66 ■	Station de Bambari (Préfecture de la Ouaka)		
			67 ■	Station de Bokolobo (Préfecture de la Ouaka)		
			68 ■	Station de Tambia (Préfecture de la Basse, Kotho)		
Gabon			69 ■	Ranch de Franceville (Région du Haut Ogooue)		
			70 ■	Ranch d'Ofouma (near Moanda)		
Congo	34 ✚	Laboratoire Vétérinaire de Brazzaville	71 ■	Ferme de Mpassa (near Mindouli)		
			72 ■	Ferme de l'APN (near Kindamba)		
			73 ■	Ranch de la Loulla (near Mindouli)		
			74 ■	Ranch de la Louamba (near Kayle)		
			75 ■	Ranch de la Louboulou (région de la Bouenza)		
			76 ■	Office du Ranch de la Dihesse (Loudima)		
			77 ■	Ranch de Massangui (near Mouyounzi)		
			78 ■	Ferme Ovine d'Odziba (Région du Pool)		

Table 2.4, cont.

Country	- Research Centres		- Multiplication Herds		- Development Projects (HQ) -	
	No. & symbol	Name	No. & symbol	Name	No. & symbol	Name
Zaire	35 ✚	Laboratoire Vétérinaire de Kinshasa	79 ■	Groupement d'Economie Rurale (M'Banza - Ngungu, Bas-Zaire)	123 △	Progrès Populaire d'Idiofa (Idiofa, Bandundu)
			80 ■	Station de Mvuazi (Bas-Zaire)		
			81 ■	Ranch d'Inkisi (Bas-Zaire)		
			82 □	Ranch de Kolo (Bas-Zaire)		
			83 □	Ranches de Mateba (3) (Bas-Zaire)		
			84 □	Ranches des Plantations et Elevage de Kitobola (Kitobola, Lovo, Bas-Zaire)		
			85 ■	Station de Gimbi (Sous-region du Bas-Fleuve, Bas-Zaire)		
			86 □	Ranch de Donga Zola (Moanda)		
			87 □	Elevage du Diocèse de Kikwit (Bandundu)		
			88 □	Métayage du Bureau Diocésain de Développement (Kikwit, Bandundu)		
			89 □	Elevage de la Kalombi (Feshi, Bandundu)		
			90 ■	Ranch de Gungu (Bandundu)		
			91 □	Ranch de Ndjokélé (Mushie, Bandundu)		
			92 ■	Ranch de la Mpaka (near Gemena, Equateur)		
			93 □	Ranch de la Lombo (near Gemena)		
			94 ■	Ranch de la Lola (near Gemena)		

Source: Compiled by authors.

CHAPTER 3

DESCRIPTION OF TRYPANOTOLERANT LIVESTOCK

3.1 THE N'DAMA CATTLE GROUP

N'Dama is the most widely used name for the group of humpless longhorn cattle which includes the N'Dama breed and its varieties. The Fouta Djallon region of Guinea is said to be the area of origin of these cattle; Diallo (1965) mentions that the term N'Dama comes from the name of a Kadé village in the Gaoual area in the northern part of Fouta Djallon.

The original cattle in Africa were humpless longhorns which first appeared in Egypt. By the third millenium B.C. this type was apparently found throughout northern Africa, but was then replaced by a shorthorned humpless type. In northern Africa, the longhorns disappeared completely, but in West Africa they remained in the N'Dama area to the west and the Kuri area to the east. More recently, Zebu have exerted pressure on the northern boundary of the N'Dama zone.

3.1.1 NUMBERS AND DISTRIBUTION

The N'Dama, with about 3 400 000 head in West and Central Africa, is numerically the most important trypanotolerant breed. It is represented in all 18 countries covered by the study, as indicated in Table 3.1. In this table the original breeding area (Guinea and neighbouring countries) and the areas of more recent introduction are listed separately.

The eight countries forming the primary breeding area of the N'Dama can be divided into three groups:

a. Countries with virtually only N'Dama, including Guinea (except for a few N'Dama crosses in the northeast near Siguiri), Guinea Bissau, The Gambia (with a little crossbreeding in the east) and Sierra Leone;

Table 3.1 Distribution of the N'Dama group.

Country	N'Dama population in study area ('000)	Percentage of total N'Dama population	Total cattle population of study area ('000)	Percentage of N'Dama in total cattle population of study area
Original Areas				
Guinea	1 154	33.7	1 215	95.0
Senegal	746	21.8	1 310	57.0
Mali	465	13.6	1 810	25.7
The Gambia	296	8.7	296	100.0
Sierra Leone	207	6.0	207	100.0
Guinea Bissau	166	4.9	166	100.0
Ivory Coast	70	2.0	516	13.6
Liberia	11	0.3	26	41.2
Sub-total	3 115	91.0	5 546	56.2
Areas of Introduction				
Zaire	240	7.0	281	79.0
Congo	33	1.0	43	75.0
Ghana	17	0.5	777	2.2
Nigeria	15	0.4	766	2.0
Gabon	2	-	3	59.4
Camercon	1	-	2 917	-
Central African Republic	1	-	1 115	-
Benin	<1	-	726	-
Togo	<1	-	214	-
Upper Volta	<1	-	1 534	-
Sub-total	308	9.0	5 902	5.2
Total	3 423	100.0	11 448	29.9

Source: Information from country visits.

b. Sudano-Sahelian countries forming the transition zone between N'Dama and Zebu. This includes Senegal, with N'Dama in the south (Casamance and Senegal Oriental) but with more Zebu than N'Dama overall and an intermediate belt with crossbreds (Djakoré), and Mali, with a similar distribution of Zebu, N'Dama and crossbreds (Bambara);

c. Guinean countries forming the transition zone between N'Dama and Short-

horn, including Ivory Coast, where only the northwest is predominantly N'Dama and the humpless Baoulé and the Zebu are more numerous overall, and Liberia, with N'Dama in the north and Shorthorn (Muturu) in the south, both in small numbers.

The ten other countries included in the study have all imported N'Dama cattle. While numbers have increased considerably in some countries, in others N'Dama are rarely found outside the breeding stations or other government centres. Ivory Coast is in an intermediate position in that there are some original N'Dama areas but the breed has also been introduced in other parts of the country. Only in Guinea, the country with the largest N'Dama population, do numbers seem to be decreasing. The reasons for this trend are complex and are touched on in Volume 2. Apparently there is a migration of animals to neighbouring countries. In all the other original N'Dama areas the total number of cattle is rising fairly rapidly, partly due to improvements in disease control and meat marketing. However, as extensive crossbreeding is taking place in Senegal and Mali, the rise in total numbers is to some extent occurring at the expense of the pure breeds.

Turning to the countries where N'Dama have been introduced, the breed has increased rapidly in Zaire and Congo, especially on commercial and government ranches. In Ghana and Nigeria, the numbers continue to rise on government farms and ranches, but in the villages N'Dama sires are used mainly for crossbreeding with the local cattle. In the other countries studied, the total numbers of N'Dama cattle appear static at very low levels.

3.1.2 THE ENVIRONMENT

In their original breeding area, N'Dama are generally found in the Guinean and Sudano-Guinean bioclimatic zones, covering a considerable range of environments. Their original home, the Fouta Djallon massif, consists of Sudano-Guinean highland savanna. From there, N'Dama have spread to the Guinean zone and in upper Guinea, Ivory Coast, Sierra Leone and, to a lesser extent, Liberia they are found in the forest area. At the other extreme, they are found in much more arid zones - southern Sine Saloum and Senegal Oriental in Senegal and in Mali. In the areas where they have been introduced, N'Dama have adapted to diverse conditions, including forest environments in Congo, Ghana and Liberia and palm, cocoa and rubber plantations (see Figures 3.18 and 3.23).

3.1.3 BREED CHARACTERS

The standard descriptions of the Guinean N'Dama have been given by Doutressoulle (1947) and Coulomb (1976). The N'Dama breed has a medium-sized body, harmonious proportions and a straight facial profile. They are relatively compact animals with a fairly light skeleton, good for meat production. The head is large and strong. The muzzle varies in colour, but is usually pale in the typical type. The horns are rather variable from average length to long and from crescent

to lyre shape, though the lyre shape is considered the norm. The horns are amber with black tips. The back is straight and slightly sloping, especially among the females, and the rump is short, well muscled and more horizontal than among the Zebus. The coat is usually self-coloured in various shades of fawn to brown. Pied or mainly black coats also occur in the breeding areas, and particularly in the original breeding area of Fouta Djallon. The skin is thin and supple, the hair fine. There is a moderately developed dewlap, more apparent on the bull. Sexual dimorphism is marked. The bull is thick set and appears heavy, with a short, strong neck. The female is more slender with a lighter appearance and the udder is of medium size, the teats thin.

Typical Guinean N'Dama are found in Guinea, Sierra Leone, Liberia, Mali and Ivory Coast (see Figures 3.1 and 3.2). N'Dama in the new breeding areas are usually of the typical variety because imported animals have been carefully selected and atypical animals avoided. On the other hand, in their original breeding area N'Dama are surprisingly variable and rather small. In Senegal, the typical variety is called N'Dama Petite.

Two variations rather different from the Guinean type were observed in the field, one in Casamance (Senegal) and Guinea Bissau, the other in The Gambia and Senegal Oriental. The most common colour of Guinea Bissau N'Dama is not fawn, but white with black extremities. They are called N'Gabou or Boenca (see Figure 3.6). The same type predominates in Kolda and Velingara in Middle and Upper Casamance (see Figures 3.8 and 3.11). Black markings, especially on ears and muzzle, accompany a pale, often white, coat. Body and horns are of medium size. This colour pattern is particularly common around Velingara and is reminiscent of the Borgou of Benin. It is difficult to explain this special colour pattern, so different from the majority of N'Dama. There may have been absorption of West African Shorthorns which were previously found in this region but it seems more likely that this variety has arisen from a mixture with Zebu.

A Gambian N'Dama type is also found on the northern limits of the N'Dama area, in The Gambia, Senegal and Mali (see Figure 3.7). This population is continuous with the Zebu x N'Dama crossbreds (Djakoré, Bambara) and shows a similarity to them which must be due to a mixture with Zebu. Pale coat colours, especially fawn or white, predominate. These animals are fairly large, and their horns are usually long and strong. They appear less compact and thick set than the classical type. This variety used to be called N'Dama Grande in Senegal. It is found particularly in southern Sine Saloum and Senegal Oriental except in the Kedougou region where the animals are the typical Guinean N'Dama.

A type called the N'Dama of Kaarta or the crossbred of Kaarta is found in Mali. Its appearance is similar to that of the Gambian type, with uniform, light fawn coats.

3.1.4 HUSBANDRY SYSTEMS

3.1.4.1 Traditional

N'Dama are usually owned by Fulani (or Foula) people in The Gambia, Guinea and Sierra Leone. In these areas they are managed along similar lines in spite of the very different environments. However, there are many differences in detail which are noted in the country studies of Volume 2.

In general, cattle production under traditional management is becoming increasingly sedentary (see Figure 3.3) though transhumance is still practised in some areas. During the cropping season the animals are grazed on fallows and areas of natural vegetation (see Figure 3.9). In the dry season, they are brought back to the cultivated areas where they are fed crop residues (see Figure 3.15) and also graze in swamps, rice fields and various other areas which they cannot use during the wet season. Herding is continuous during the rains but much more casual in the dry season. The herds are gathered every evening and are either penned (Sierra Leone, see Figure 3.4) or tethered (The Gambia, see Figure 3.5), and sometimes the cows are tethered inside the pens. The unweaned calves are separated from their mothers, both in the pens and out in the pastures.

Under this system, cows are milked regularly, generally in the morning and evening (see Figure 3.14). Milk is important as a component in the family's diet and is also sold, often in curdled form. When the herdsman is paid a salary, milk is always part of his remuneration. The importance of milk in Fulani society justifies the special care given to young cows. It also explains the late weaning of calves because milking only takes place when calves are suckling, though this practice may have a detrimental effect on fertility. In some cases (e.g. in the western part of The Gambia) the herds do not belong to the Fulani, but herdsmen are recruited from this tribe. The same management practices are found. N'Dama herds under Fulani management can be quite large - from 50 to 150 head. In the Fouta Djallon, however, the herds are generally much smaller.

A characteristic of the composition of Fulani N'Dama herds is the large proportion of cows. In The Gambia, 70% of the herd may be females, with 45% adult cows. The proportion of males varies according to the importance of ox ploughing; there can be 10% more oxen in areas where draught animals are commonly used, as in upper Guinea. Towards the forest area where N'Dama have been introduced fairly recently, such as in the Guinean zone of Sierra Leone and Liberia, management is often rather different because the herds are looked after by other groups. Cattle are less carefully herded and milking is rare or incidental.

Better management and more favourable conditions for fodder production generally produce heavier animals. This is the case in Guinea, where the animals tend to be more solid and heavier in the forest region (Beyla) than in Fouta Djallon (Labé). In West Africa, calving takes place during the first part of the dry season, and mating occurs during the second part when it is cooler. The calving season is from November to February in Sierra Leone and from October to January in Ivory Coast.

3.1.4.2 Metayage

The metayage system is used to introduce cattle husbandry at the village level in regions where this has not been a traditional activity. The metayage is based on the provision of a basic breeding herd (5 to 10 heifers and a bull) to an individual or a small group by a commercial, governmental or religious organization which maintains central breeding herds (see Figure 3.21). The individual or group has a 5- to 10-year contract with the central organization which provides technical and veterinary assistance and veterinary products such as acaricides and minerals. Also, if losses in the basic breeding herd occur due to natural causes, the animals are replaced without charge.

The farmer, on his part, must provide basic facilities such as spraying equipment, a night pen or fenced pasture and a watering point. At the end of the contract, he must reimburse the organization for the breeding stock, sometimes plus interest, in the form of young animals. Assistance is still provided after the end of the contract if the farmer wishes, but the terms may be changed.

The most important metayage operations are carried out in Central African Republic, Gabon, Congo and Zaire. Dwarf and Savanna Shorthorn were originally preferred because of their smaller size and more docile temperament, but more recently large operations in Zaire and Congo have been based on N'Dama. These operations have achieved varying degrees of success, but altogether they have introduced about 100 000 head of cattle at the village level and have accomplished their main objective of interesting local farmers in cattle husbandry.

3.1.4.3 Ranching

The ranching system is most highly developed in Zaire and Congo and more recently in Ivory Coast and Nigeria (see Figures 3.24 to 3.26). Cattle are raised on fenced pastures where they graze day and night or are herded by day and kept in pens at night. They graze chiefly on *Hyparrhenia* grass which is common in the natural Guinean savanna areas where the ranches are found. Carrying capacity varies from 2 to 5 ha per head, and the savanna is burnt every year. Cattle usually have access to mineral salt licks and are dipped or sprayed 2 to 4 times a month, which is the only contact with people for the animals raised on fenced pastures. The herds are separated according to sex and age categories. Ranch sizes vary considerably from a few hundred to 25 000 animals.

3.1.5 PERFORMANCE

Table 3.2 presents a typical range of N'Dama performance levels, covering the more important traits under both traditional and improved management systems. These have been taken from the country sections of Volume 2. Figures for the traditional system come from The Gambia and Ivory Coast, those for ranches from Zaire and Ivory Coast and those for stations from Ivory Coast and Sierra Leone.

Table 3.2 Range of N'Dama performance levels under traditional and improved management.

Performance Trait	Management System		
	Traditional	Ranches	Stations
Age at first calving (months)	48	42	35-39
Calving interval (months)	18-24		14-15
Calving rate (%)	50	75-80	88
Mortality: calves (%)	12-30	10	-
1-2 years (%)	12	2-4	-
adults (%)	3		
Milk yield	0.4-0.8 kg/day (partial milking)	-	400-600 kg per lactation
Rate of gain	20-40 kg per year	0.3-0.7 kg per day	
Beef Production	**Mature Oxen**	**Steers**	
Age (years)	8-9	4	
Liveweight (kg)	360	365	
Carcass weight (kg)	167	199	
Dressing out %	46.0	54.5	

Source: Country studies in Volume 2.

3.2 THE WEST AFRICAN SHORTHORN

The original breeding area of the West African Shorthorn (WAS) stretches in an almost continuous belt from Liberia to Cameroon. They are found in all the coastal countries and also in southern Upper Volta. They are derived from the shorthorned humpless *(brachyceros)* cattle which appeared in ancient Egypt in the middle of the second millenium B.C. and were first recorded in West Africa during the second half of the first millenium B.C. Shorthorned humpless cattle are depicted among the prevailing longhorns in rock paintings on the Bauctic plateau of Nigeria dating from this period. Before the Fulani invasions of about 1820, they were the most common type in northern Nigeria (Epstein, 1971). They have nowbeen replaced by Zebus in this area and are under pressure from Zebus or from N'Dama in all other areas. More recently, Shorthorn cattle have been introduced into the francophone countries of Central Africa (Central African Republic, Gabon, Congo and Zaire), though they are not numerous in these countries and are found only in pockets.

The Shorthorn may be divided into two subgroups according to size, conformation and environment (see Figure 2.5):

1. The larger animals found in the Guinean or Sudano-Guinean savannas, from Ivory Coast to Cameroon. They are Baoulé (Ivory Coast and Upper Volta), Ghana Shorthorn, Somba (Togo and Benin), Savanna Muturu (Nigeria) and Bakosi, Doayo and Kapsiki (Cameroon). This typical Shorthorn type is referred to as Savanna Shorthorn;

b. The Dwarf Shorthorn, including the Lagune (Ivory Coast, Togo and Benin) and Forest Muturu (Liberia and Nigeria). These populations are found in small numbers in the coastal and forest regions. They were presumably derived from the larger type by natural selection in a humid forest environment where nutrition is poor and the climate harsh.

In Nigeria, no distinction is made and both groups are called Muturu (which means humpless).

3.2.1 THE SAVANNA SHORTHORN

3.2.1.1 Numbers and Distribution

There are approximately 1 673 000 West African Savanna Shorthorn found in eight countries of West and Central Africa, as indicated in Table 3.3.

In the northern parts of Ivory Coast, Ghana, Togo and Benin and in the southern part of Upper Volta, the West African Shorthorn is found in a relatively continuous belt through the savanna areas, as shown in Figure 2.5, although livestock densities vary considerably. There are some areas where the population is very dense, such as the Senoufo (Korhogo) and Lobi (Bouna) areas in northern Ivory Coast, the Lobi area (Gaoua) in southern Upper Volta, Wa, Tamale and Bolgatanga in Northern Ghana, the Dapaong savanna region and Kara (Lama Kara) in northern Togo and the Atacora plains in western Benin. Towards the east, there are many Shorthorn crossbreeds - from northeastern Benin eastwards where the Borgou type is found - and the original type is seen only in pockets. Thus the Shorthorn are found in a few scattered, isolated zones in Nigeria, while in Cameroon, the most eastern part of the original breeding area, there are only a few traces left in very small pockets.

The southern region is less densely populated. A belt from 200 to 400 km wide where almost no cattle are found stretches from Ivory Coast to the southeastern Nigerian highlands, approximately following the eighth parallel before bending to the south in Nigeria. This area stretches over Seguela, Bouaké and Bondoukou in Ivory Coast, Sunyani in Ghana, Atakpamé and Sokodé in Togo and Savalou and Savé in Benin, and it forms a crescent from Ibadan to Nsukka to Enugu in Nigeria. This region is characterized by peri-forest savanna vegetation (Ivory Coast, Ghana and Nigeria) or Guinean or sub-Guinean bush savanna (Togo, Benin), with disease affecting both humans (e.g. sleeping sickness, onchocercosis) and

livestock (e.g. trypanosomiasis, contagious bovine pleuropneumonia, rinderpest and streptothricosis).

Table 3.3. Distribution of the West African Savanna Shorthorn group.

Country and Breed Name	Shorthorn population in study area ('000)	Percentage of total Shorthorn population	Total cattle population of study area ('000)	Percentage of Shorthorn in total cattle population of study area
Original Areas				
Ghana (Ghana Shorthorn)	616	36.8	777	79.3
Upper Volta (Baoulé, Lobi or Méré)	484	28.9	1 534	31.6
Ivory Coast (Baoulé)	250	15.0	516	48.4
Togo (Somba)	144	8.6	214	67.3
Nigeria (Muturu)	82	4.9	766	10.7
Benin (Somba)	75	4.5	726	10.3
Cameroon (Doayo, Kapsiki, Bakosi)	7	0.4	2 917	0.2
Sub-Total	1 658	99.1	7 450	22.3
Area of Introduction				
Central African Republic (Baoulé)	15	0.9	1 115	1.3
Total	1 673	100.0	8 565	19.5

Source: Information from country visits.

The Shorthorn breeds have different names in the various countries of the study area, as follows:

- Baoulé: This name is used chiefly in Ivory Coast, after the Baouié tribe. Numbers are significant. Crossbreeding is mostly with Zebus in the north (Korhogo), and the breed is still relatively pure towards Bouaké, Dabakala and Bouna (see Figures 3.33, 3.37);

- Lobi: The Lobi tribe near Bouna in northeastern Ivory Coast and in the Gaoua region of southwestern Upper Volta breed cattle very similar to the Baoulé, which are called Lobi in both countries. In Upper Volta outside the Lobi area there is a high proportion of crossbreds (see Figure 3.38);

- Méré: This term (which means small) is used by the Fulani for both crossbred and purebred Shorthorns. It would be preferable to restrict this term to the crossbreds and to describe the purebreds as Lobi or Baoulé of Upper Volta;

- Ghana Shorthorn: The most common name used in Ghana is West African Shorthorn (WAS). However, this group includes a fairly large crossbred population with more Shorthorn than Zebu blood. In the northwest (Wa region), the populations linking those of northeastern Ivory Coast with those of southern Upper Volta are still relatively pure (see Figures 3.45 and 3.47);

- Somba: The Somba breed is a typical Shorthorn, very similar to the Baoulé. It is the predominant breed in Togo and forms a continuation in the north with the Ghana Shorthorn (see Figure 3.34 and 3.44). This breed is believed to have originated in the Atacora highlands in Benin where the Somba tribe lives, though east of the Atacora the Borgou breed predominates. In the rest of the country the cattle are of the Somba type as far south as Abomey (see Figures 3.44); further south the Lagune breed is found (see Figure 3.31).

- Nigerian Savanna Muturu: In Nigeria all Shorthorn are called Muturu. A large part of this population is found in the savanna regions of Benue and Anambra (30 000 to 50 000), and small numbers are found in Kwara and Oyo (4 000 to 7 000). There are no precise statistics available on Shorthorns in Nigeria but numbers are decreasing rapidly, a trend which began with the civil war in the late 1960s and has continued since then (see Figures 3.35 and 3.40).

3.2.1.2 Environment

The typical environment of these Shorthorn populations is the humid Guinean or Sudano-Guinean bush or grass savanna, characterized by tall perennial grasses (*Andropogon*, *Pennisetums* and *Panicum*). These areas are burnt annually and livestock, unless overstocked, perform well. In the dry season, the little pasture available is of good quality. The Shorthorns are not always found in a humid environment, however. They are sometimes found in Sahelo-Sudanian areas along with Zebus and crossbreds, for example in Upper Volta.

3.2.1.3 Breed Characters

Typically, Shorthorn are small animals, averaging 90 to 100 cm at withers for the breeds in Ivory Coast, 92 to 97 cm for the Somba of Atacora, and 98 to 110 cm for the Ghana Shorthorn (see Figures 3.33, 3.36). They have a compact conformation with good muscling. The head is heavy compared with the rest of the body. The forehead is wide and the facial profile straight. Horns are short, circular in section and thick at the base, being thicker on bulls and firmer and more pointed on cows. The horns project laterally, forming a crescent pointing for-

wards and sometimes upwards (in males). They are pale in colour, sometimes with black tips. Ears are small and lateral. Mucosae are usually black. Neck and withers are short, thin in cows and thick in bulls, forming a continuous line with the back. The dewlap is small. The back is straight, loins short, chest wide and round but constricted behind the front legs, sloping down slightly from rump to withers. The tail is long with a high and protruding attachment. The terminal tuft is conspicuous. The udder is small and retracted and the teats poorly developed. In more wooded areas, black or black-and-white coats predominate, though occasionally brown, red or fawn animals are also found.

3.2.1.4 Husbandry Systems

Shorthorn cattle are usually kept by sedentary farmers. In some cases livestock still play an important traditional role in society, for example among the Lobi of Ivory Coast and Upper Volta and the Kapsiki and Doayo of northern Cameroon, while in other areas they are kept for milk or meat production or as draught animals (see Figures 3.45, 3.46 and 3.47).

In traditional systems where livestock are chiefly kept for religious or social reasons, they are usually slaughtered on ritual occasions, such as funerals, circumcisions and weddings. Cattle are also often included in dowries. In such societies, cows are never milked and draught animals are not used. During the cropping season (and sometimes in the dry season) the herd is tended by village children or by herdsmen belonging to the same tribe. The number of animals per family is very small and the village cattle are usually combined in one or more collective herds which go out to pasture together. In certain isolated villages in the forest and in the plantation areas, the animals are often left to roam freely. Cultivated plots near the homesteads are protected by hedges.

In most areas where Shorthorn cattle are kept for meat, milk or draught power, husbandry systems are changing rapidly, but they tend to have several characteristics in common. Animals from several owners are generally herded together, looked after by hired Fulani herdsmen, for example in Ivory Coast, Ghana, Togo and Benin. Milking is practised; milk is part of the herdsman's wages and the owners are beginning to introduce milk into their diets as well. Commercial offtake is often slight; animals are consumed by the villagers themselves, usually as part of traditional ceremonies. The use of draught animals is increasing in several Shorthorn areas such as southern Upper Volta, northern Ivory Coast and northern Ghana, and for this reason crossbreeding with Zebu is increasing virtually everywhere.

Baoulé cattle have also been introduced in Central African Republic as part of a large-scale metayage operation (see Figure 3.48).

3.2.1.5 Performance

Most Shorthorn cattle are bred under traditional village conditions, but some productivity statistics have been recorded at research stations, such as

Nungua in Ghana and Bouaké in Ivory Coast. Table 3.4 presents some typical Savanna Shorthorn performance levels, covering the more important traits under both traditional and improved management. These have been taken from various country sections of Volume 2.

Table 3.4 Range of West African Savanna Shorthorn performance levels under traditional and improved management.

Performance trait	- Management System -	
	Traditional	Improved
Age at first calving (months)	ca. 48	26-35
Calving interval (months)	18-24	12-13
Calving rate (%)	40-55	82-85
Mortality: birth - 1 year (%)	15-17	n.a.
1 - 2 years (%)	5-6	n.a.
adults (%)	3-4	n.a.
Milk yield (kg)	100-300 (incomplete milking)	up to 700
Rate of gain	n.a.	0.2-0.5 kg/day
Beef Production	Males	Males
Age (years)	5+	4+
Liveweight (kg)	188-191	267
Carcass weight (kg)	n.a.	133
Dressing out %	n.a.	49.5

Source: Country studies in Volume 2.

3.2.2 THE DWARF WEST AFRICAN SHORTHORN

The Dwarf Shorthorn are known as Lagune in the francophone countries and Muturu in the anglophone. They are distinguished from the Savanna Shorthorn geographically and by their smaller size.

3.2.2.1 Numbers and Distribution

There are about 98 000 Dwarf Shorthorn cattle in the study zone, making them the smallest trypanotolerant cattle group. Their numbers are usually estimated, rather than based on recent censuses. Table 3.5 gives the estimated population of Dwarf Shorthorn in each country where they are found. Of the total population, 75% are found in Nigeria, Benin and Liberia, which are the original breeding areas, and 25% in Zaire, Congo and Gabon where they have been introduced

more recently. Additionally, small populations of less than 1 000 are found in Ivory Coast (Lagune), Ghana (Muturu), Togo (Lagune) and Cameroon (Muturu).

As shown in Figure 2.5, Dwarf Shorthorn cattle are found scattered along the coastal areas and southern forest zones from Liberia to Cameroon, with some populations in very small pockets. Recent areas of concentration are Maryland and Sinoe Counties in southern Liberia, South Province, especially Ouémé, in Benin, and Bendel, Cross Rivers, Imo, Ondo and Ogun States in southern Nigeria. All the Muturu in Nigeria are not included in this estimate of the Dwarf Shorthorn population however, only those of the forest zone which constitute approximately one-third of the total. In Ivory Coast, Ghana, Togo and Cameroon, Dwarf Shorthorn numbers are very low; in fact, the breed is in the process of extinction. Traces of two other Shorthorn populations were found, one in Basse Casamance in Senegal and in southwestern Gambia and the other in Guinea Bissau (the Manjaca breed). These two populations are being rapidly absorbed by the N'Dama, and their numbers are so low that they need not be discussed. The Dwarf West African Shorthorn has also been introduced into Congo, Zaire and Gabon in Central Africa at the village level, through the metayage system (see Figures 3.28, 3.30, 3.32).

Table 3.5. Distribution of the Dwarf Shorthorn group.

Country and Breed Name	Dwarf Shorthorn population in study area ('000)	Percentage of total Dwarf Shorthorn population	Total cattle population of study area ('000)	Percentage of Dwarf Shorthorn in total cattle population of study area
Original areas				
Nigeria (Muturu)	38.0	38.8	766.0	5.0
Benin (Lagune)	20.0	20.4	726.0	2.7
Liberia (Muturu)	15.0	15.3	25.5	5.9
Sub-Total	73.0	74.5	1 517.5	4.8
Areas of introduction				
Zaire (Dahomey)	13.0	13.3	281.0	4.6
Congo (Lagune)	10.8	11.1	43.3	25.0
Gabon (Lagune)	1.1	1.1	3.2	34.4
Sub-Total	24.9	25.5	327.5	7.6
Total	97.9	100.0	1 845.0	5.3

Source: Information from country visits.

3.2.2.2 Environment

Dwarf Shorthorn cattle are found in the coastal or forest belt of the Gulf of Guinea, from Monrovia to Douala. The vegetation in this zone is diverse: there are forest, farming and cleared areas in Nigeria, coastal savannas in Liberia's Maryland County, flood plains in Ouémé in Benin, lagoon areas with savanna in Benin, and palm groves in the Sassandra area of Ivory Coast. Cattle are rarely kept in dense forests where there is very little pasture. Rather they are found in the derived savannas, such as Maryland County in Liberia and in Benin, where soil and vegetation are not favourable. Coconut palms are numerous and the pasture is scanty and of poor quality, with *Imperata cylindrica* the most common grass, which has a low feed value. Fallow fields in cultivated areas also provide poor feeding because of inedible bushes. Thus in terms of nutrition, the environment is harsh.

3.2.2.3 Breed Characters

The Dwarf Shorthorn differs from the typical West African Shorthorn chiefly in terms of its smaller size - 85 to 90 cm at withers compared to 90 to 110 cm (see Figures 3.27, 3.28). The head is less bulky and longer, with a conspicuous poll and protruding eyes. The horns are very imperfect, often thin or flat and sometimes loose or absent. The line of the back slopes down from rump to withers more steeply (3 to 5 cm) than in the Savanna Shorthorn. Coats tend to be pure black, especially among the Lagune.

3.2.2.4 Husbandry Systems

In the Lagune cattle areas, livestock production is of secondary economic importance. Cattle are consumed by the family on special occasions. The herd is sedentary and not always tended; night pens have recently been introduced and in some cases animals are tethered during the day to protect the crops. There is no tradition of milking and there are no skilled herdsmen. Cattle are never given supplementary feeding, with the exception of minerals in some cases, and they receive virtually no veterinary attention.

A more elaborate and productive system is being developed on palm plantations where cattle are herded and tethered individually to the coconut, oil palm or cocoa trees in order to fertilize them (see Figure 3.29, 3.63). As the females come into season for short periods which are difficult to detect, this isolation of the animals leads to poor reproductive performance. Herdsmen are employed, and if they are Fulani the cows are milked. Some animals are also sold outside the village.

In almost all areas where Dwarf Shorthorn are kept, for example Benin, Ivory Coast and Togo, there is a tendency to introduce heavier Borgou, Sanga or N'Dama sires with the aim of improving herd productivity in terms of size and meat and milk production.

3.2.2.5 Performance

Few studies have been carried out on the performance of Dwarf Shorthorn cattle. Lagune cattle kept at the Samiondji station in Benin (FAO project) showed a calving rate of 58%, with mortality at 24% up to one year and 5% for adult cows. Calves weighed 10 kg at birth, 48 kg at 6 months and 85 kg at 1 year. The average weight of adult cows has been estimated by several authors at 130 to 180 kg.

3.3 THE ZEBU X HUMPLESS CATTLE GROUPS

In general in West Africa humpless cattle are found in the humid zone (annual rainfall exceeding 1 m) and the Zebu in the drier tsetse-free zone (annual rainfall often under 500 mm). In the intermediate zones, there are several crossbreed types which have different names in different countries. Crossbreeding seems to be increasing in most countries, with Zebu moving towards the humid zone in the south traditionally populated by the humpless type. These movements of Zebu include both transhumance during the dry season in search of forage and water and more-or-less permanent migration leading to sedentarization. In both cases, Zebu and humpless herds meet and stay together for long periods with resultant increased crossbreeding.

Crossbreeding is not generally accidental; it is usually controlled with a male Zebu introduced into a humpless cow herd. The most common motivation is to produce a suitable conformation for a draught animal, plus higher meat production and higher milk yield. Only rarely does crossbreeding occur the other way round - between humpless bulls and Zebu cows. The Zebu x humpless crossbreeds may be divided into two main subgroups according to the original humpless female type involved - N'Dama or Shorthorn.

3.3.1 NUMBERS AND DISTRIBUTION

A total of 2 441 000 Zebu x humpless crossbreds are distributed throughout 11 countries of West and Central Africa. Table 4.6 gives estimated numbers in each country of N'Dama and Shorthorn crosses.

Large numbers are found in a continuous belt through Senegal, Mali, Upper Volta, Benin and Nigeria. Here crossbreeds have existed for some time and commonly a stabilized type has developed, for example the Djakoré and the Borgou. The boundary between the N'Dama and the Shorthorn crossbreeds is the Mali - Upper Volta border; the N'Dama are found to the west and the Shorthorn to the east.

Figure 2.5 illustrates the distribution of the crossbreed types. Although the main breeding area is the Sudanese belt which stretches from Senegal across southern Mali and northern Benin to Nigeria, the coastal zone is also becoming

populated with crossbreds. The coastal savanna stretches from Accra in Ghana to Cotonou in Benin. Because the average rainfall is low (less than 1 000 mm), this area is not forested but is largely savanna country with oil palm and coconut groves. In both the savannas of the Accra plains and the coconut groves of southern Benin, the main cattle type is the Sanga or Borgou. The few Lagune herds left in this area are being absorbed.

Table 3.6. Distribution of the Zebu x humpless cattle group.

Country and Breed Name	Zebu x N'Dama cross-breds ('000)	Zebu x Shorthorn cross-breds ('000)	Percentage of all cross-breds	Total cattle population of study area ('000)	Percentage of cross-breds in total cattle population of study area
Upper Volta (Méré)	-	540	22.1	1 534	35.2
Mali (Bambara)	522	-	21.4	1 810	28.8
Benin (Borgou)	-	500	20.5	726	68.9
Senegal (Djakoré)	406	-	16.6	1 310	31.0
Nigeria (Keteku)	-	165	6.7	766	21.5
Ghana (Sanga)	-	122	5.0	777	15.7
Togo (Borgou)	-	66	2.7	214	31.0
Guinea (Méré)	61	-	2.5	1 215	5.0
Ivory Coast (Méré)	-	36	1.5	516	7.0
Zaire	21	-	0.9	281	7.5
Central African Republic	2	-	0.1	1 115	0.2
Total	1 012	1 429	100.0	10 264	23.8
	2 441				

Source: Information from country visits.

In many of the countries with trypanotolerant cattle, crossbreeding is increasing, leading to a steady rise in the proportion of Zebu blood. This results in heterogeneous populations which are difficult to classify. An attempt has been made in Volume 2 to define the main types in each country concerned and to estimate their distribution.

3.3.2 ENVIRONMENT

The Zebu x humpless crossbreed environment is the Sudanese zone. This is an important agricultural area, producing groundnuts, cotton and sorghum. Farming is intensive and livestock density is high. During the rainy season, live-

stock are confined to the fallows or areas unsuitable for cultivation. During the dry season, the animals are left to graze freely and agricultural residues contribute substantially to their diet. These residues are usually cereal straws and groundnut haulms. Fodder is not usually grown specially for cattle, but there is an abundance of groundnut stalks and standing hay in the area.

3.3.3 HUSBANDRY SYSTEMS

When the herdsmen are Fulani, the management of crossbred herds is similar to that of the N'Dama. Draught animals are widely used to pull carts and ploughs in many of these areas, such as Sine Saloum in Senegal, southern Mali southern Upper Volta and Borgou Province in Benin. The cattle are also used for manuring the fields; in Borgou Province of Benin, for example, animals are tethered in the fields after the harvest and agricultural residues form part of their feed supply in the dry season. Herds are often large (50 to 150 head) and the percentage of males is high (28 to 32%).

3.3.4 ZEBU X N'DAMA CROSSBREEDS

There are two main types of Zebu x N'Dama crossbreeds - the Djakoré of Senegal (see Figures 3.49, 3.53 and 3.54) and the Bambara of Mali (see Figure 3.55).

3.3.4.1 Djakoré

The Djakoré of Senegal are a cross between Gobra Zebu and N'Dama. They are mainly found in the Sine Saloum and Senegal Oriental Regions. All intermediate types between the N'Dama Grande and the Gobra Zebu (or Senegal Fulani) are considered Djakoré. They are large, 135 cm at withers at Bambey. The hump is not very conspicuous and is carried further forward than in the Zebu. The skeleton is light. The horns are thin, and usually rather long. The coat varies but is mostly self-coloured and pale - white, greyish or yellow.

Very few data are available on Djakoré performance under traditional management, but some records have been kept on research stations, such as the Bambey CNRA and the Dakar Laboratory at Hann. As an indication of possible body weight, Hamon (1969) quotes 140 kg for females and 159 kg for males at one year, 236 kg for females and 260 kg for males at two years, and 332 kg for females and 369 kg for males at three years at the Bambey CNRA. According to Pagliese and Calvet (1973), Djakoré males between the ages of 3 and 5 years gained an average of 938 g/day during a 112-day intensive fattening test. The average food conversion index was 8.1. In terms of weight gain and ration efficiency, the Djakoré's performance was lower than the Zebu's but higher than the N'Dama's.

3.3.4.2 Bambara

The Bambara (or Méré) in western Mali are a continuation of the Senegalese

Djakoré. Their origin is similar, except that the Zebu parent is the Sudanese Fulani Zebu of Mali instead of the Gobra Zebu. Northeastern Guinea and northwestern Ivory Coast also have small populations of Bambara. Doutressoulle (1947) considers this Bambara type a stabilized variety, with a relatively uniform conformation. The situation is rather complicated in southern Mali which is the transition zone between the N'Dama and the Shorthorn. Here the heterogeneous populations are called Méré, but according to Dumas (1973) the Méré are an intermixture of three breeds, the N'Dama, Zebu and Shorthorn of the Baoulé type. These Méré populations are made up of animals similar to the Bambara, together with N'Dama x Baoulé crossbreds, Baoulé x Zebu crossbreds and a few Shorthorn. It is impossible to speak of a Méré breed or to define an average type as the Fulani use this name for all cattle which are smaller than the Zebu.

According to Dumas (1973), coats vary considerably and estimated body weights are 255 kg for cows, 270 kg for bulls and 310 kg for oxen.

3.3.5 ZEBU X SHORTHORN CROSSBREEDS

There are three main types of Zebu x Shorthorn crossbreeds, the Méré in Upper Volta and Ivory Coast (see Figure 3.55), the Sanga in Ghana (see Figure 3.57), the Borgou in Togo and Benin (see Figures 3.50 and 3.58) and the Keteku in Nigeria (see Figures 3.51 and 3.59).

3.3.5.1 Méré

It has already been mentioned that in Upper Volta both Shorthorn and crossbreds are known as Méré. In order to avoid confusion, the term Méré is used here to describe the crossbreds only. The Méré observed in Upper Volta and northern Ivory Coast are a cross between the Fulani Zebu and the Baoulé Shorthorn. The zone inhabited by these populations in southern Upper Volta is a continuation of the Mali zone. Their external appearance varies: the size is generally quite small, 100 to 110 cm at withers. The horns are medium-sized and the coat is often black. These crossbreds have been developed recently and there are several herds where first or second generation crossbreeding is evident, using Zebu or Zebu-cross bulls with Baoulé cows.

3.3.5.2 Sanga

The Sanga of northern Chana are very similar to the Méré just described. In the Accra Plains and Volta Region of southern Ghana, however, there is a Sanga which, oddly enough, resembles the Borgou and is called White Sanga because of its white coat. This type is more stabilized than the northern Sangas which vary like the Méré.

3.3.5.3 Borgou and Keteku

The Borgou are mainly found in northern Benin, but they are beginning to

spread throughout the country. They originate from the partial absorption of the Somba breed by the White Fulani Zebu, and they are now relatively stabilized (see Figure 3.62). In Nigeria the term Keteku is used to describe a population part of which is very similar to the Borgou, though it also includes animals which differ from the Borgou in colour, size and shape. Two similar Nigerian populations, formerly known as the Biu in Bornu State and the Yola in Longola State, seem to have disappeared. It is said that they have been absorbed by the Zebu which are predominant in these areas. The small Shorthorn populations in Cameroon have not produced any specific crossbreed type, although an absorption process is apparently under way there too. The Borgou of Benin and the Keteku of Nigeria are very similar; they are found on both sides of the border, in Borgou Province east of Parakou in Benin and in Kwara State and north of Oyo State in Nigeria. They seem to be of common origin, crosses between White Fulani Zebu and Somba from Benin or Savanna Muturu from Nigeria. These relatively stabilized populations are often considered to be breeds. The predominant coat colour is white, often with black points (ears and nose); in addition, some are white with black spots or black-and-white. The hump is usually inconspicuous and the horns are quite short.

Size increases in proportion to the percentage of Zebu blood, and typical cow body weights are 237 kg for the Borgou in Benin (FAO/UNDP, 1977) and 295 kg for the Keteku in Nigeria (Oyenuga, 1967). Calving rates of 52% have been recorded under traditional management, reaching 75% under improved management, such as in the FAO project in Benin. Age at first calving has been recorded from three to four years in Nigeria and Ghana, but is most probably over four years under traditional management.

3.4 SHEEP AND GOATS

Djallonké sheep and Dwarf goats are found throughout the tsetse areas of West and Central Africa where there are no other breeds of small ruminants. There is little experimental work on their tolerance to trypanosomiasis, but the fact that they are able to live without any veterinary attention, and yet show little or no sign of disease in an infested zone, is taken as evidence of their trypanotolerance.

3.4.1 NUMBERS AND DISTRIBUTION

Sheep and goats are found in large numbers in each of the 18 countries of the study area. Table 2.1 gives the estimated numbers of each species in each country. For three countries, it was not possible to obtain estimates of the two species separately and therefore estimates of total small ruminants are quoted from FAO (1978).

There are 72 million sheep and goats in the 18 countries studied, with between 26 and 27 million in the study area which are all considered trypanotolerant.

There are 1.3 goats for each sheep in the 15 countries where the population of each species is known, and 1.7 goats for each sheep in the study areas of those countries. In the coastal countries from Senegal to Liberia, there are more goats than sheep, with the exception of Guinea where there are equal numbers of the two species. In Ivory Coast, Ghana, Togo and Benin on the other hand, there are more sheep than goats. In Nigeria and the Central African countries there are more goats than sheep, with sometimes very high ratios such as 10 goats to 1 sheep in the Central African Republic and 3 goats to 1 sheep in Zaire.

3.4.2 ENVIRONMENT

As the two species are found throughout the entire study area, the description of the environment given in section 2.1 is relevant. Sheep and goats are reared in many different environments and appear to adapt easily. It is common to find animals of apparently the same type living in the dense forests of the equitorial Guinean zone, in the Sudan zone and in the highlands. Although there are large areas of West and Central Africa without cattle, sheep and goats are present everywhere, especially in all densely populated regions. Another difference between the distribution of cattle and that of sheep and goats is that non-trypanotolerant Zebu cattle show a tendency to extend south into tsetse-infested areas, whereas, among sheep in particular, the trypanotolerant types are found right up to and sometimes beyond the northern tsetse boundary, especially in Mali and Cameroon.

3.4.3 HUSBANDRY SYSTEMS

The management system is usually similar for sheep and goats, but varies according to the type of environment. In the forest environment, sheep and goats are usually left free to roam around the villages and in nearby coffee or cocoa plantations and palm groves (see Figures 3.75 and 3.85), suffering injuries and losses both on roads and from crop owners. They are usually brought back to the village in the evening, where they may be kept in a special hut or sometimes tethered (see Figure 3.71). Their main diet consists of grass from roadsides and domestic refuse. In savanna country on the other hand, it is common to see collective village flocks which are often tended together with the cattle (see Figure 3.47). Sheep are frequently tethered near the village during the cropping season, while in the dry season as a rule they are left to roam free. The number of animals per family is often higher in the savanna areas than in the forest. In the humid zone, sheep and goats are reared for meat production and play important social roles, given as part of dowries or gifts or slaughtered in honour of special guests. They are never milked in the forest areas and only occasionally in the savannas of Guinea, Upper Volta and northern Nigeria.

3.4.4 SHEEP DESCRIPTION

The trypanotolerant sheep of West and Central Africa are sufficiently homogeneous to be considered as a single group, the Djallonké (see Figures 3.70 to

3.77). Other common names are Fouta Djallon, Guinean Southern sheep or Forest sheep. This group is the one described by Mason (1951) as 'West African Dwarf' sheep. Epstein (1971) distinguishes the Dwarf sheep of Cameroon and the Dwarf sheep of West Africa, but it is difficult to accept this distinction. The Djallonké group includes all the populations of small sheep in West and Central Africa, and in this report two sub-groups are recognized, the Dwarf Forest type and the Savanna type, which includes the sheep populations of the Sudanese belt near the northern boundary of the tsetse area known under different names in each country, such as the Mossi sheep of Upper Volta (see Figure 3.76).

The Djallonké is a hair sheep with a thin tail. The Savanna type is larger than the Forest type: the Dwarf Forest sheep measures from 40 to 55 cm at withers, while the Savanna sheep averages 55 to 65 cm. In general, the higher the altitude the larger the sheep, as in Cameroon for instance. The head is small with a straight profile. The ears are also small and droop a little, but less than in the Sahelian type. The males have short spiralled horns, larger among the Savanna sheep than among the Dwarf Forest type. In general, females are hornless, but they sometimes have spurs. The hair of the adults is short and quite smooth, but sometimes rough among the young. The well-developed mane of the rams is a characteristic of this group. It is made up of a mass of long hairs which, in general, cover the neck, withers, shoulders and front part of the chest. The main coat colour is white with black spots (see Figures 3.70 and 3.74), though some are also plain white (see Figure 3.71) or plain black. Tan or tan-and-white animals are rare in West Africa. However, in Central Africa a sheep population is found in forested areas with a wide variety of coat colours, including white, black, red and combinations. There is, in particular, a red sheep with a black belly, described by Epstein (1971) among the dwarf sheep of Cameroon, which is similar to and could be the ancestor of the Barbados Blackbelly sheep. These are also found in the coastal regions of Gabon, Congo and Zaire (see Figures 3.72).

3.4.5 SHEEP PERFORMANCE

There are almost no records of Djallonké sheep performance under village conditions, but a few studies have been carried out at research stations. Females are early maturing, especially in the equitorial Guinean environment, with first lambing sometimes before one year (Rombaut and Van Vlaenderen, 1976). Several studies carried out in other environments record an average age at first lambing of 18 months. Prolificacy varies according to region, with 117% recorded in Cameroon (Vallerand and Brankaert, 1975), 110% in Ivory Coast under village conditions (Ginisty, 1976), 127% from another sample in Ivory Coast (Rombaut and Van Vlaenderen, 1976) and 161% in Nigeria (Dettmers and Hill, 1974). These studies all report twin lambings but very few triplets. However, in Nigeria Dettmers and Hill (1974) recorded 8% triplets and 55% twins at the Ibadan University Farm. The average lambing interval is eight months according to different authors. Annual overall fecundity can be very high, for example 206% according to Rombaut and Van Vlaenderen (1976) and 175% according to Ginisty (1976) under village conditions.

The Djallonké sheep are very well adapted to their environment. Both in the savanna and forest regions, they generally appear in good health. However, the mortality rate is high among the young. Rombaut and Van Vlaenderen (1976) point out that this high mortality rate among the young curbs numerical productivity considerably in lower Ivory Coast, despite the very high fecundity rate. According to the same authors, mortality is correlated with the ewe's general condition and with lamb weight at birth. They point out maximal mortality rates for offspring of primaparous ewes and the pluriparous ewes worn out by close gestations. In Nigeria, Matthewman (1977) reports mortality rates of 15% before weaning and 11% for adults under village conditions, but these estimates seem rather low, especially for young animals. According to Vallerand and Brankaert (1975), mortality rates under village conditions in southern Cameroon are 35% from 0 to 8 months and 10% from 8 to 16 months.

The growth rates of Djallonké sheep have been recorded at various stations. At Ibadan University Farm, Oyenuga (1967) recorded average weights of 11 kg for females and 12 kg for males at six months, 16 kg for females and 19 kg for males at one year, 24 kg for both females and males at two years, and 24 kg for females and 31 kg for males at three years. Carcass yields recorded in Ivory Coast by Ginisty (1976) averaged 46.7% for all males and 49.6% for fattened males. Studies carried out in Nigeria (Dettmers and Hill, 1974) and in Cameroon (Vallerand and Brankaert, 1975) report average carcass yields varying from 39 to 53%.

3.4.6 GOAT DESCRIPTION

The main characteristic of the goats studied in the tsetse-infested area is their small size. On the whole, populations from Senegal to Zaire are sufficiently similar to fit into one group, commonly known as West African Dwarfs (see Figures 3.78 to 3.85). Other names used are Guinean goat or Guinean Dwarf goat, Djallonké goat or Fouta Djallon goat or Forest goat, though it is not easy to distinguish between these different breeds in each country. The Dwarf goats are also very similar in the forest and savanna areas within the tsetse zone. Forest goats are smaller than the savanna populations, but the savanna goats are also dwarf. According to Epstein (1971), the Dwarf goat of Nigeria is kept by the Hausas in the northern part of the country in Sokoto, Katsina and Zaria. Attempts to classify these goats into different breeds on the basis of their size are hazardous and unjustifiable.

Dwarf goats measure 40 to 50 cm at withers and are stocky with short legs. The head is short and wide, the ears are medium sized and carried horizontally or erect, and the horns are short, wide at the base in males and more slender in females. There are also a few hornless animals. Colours vary considerably: the most common coats are fawn to brown with a black back line, tail and belly (Chamoise) (see Figure 3.81), black (see Figure 3.80), black-and-white (see Figure 3.82), white, yellow or tricoloured white, red and black. In the forest areas, dark coats and black-and-white are common. In savanna areas, the predominant coat colours are fawn and brown, becoming lighter towards the Sudanese belt in the north.

3.4.7 GOAT PERFORMANCE

Age at first kidding is 13 to 14 months on stations and 14 to 18 months under village conditions. Fertility and prolificacy can be very high: Buadu (1972) reports 35% single, 47% twin, 17% triplet and 1% quadruplet births in Ghana, and Matthewman (1977) reports 27% to 34% single, 62 to 67% twin, and 5 to 6% triplet births in Nigeria. According to Matthewman (1977), prolificacy increases considerably with the number of kiddings, averaging 100 to 110% at first kidding, 150 to 170% at second and third kidding and 200% at fourth, fifth and sixth kidding. The kidding interval averages about eight months.

Dwarf goats are well known for their hardiness and adaptability, and in particular their trypanotolerance. The normal mortality rate is 15% under village conditions, according to Matthewman (1977). On stations, the mortality rate is sometimes very high, due mainly to Peste des Petits Ruminants (PPR) and gastro-intestinal parasites. Rearing goats or sheep in large units is extremely difficult. The growth rate for Dwarf goats is slower than for Dwarf sheep, but few data are available.

3.5 CONCLUSIONS

In the study area, the N'Dama represent the largest population of trypanotolerant cattle, with approximately 3.5 million head, while there are 1.7 million Savanna West African Shorthorn, 0.1 million Dwarf Shorthorn and 2.4 million Zebu x humpless crossbreds. There are also approximately 11.5 million trypanotolerant sheep and 15 million goats. N'Dama are found in all 18 countries of the study zone, Savanna Shorthorn in 8, Dwarf Shorthorn in 6, crossbreds in 11, and sheep and goats in all 18.

The number of N'Dama appears to be increasing, but the Savanna Shorthorn are declining slowly and the Dwarf Shorthorn are declining rapidly, mainly due to crossbreeding, resulting in an increase in crossbred cattle types. Sheep and goat populations appear relatively static overall. The type and degree of cattle crossbreeding vary over time with gradual changes in feed availability and disease frontiers influenced by climatic conditions.

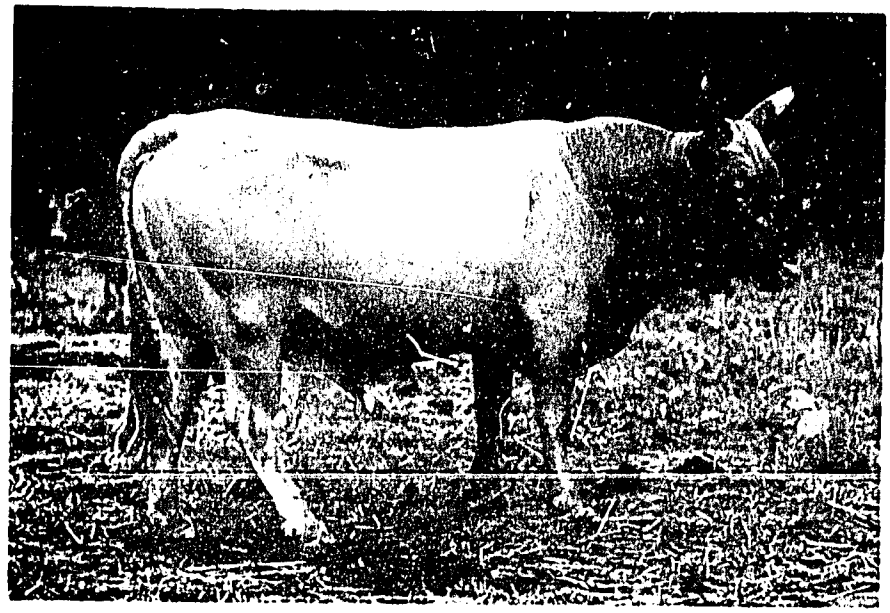
N'Dama and crossbred cattle types are found in both traditional and ranching systems, while West African Shorthorn cattle and sheep and goats are generally found in traditional systems only. The metayage system is used to introduce cattle husbandry at the village level in situations where this has not been a traditional activity.

It has been suggested on a number of occasions that Zebu and trypanotolerant cattle maintained on natural savannas have different grazing patterns, with the trypanotolerant animals less selective and better able to utilize poor

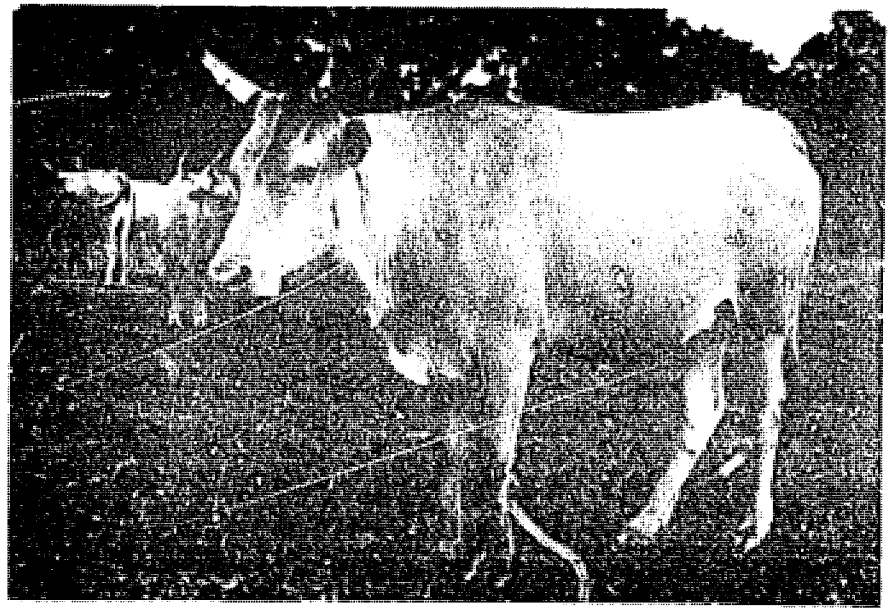
quality forage and thus exploit the natural savannas more fully. No objective information in support of this contention has been found, however.

Although trypanosomiasis is the major disease limiting the use of Zebu cattle in the tsetse zone, it is not the only one. The trypanotolerant cattle are also more resistant to streptothricosis, which is widespread throughout West Africa and for which there is no effective prevention or cure (see Coleman, 1967; Obeid, 1973; Roberts and Gray, 1973). There is little precise experimental evidence on this point, but it was mentioned by Stewart (see Epstein, 1971) and it was noted during several of the country visits (e.g. Sierra Leone, Ivory Coast, Ghana, Nigeria, Zaire). Some authors maintain that the N'Dama and the West African Shorthorn appear more resistant than the Zebu to other diseases, such as pleuropneumonia (Stewart, 1937) and tick-borne fevers (Esuruoso and Hill, personal communication), but again there are no precise data. Nevertheless, the reistance to streptothricosis may well be an important advantage of the N'Dama and West African Shorthorn over other breeds.

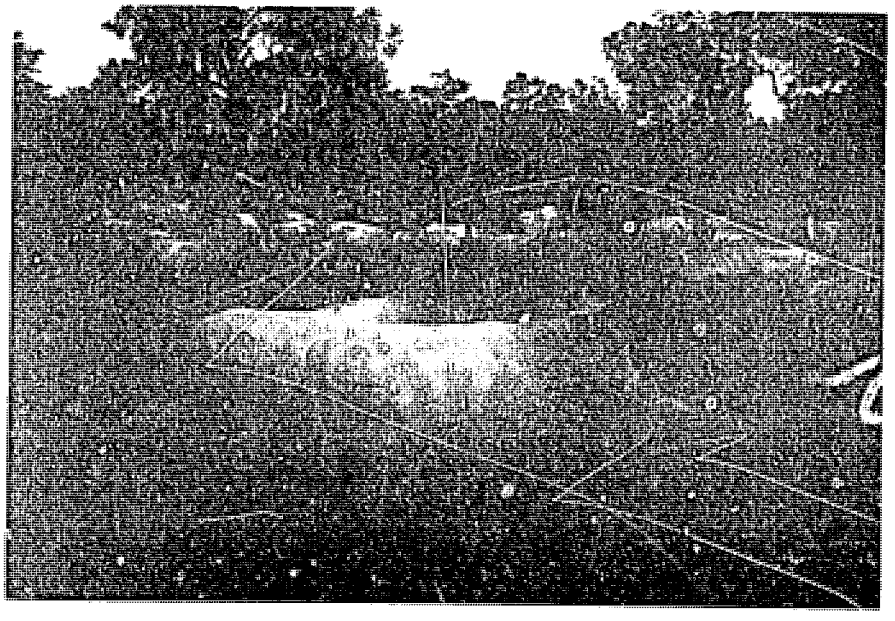
3.1
Taureau N'Dama typique
(Yanfolila, Mali)
Typical N'Dama bull
(Yanfolila, Mali)



3.2
Vache N'Dama typique
(Yanfolila, Mali)
Typical N'Dama cow
(Yanfolila, Mali)



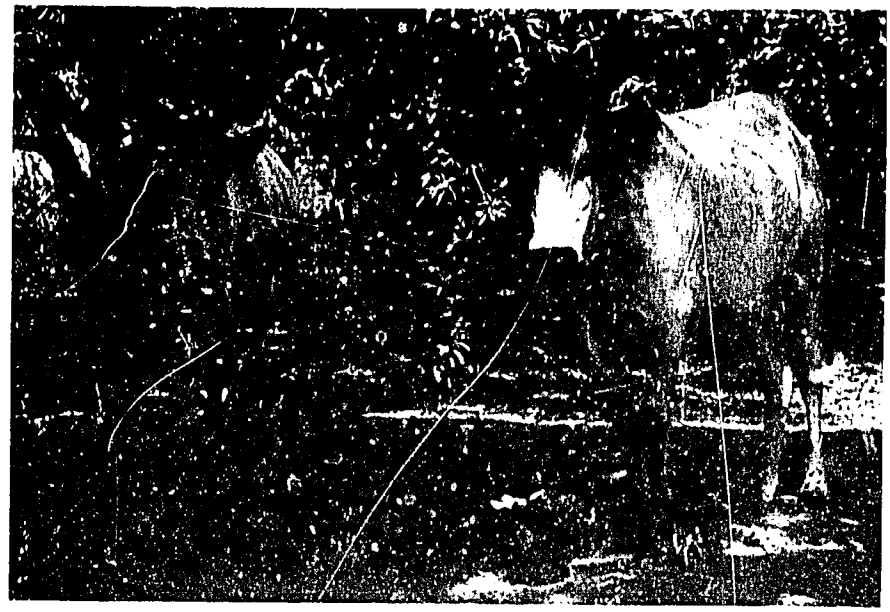
3.3
N'Dama : troupeau villageois
(Narena, Mali)
N'Dama village herd
(Narena, Mali)



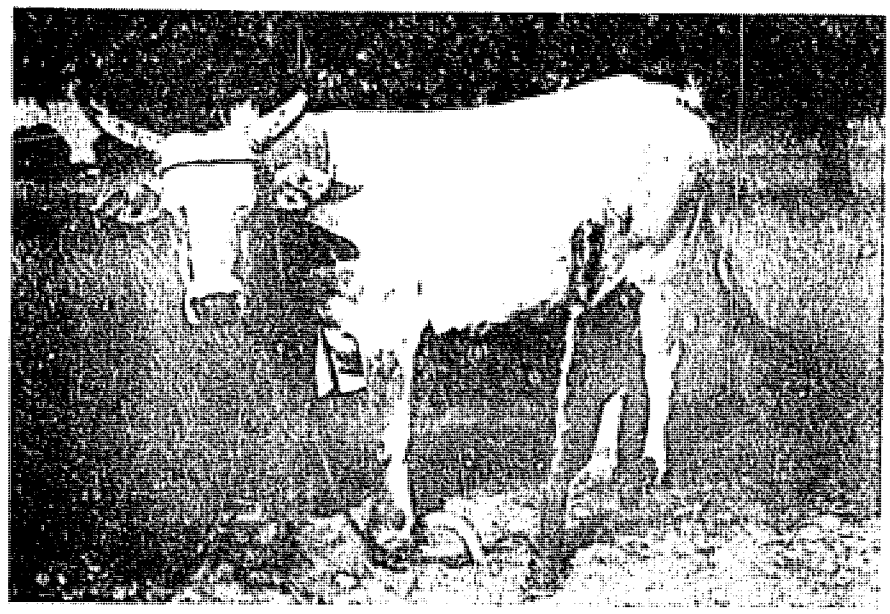
3.4
N'Dama : troupeau d'éleveur peul,
au parc
(Northern Region, Sierra Leone)
N'Dama fulani pastoralist herd,
penned
(Northern Region, Sierra Leone)

3.5
N'Dama : troupeau villageois,
au piquet
(près de Banjul, Gambie)
N'Dama village herd, tethered
(near Banjul, The Gambia)

3.6
Vache N'Dama du type de Guinée Bissau
(près de Cacheu, Guinée Bissau)
N'Dama cow, Guinea Bissau type
(near Cacheu, Guinea Bissau)



3.7
Taureau N'Dama du type gambien
(Keneba, Gambie)
N'Dama bull, Gambia type
(Keneba, The Gambia)



3.8
Vache N'Dama du type de Casamance
(Velingara, Sénégal)
N'Dama cow, Casamance type
(Velingara, Senegal)

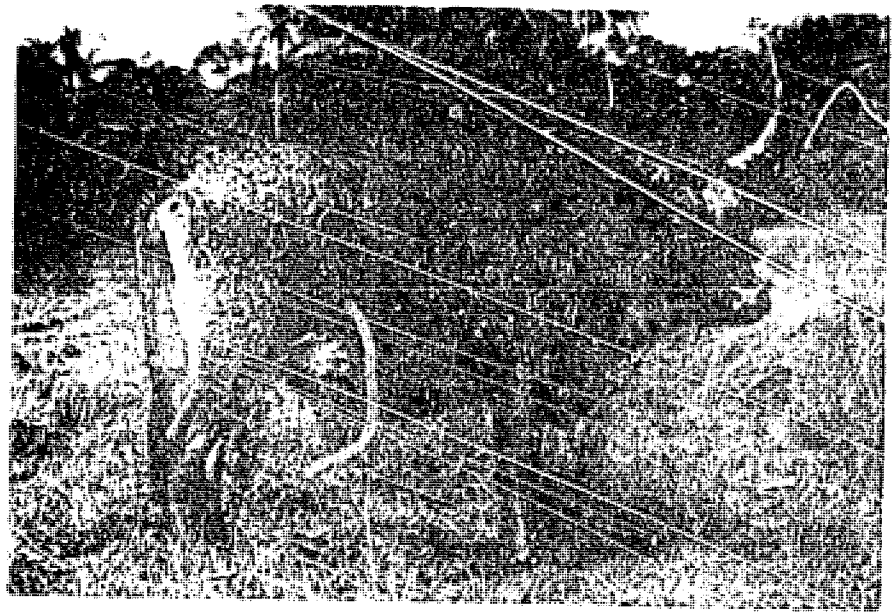
3.9
N'Dama : troupeau villageois en divagation
(Kissidougou, Guinée)
N'Dama village herd, roadside grazing
(Kissidougou, Guinea)

3.10
N'Dama : troupeau d'éleveur peul, mode de contention
(Mac Carthy Island Division, Gambie)
N'Dama fulani pastoralist herd, handling method
(Mac Carthy Island Division, The Gambia)

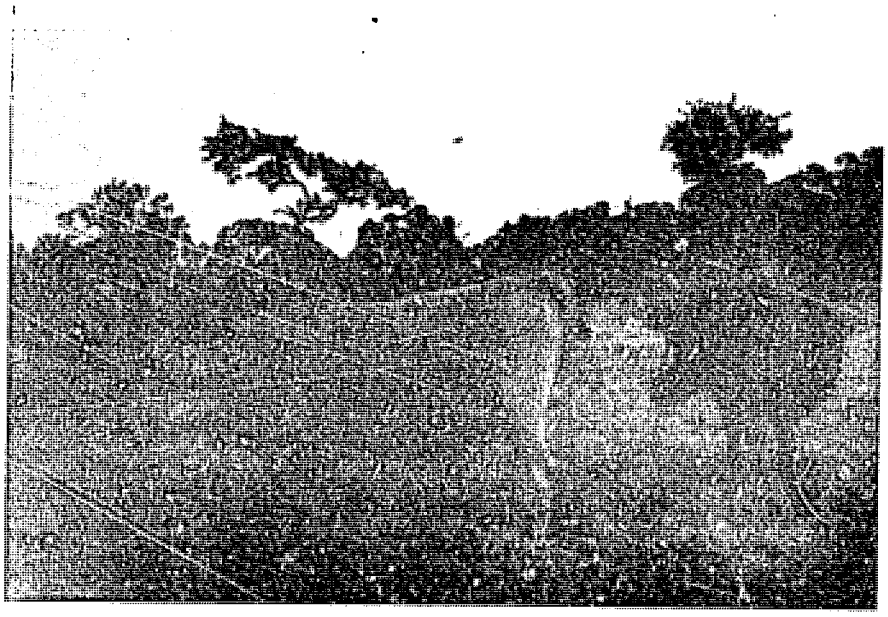
3 . 11
N'Dama : variétés de robe
(Velingara, Sénégal)
N'Dama coat colour variations
(Velingara, Senegal)

3 . 12
N'Dama : variétés de robe
(Bansang, Gambie)
N'Dama coat colour variation
(Bansang, The Gambia)

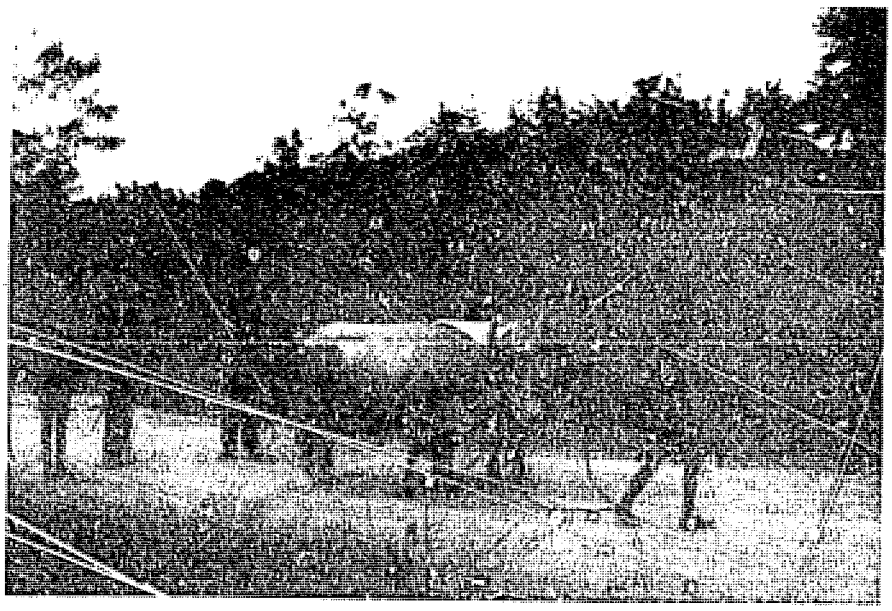
3 . 13
N'Dama : variétés de robe
(Badiana, Sénégal)
N'Dama coat colour variation
(Badiana, Senegal)



3.14
N'Dama : traite
(Fatoto, Gambie)
N'Dama milking
(Fatoto, The Gambia)

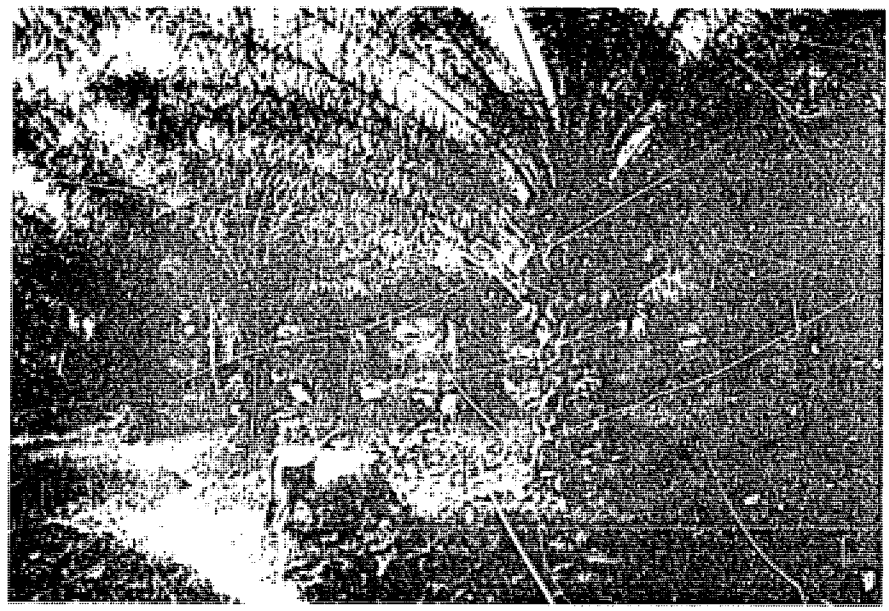


3.15
N'Dama : Complémentation avec des résidus de récoltes
(Labé, Guinée)
N'Dama supplementation with crop residues
(Labe, Guinea)

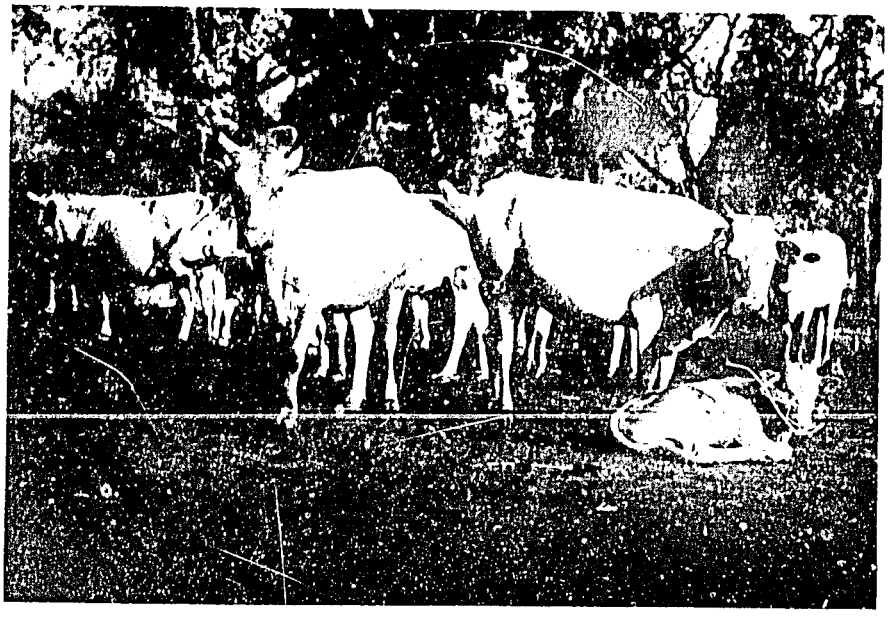


3.16
N'Dama : bœufs de culture attelée
(Beyla, Guinée)
N'Dama draught oxen
(Beyla, Guinea)

3 . 17
N'Dama : troupeau villageois en milieu arboré
(Sare Kali, Gambie)
N'Dama village herd, wooded environment
(Sare Kali, The Gambia)



3 . 18
N'Dama : troupeau villageois sous palmeraie
(près de Sassandra, Côte d'Ivoire)
N'Dama village herd on palm plantation
(near Sassandra, Ivory Coast)

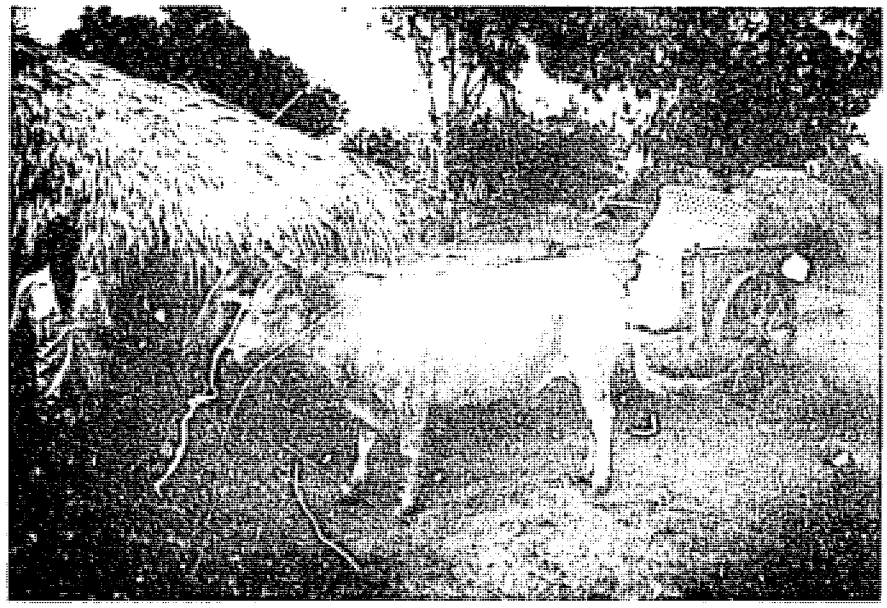


3 . 19
N'Dama en ranching :
troupeau de reproduction
(Yanfolila, Mali)
N'Dama ranch breeding herd
(Yanfolila, Mali)

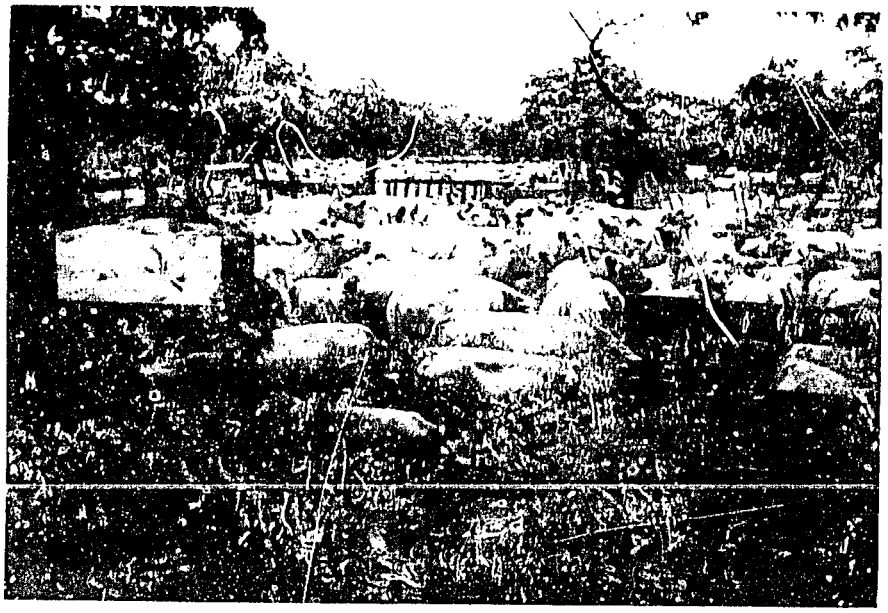
3 . 20
N'Dama en ranching :
veaux de 2-3 semaines
(Pota Ranch, Nigéria)
N'Dama ranch calves, 2-3 weeks
(Pota Ranch, Nigeria)

3 . 21
N'Dama en métayage
(Kikwit, Zaïre)
N'Dama, métayage
(Kikwit, Zaïre)

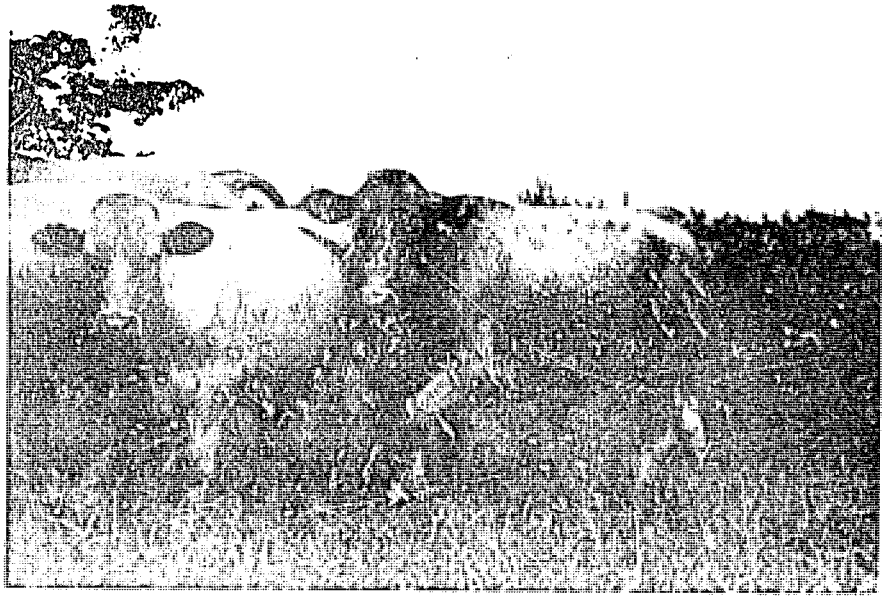
3 . 22
N'Dama : bœufs de culture attelée
(près de Bambari,
République Centrafricaine)
N'Dama, draught oxen
(near Bambari,
Central African Republic)



3 . 23
N'Dama en milieu forestier
(Sibit, Congo)
N'Dama, forest environment
(Sibit, Congo)

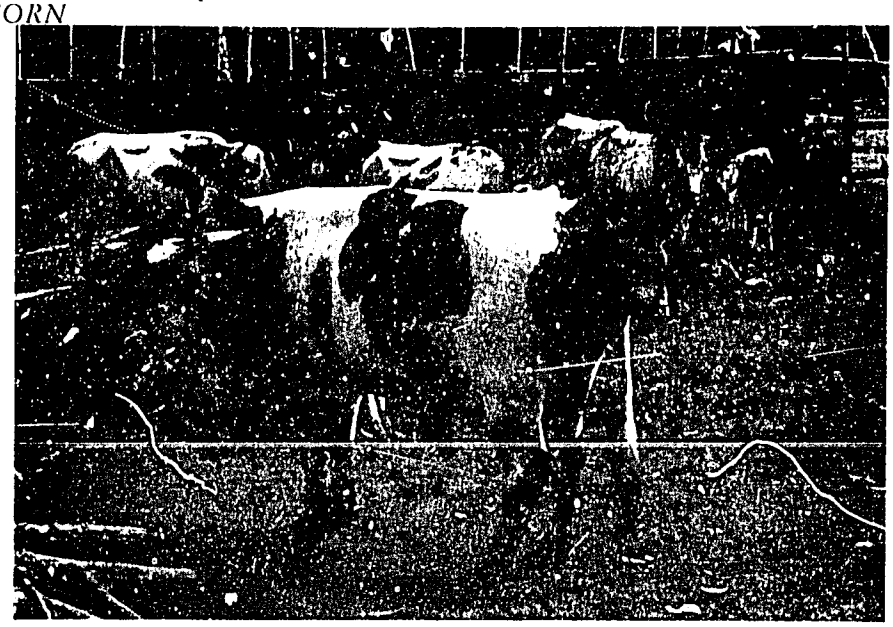


3 . 24
N'Dama en ranching : troupeau de reproduction au bain détiqueur (Kolo, Zaïre)
N'Dama, ranch breeding herd, dipping (Kolo, Zaïre)

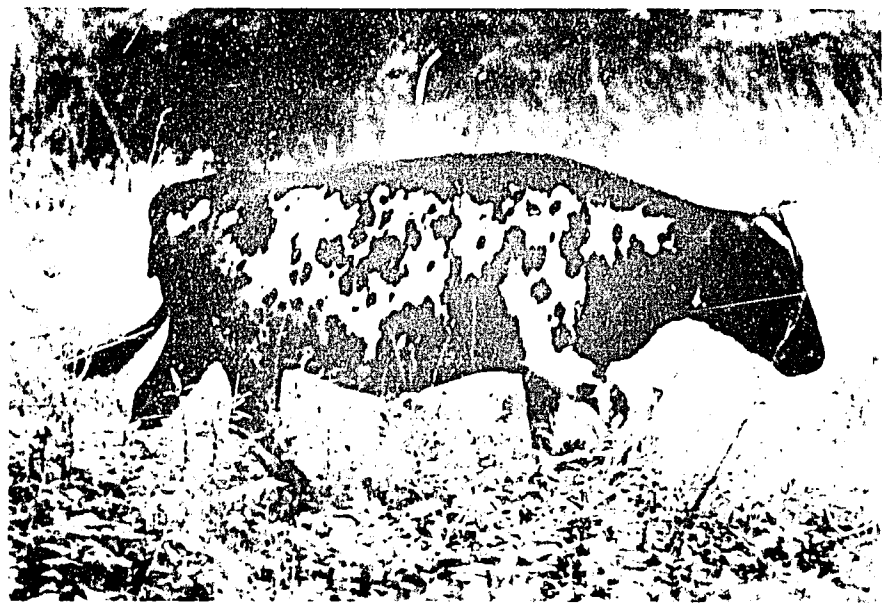


3 . 25
N'Dama en ranching : bouvillons (Mushie, Zaïre)
N'Dama ranch steers (Mushie, Zaïre)

3 . 26
N'Dama en ranching : veaux de 2-3 semaines (Kolo, Zaïre)
N'Dama ranch calves, 2-3 weeks (Kolo, Zaïre)



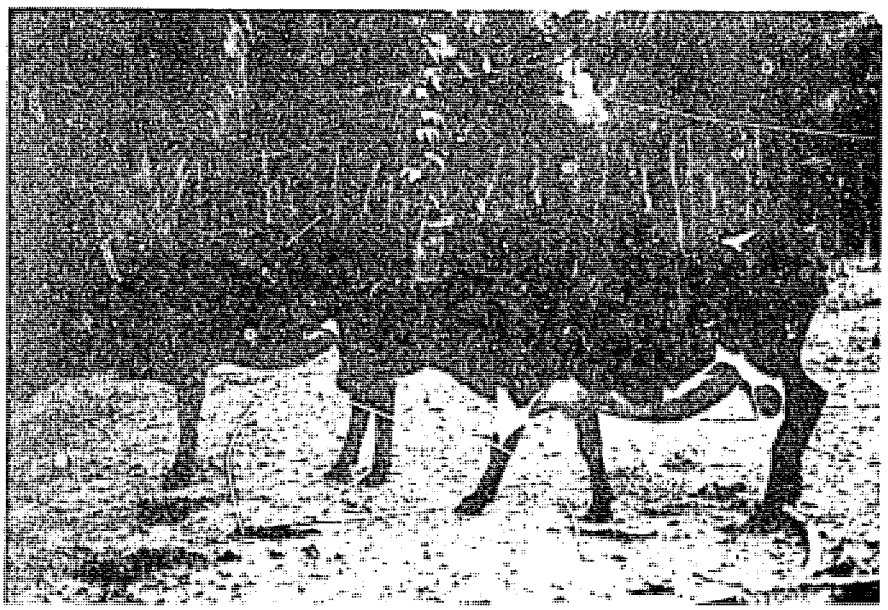
3 . 27
Taureau Lagune
(Province du Mono, Bénin)
Lagune bull
(Mono Province, Benin)



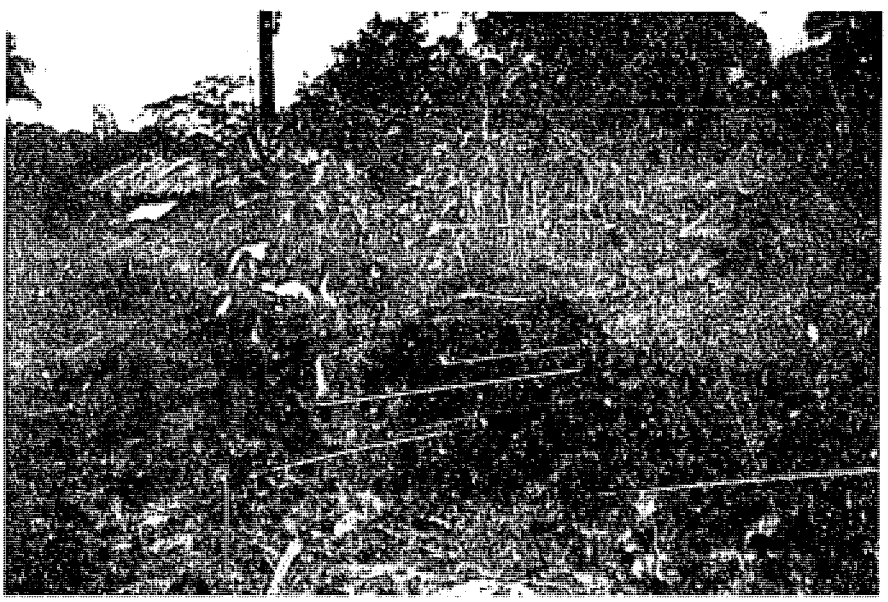
3 . 28
Vache Lagune : 85 cm au garrot
(près de Lemba, Zaïre)
Lagune cow 85 cm at withers
(near Lemba, Zaïre)

3 . 29
Lagune : troupeau en palmeraie
(Sassandra, Côte d'Ivoire)
Lagune herd on palm plantation
(Sassandra, Ivory Coast)

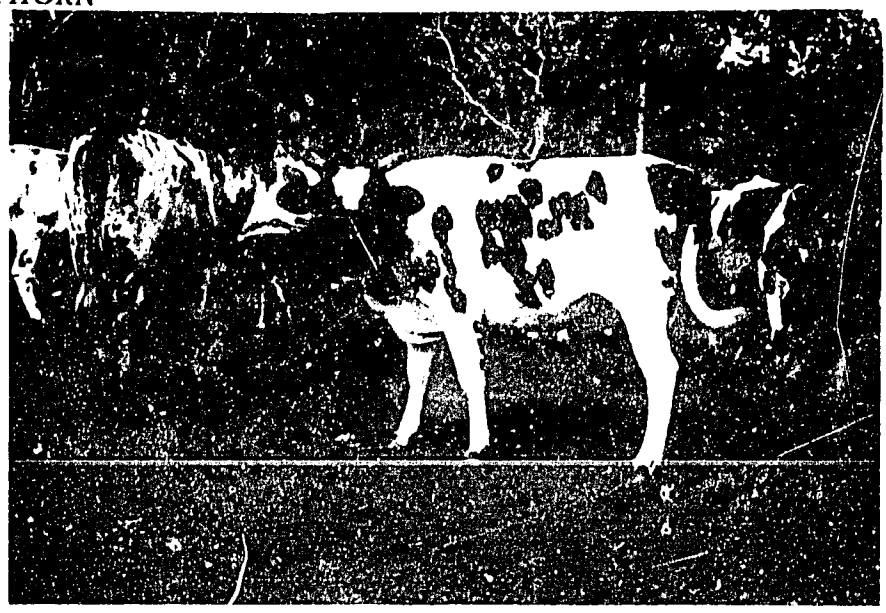
3 . 30
Vache Lagune
(près de Tchibanga, Gabon)
Lagune cow
(near Tchibanga, Gabon)



3 . 31
Génisses Lagune de 2 ans
(Lemba, Zaïre)
Lagune heifers, 2 years
(Lemba, Zaïre)



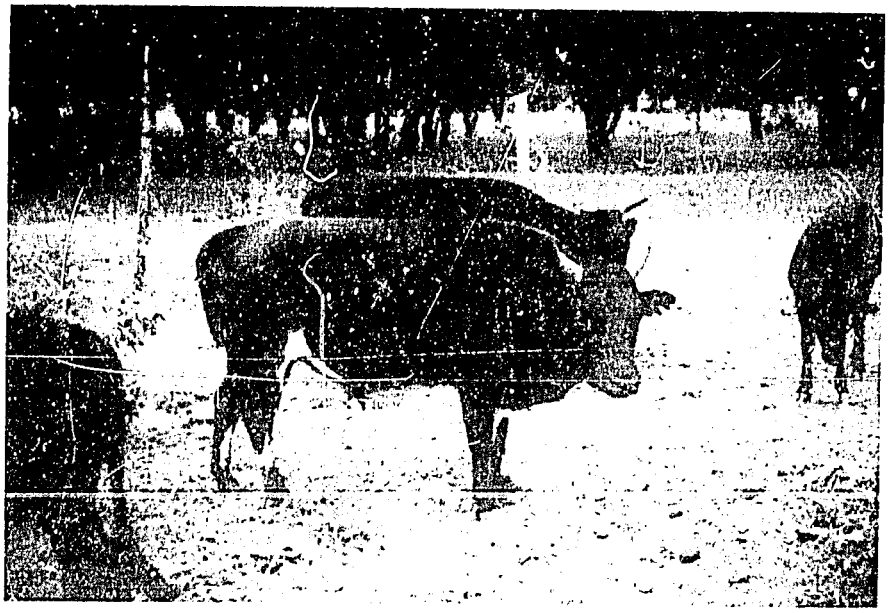
3 . 32
Lagune : troupeau en milieu forestier
(Région de Tchibanga, Gabon)
Lagune herd, forest environment
(Tchibanga region, Gabon)



3 . 33
Vache Baoulé
(près de Bouaké, Côte d'Ivoire)
Baoulé cow
(near Bouake, Ivory Coast)

3 . 34
Somba : troupeau au piquet sur champs
(près de Sokodé, Togo)
Somba herd tethered on stubble field
(near Sokode, Togo)

3 . 35
Vache Muturu
(Ado Ekiti, Nigéria)
Muturu cow
(Ado Ekiti, Nigeria)

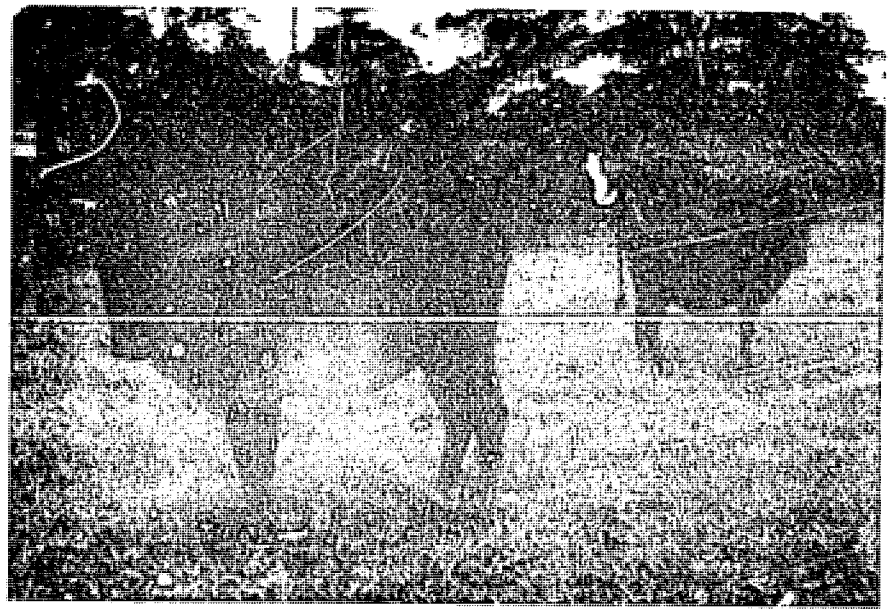


3 . 36
Taureau Baoulé
(Station de Bossembélé,
République Centrafricaine)
Baoulé bull
(Bossembele Station,
Central African Republic)

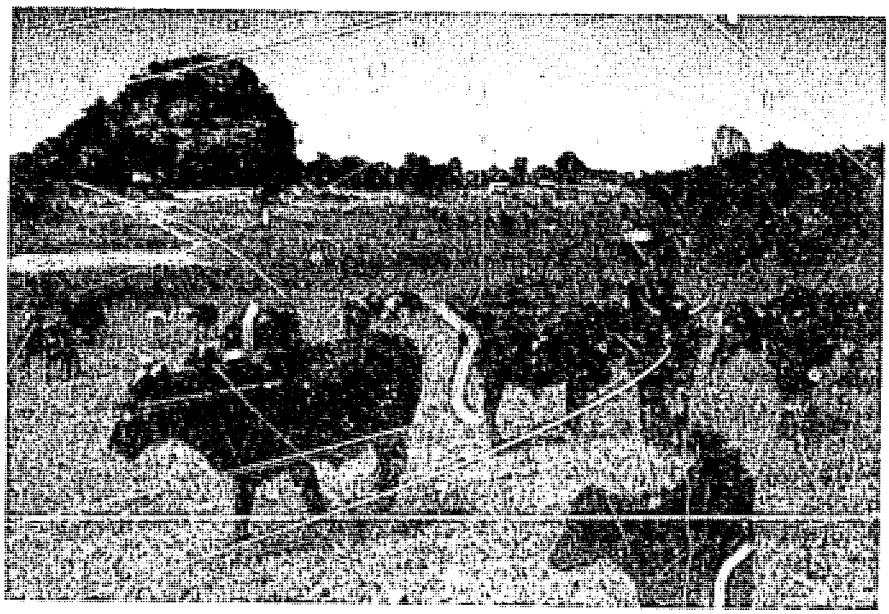
3 . 37
Baoulé : troupeau villageois au parc
(près de Bouaké, Côte d'Ivoire)
Baoulé village herd, penned
(near Bouaké, Ivory Coast)

3 . 38
Lobi sur jachères
(près de Banfora, Haute-Volta)
Lobi cattle on fallow
(near Banfora, Upper Volta)

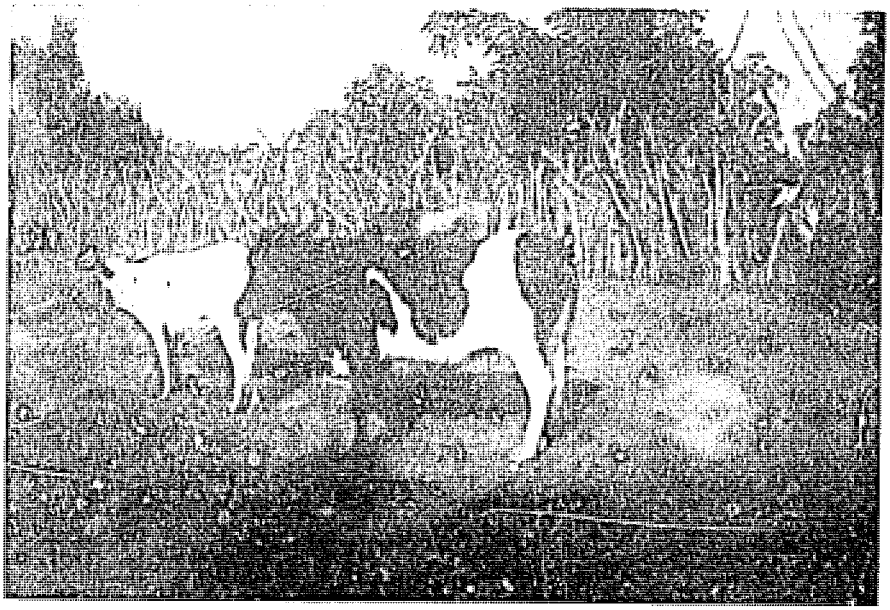
3.39
Vache Muturu
(près de Victoria, Cameroun)
Muturu cow
(near Victoria, Cameroon)



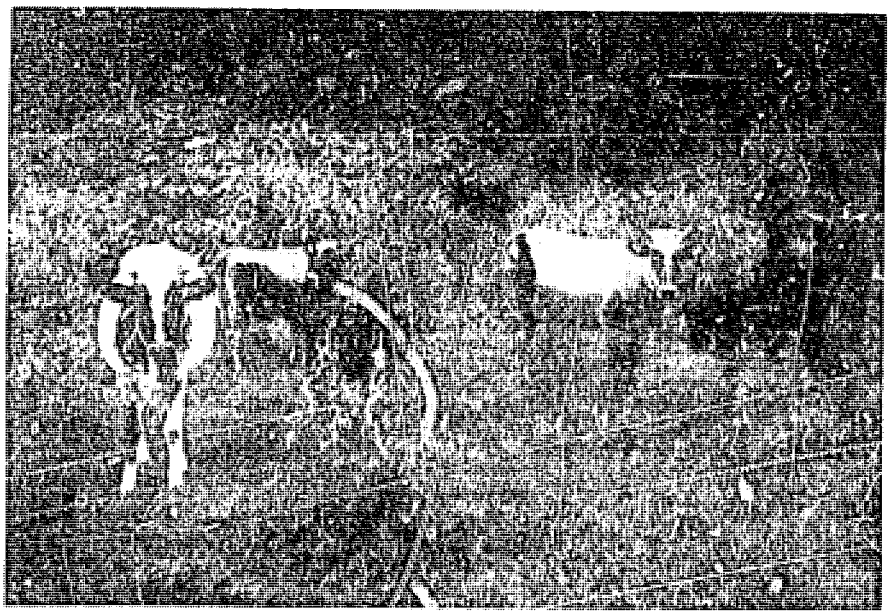
3.40
Génisse Muturu âgée de 1,5 à 2 ans
(Ethnie Tiv, Plateau State,
Nigéria)
Muturu heifer, 1.5 - 2 years
(Tiv tribe, Plateau State, Nigeria)



3.41
Kapsiki : troupeau villageois
(Nord-Cameroun)
Kapsiki : village herd
(North Cameroon)



3.42
Vache Doayo
(près de Poli, Cameroun)
Doayo cow
(near Poli, Cameroon)

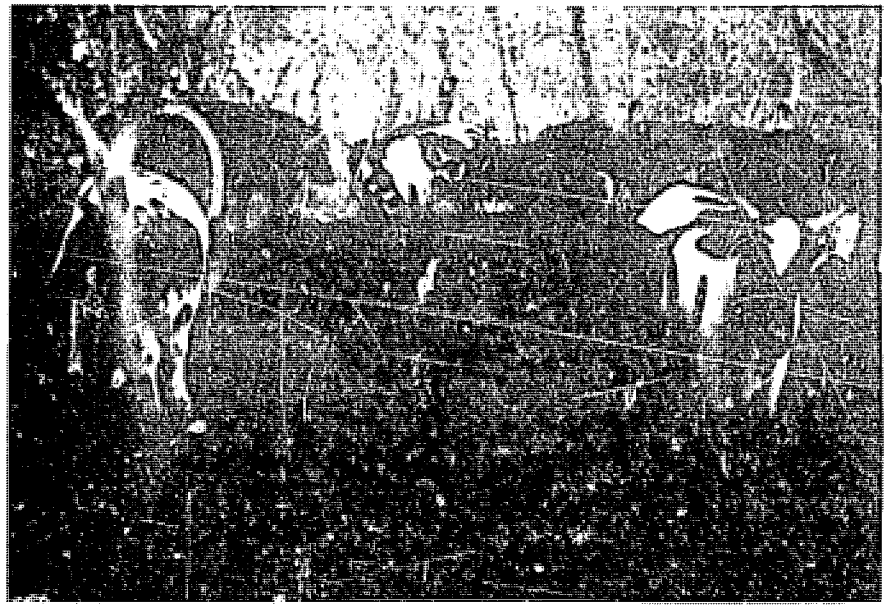


3.43
Bakosi : troupeau villageois
(Sud-Ouest, Cameroun)
Bakosi : village herd
(Southwest, Cameroon)

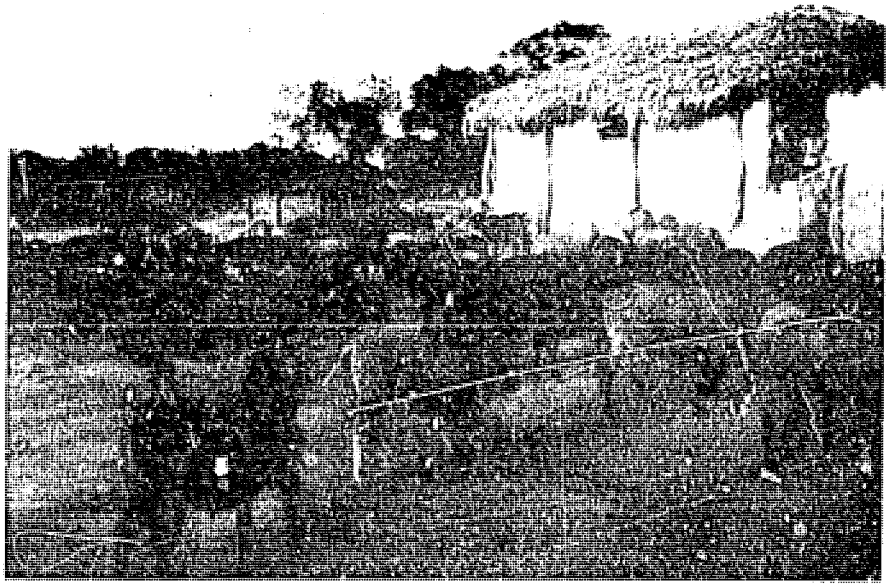
3 . 44
Somba : troupeau au piquet
(Bassa Zoume, Bénin)
Somba herd, tethered
(Bassa Zoume, Benin)

3 . 45
Ghanaian Shorthorn : traite
(Techiman, Ghana)
Ghanaian Shorthorn, milking
(Techiman, Ghana)

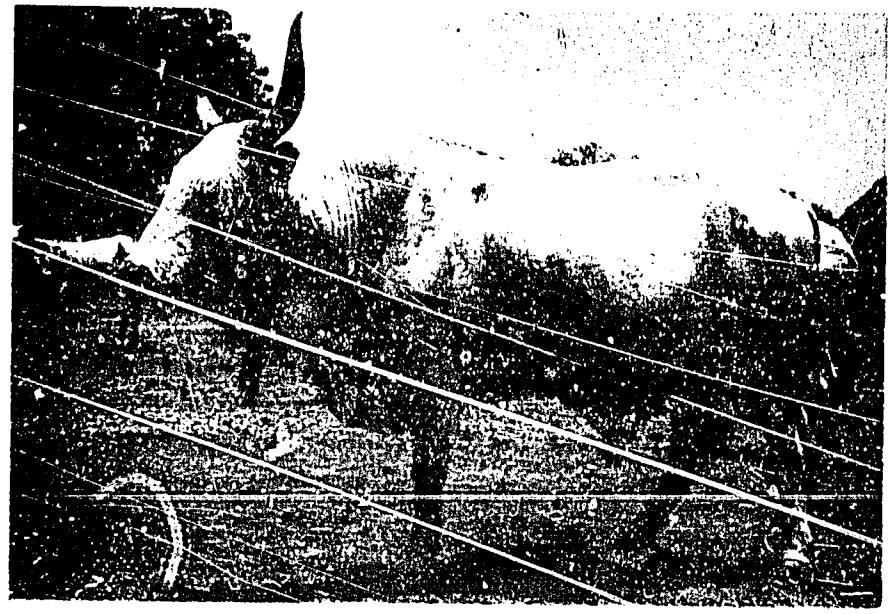
3 . 46
Baoulé : bœuf de culture âgé de
4 ans pesant 240 kg
(Région de Bambari,
République Centrafricaine)
Baoulé draught ox, 4 years, 240 kg
(Bambari region,
Central African Republic)



3 . 47
Ghanaian Shorthorn et ovins nains d'Afrique Occidentale gardés par des enfants
(Tamale, Ghana)
Ghanaian Shorthorn cattle and W.A. Dwarf sheep herded by children
(Tamale, Ghana)

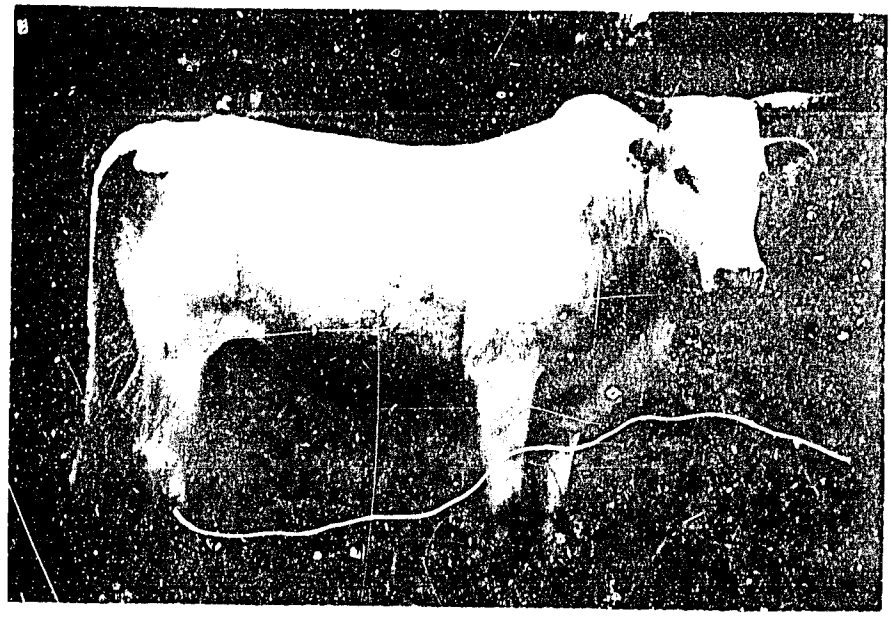


3 . 48
Baoulé : troupeau en métayage
(Région de Bambari,
République Centrafricaine)
Baoulé herd, métayage
(Bambari region,
Central African Republic)



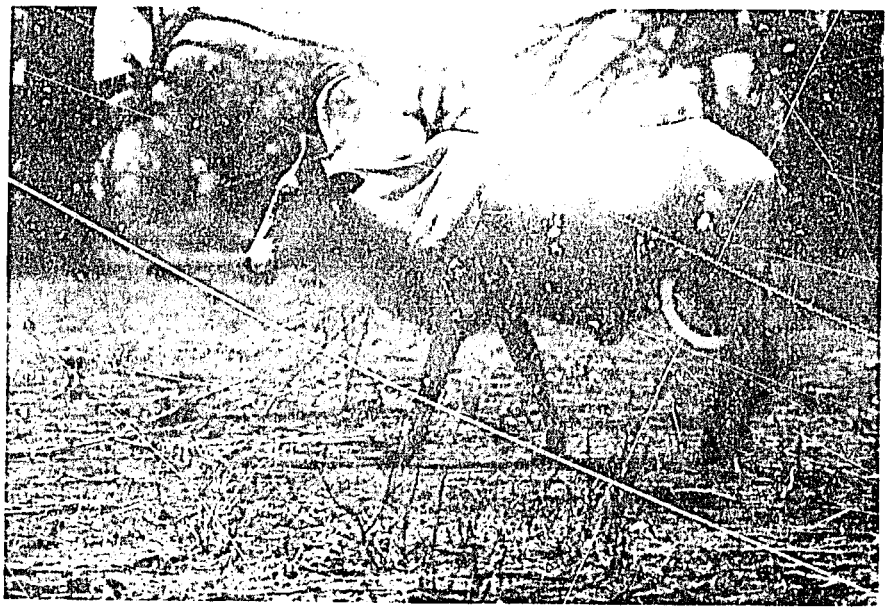
3.49
Taureau Djakoré
(près de Tambacounda, Sénégal)
Djakoré bull
(near Tambacounda, Senegal)

3.50
Borgou : taureau à l'embouche
(Ferme de Kpinnou, Bénin)
Borgou bull, fattened
(Kpinnou Farm, Benin)



3.51
Taureau Keteku
(Ado Ekiti Ranch, Nigéria)
Keteku bull
(Ado Ekiti Ranch, Nigeria)

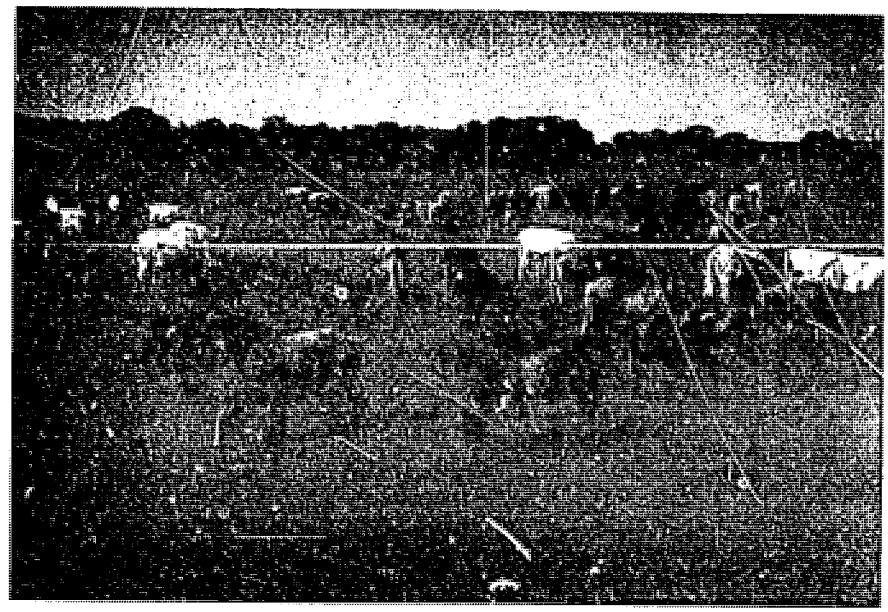
3.52
Bœuf Méré et taurillon N'Dama
(près de Odienné, Côte d'Ivoire)
Méré ox and young N'Dama bull
(near Odienne, Ivory Coast)



3.53
Vache Djakoré
(Région du Siné Saloum, Sénégal)
Djakoré cow
(Sine Saloum Region, Senegal)

3.54
Troupeau Djakoré
(Région du Siné Saloum, Sénégal)
Djakoré herd
(Sine Saloum Region, Senegal)

3.55
Troupeau Méré
(Bambara) (près de Sikasso, Mali)
Méré (Bambara) herd
(near Sikasso, Mali)



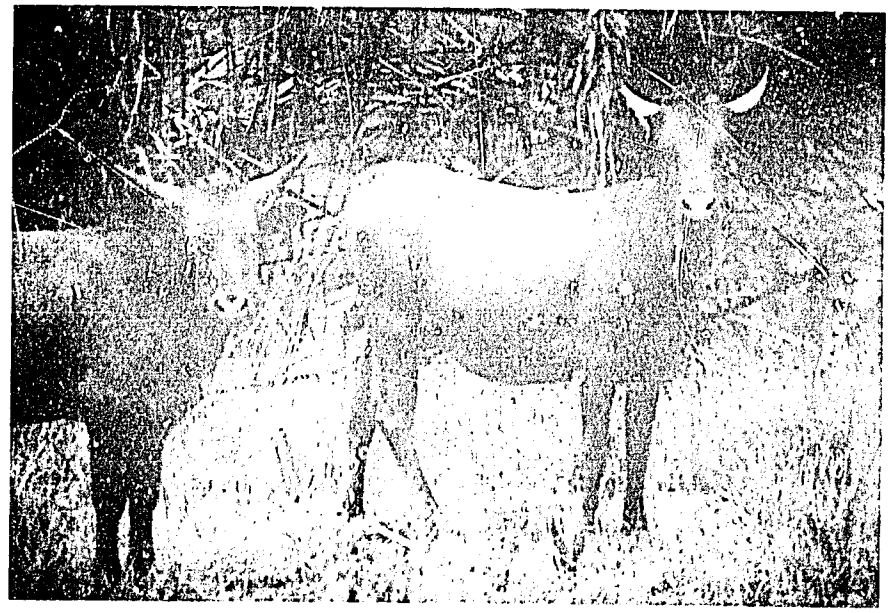
3.56
Troupeau Méré
(Banfora, Haute-Volta)
Méré herd
(Banfora, Upper Volta)

3 . 57
Troupeau Ghanaian Sanga
(White Sanga) (Sogakofe, Ghana)
Ghanaian Sanga
(White Sanga) herd
(Sogakofe, Ghana)

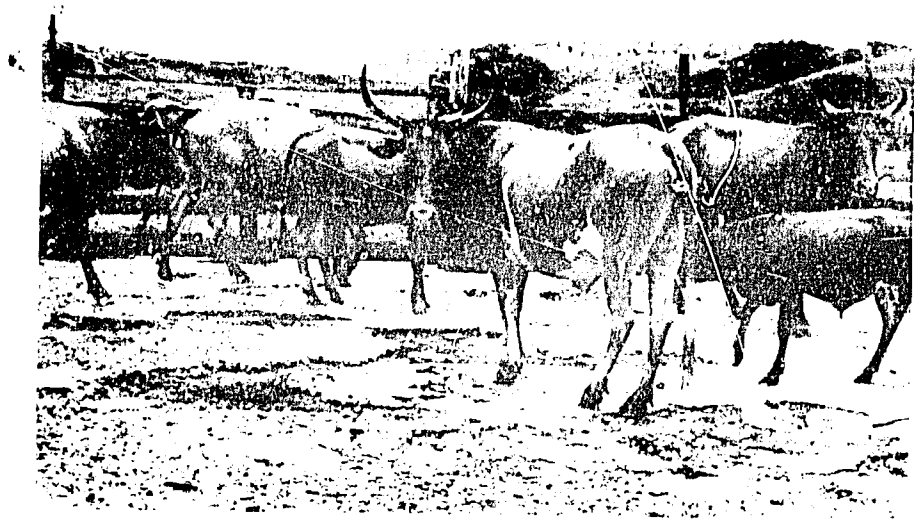
3 . 58
Troupeau Borgou
(Province du Borgou, Bénin)
Borgou herd
(Borgou Province, Benin)

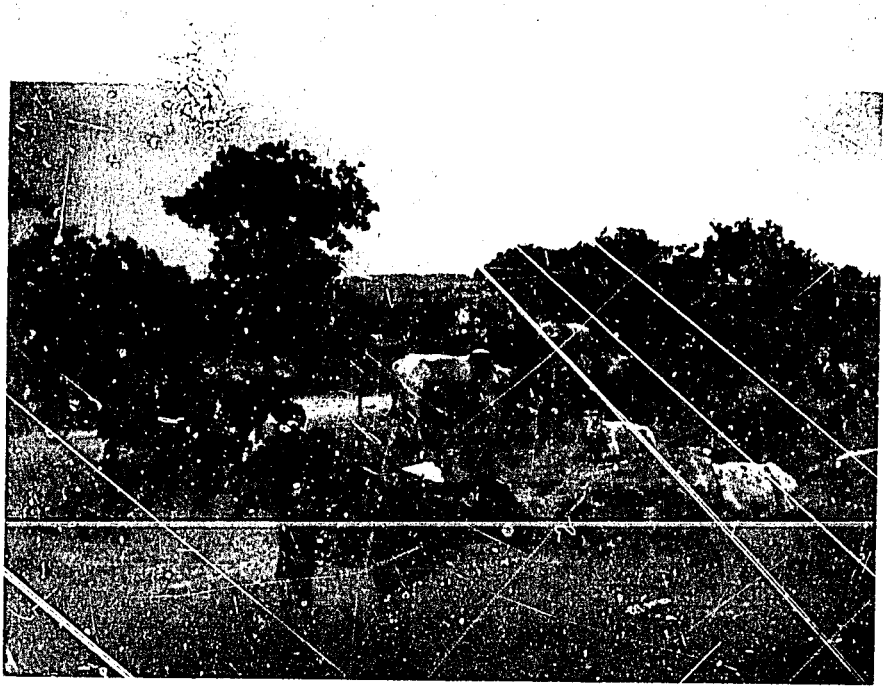
3.59
Vache Keteku
(Fashola Farm, Nigéria)
Keteku cow
(Fashola Farm, Nigeria)

3.60
Génisses Mateba
(près de Boma, Zaïre)
Mateba heifers
(near Boma, Zaïre)

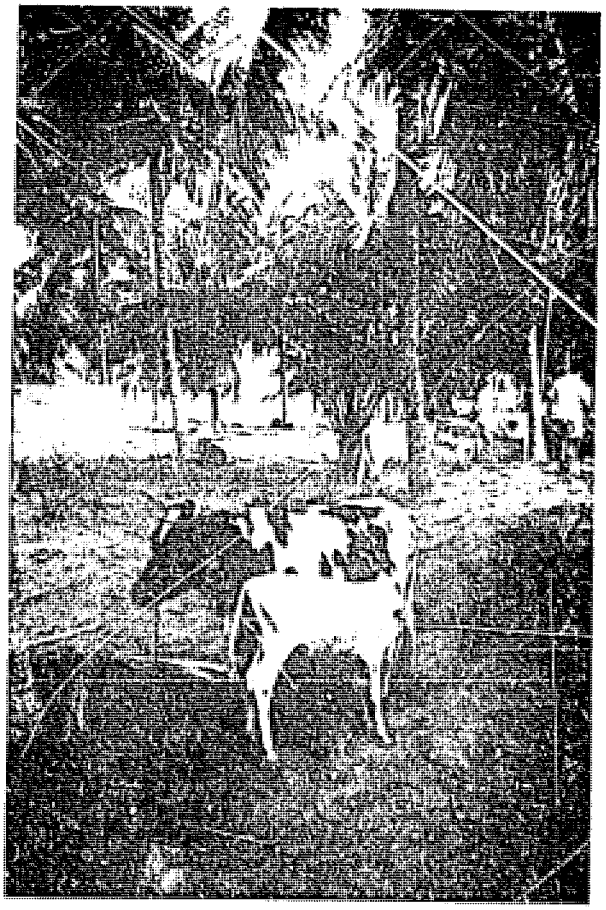


3.61
Troupeau Kisantu
(Kisantu, Zaïre)
Kisantu herd
(Kisantu, Zaïre)



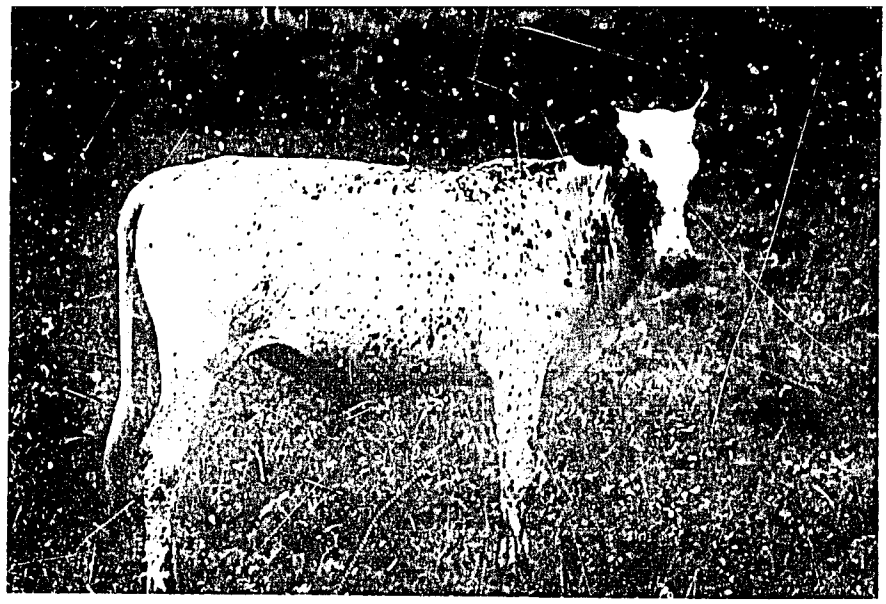


3.62
Somba et Borgou :
troupeau avec taureau Zébu
(Province de l'Atacora, Bénin)
Mixed Somba, Borgou herd with Zebu bull
(Atacora Province, Benin)

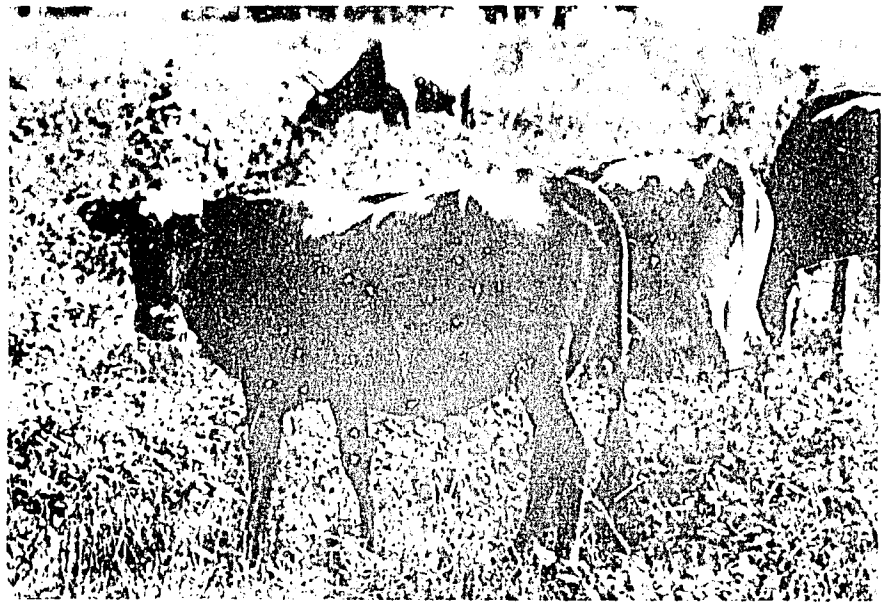


3.63
Veau métis Lagune & Borgou
en palmeraie
(Province du Mono, Bénin)
Lagune & Borgou calf on palm plantation
(Mono Province, Benin)

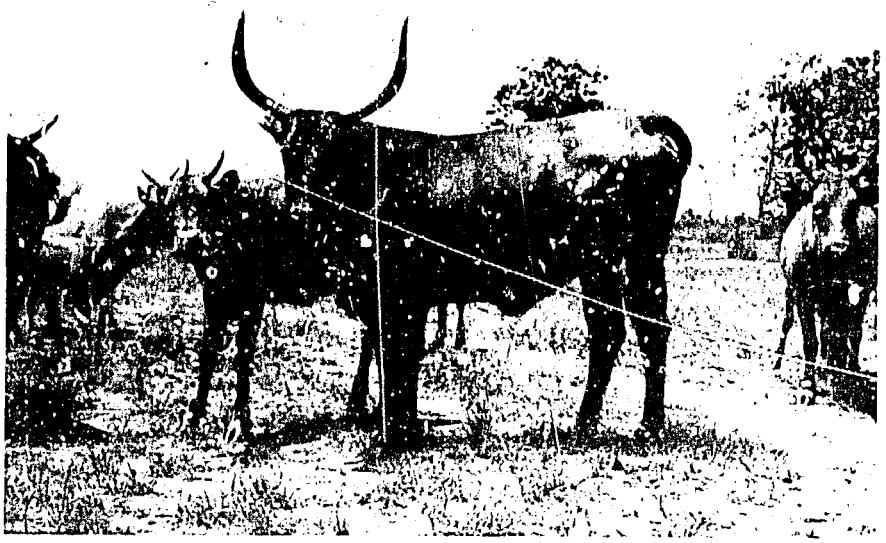
3.64
Génisse métis White Fulani x N'Dama âgée d'un an (Ezillo-Nkalagu State Farm, Nigéria)
White Fulani x N'Dama heifer 1 year (Ezillo-Nkalagu State Farm, Nigeria)



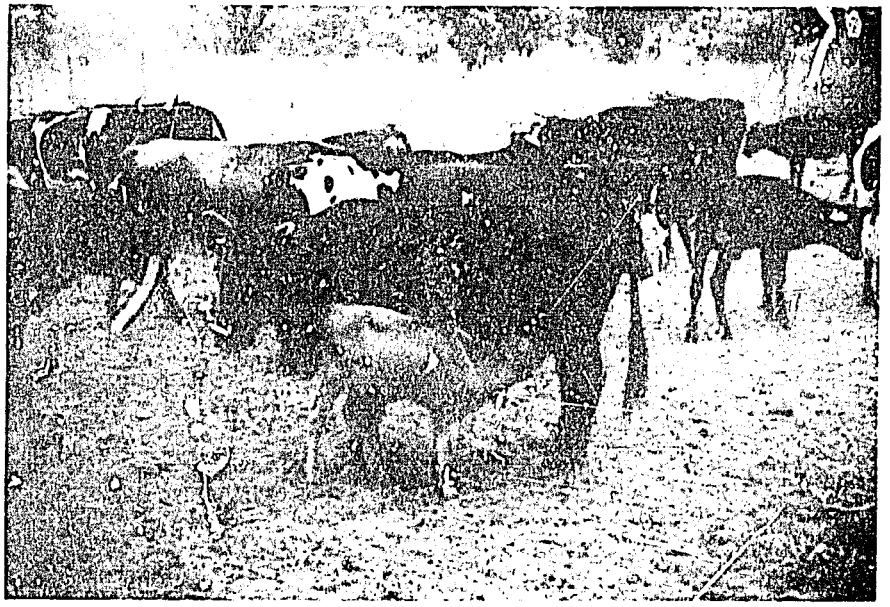
3.65
Génisse N'Dama x Muturu (Igarra Cattle Farm, Nigéria)
N'Dama x Muturu heifer (Igarra Cattle Farm, Nigeria)



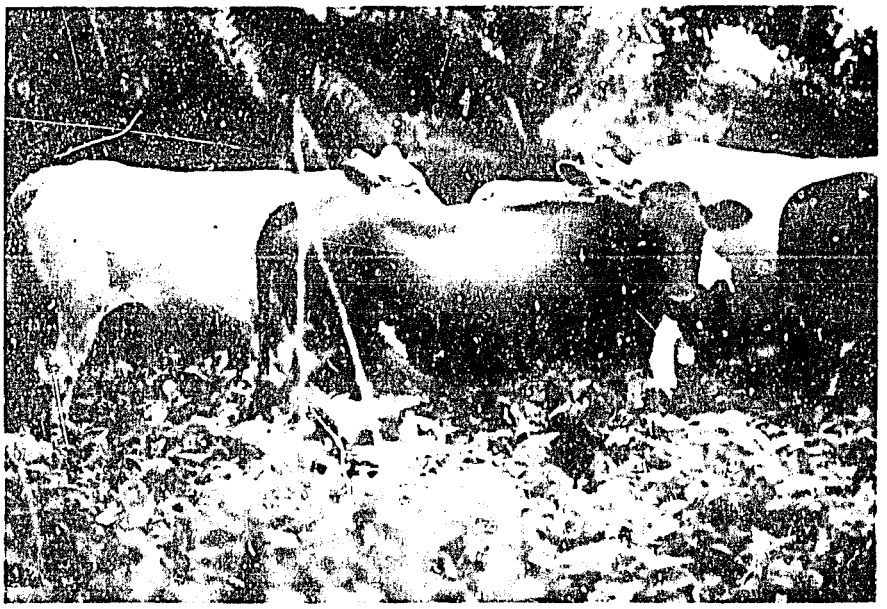
3.66
Veau Keteku x N'Dama (Fashola Farm, Nigéria)
Keteku x N'Dama calf (Fashola Farm, Nigeria)



3 . 67
Vache N'Dama x Mbororo
(Station de Bokolobo,
République Centrafricaine)
N'Dama x Mbororo cow
(Bokolobo Station,
Central African Republic)



3 . 68
Vache Baoulé avec veau métis
N'Dama
(Station de Bossembélé,
République Centrafricaine)
Baoulé cow with N'Dama-cross
calf
(Bossembele Station,
Central African Republic)

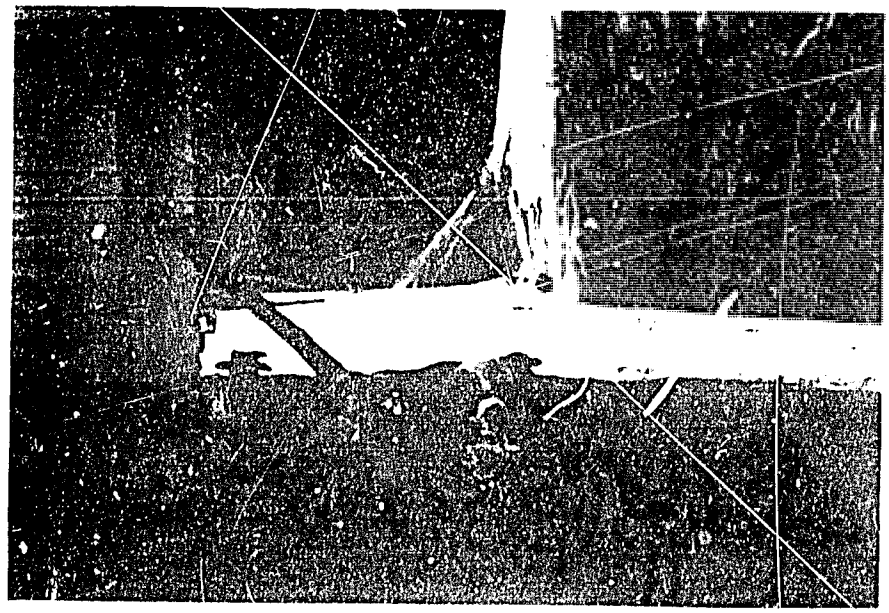


3 . 69
Métis Lagune (Dahomey) x
N'Dama en palmeraie
(Ranch de Kolo, Zaïre)
Lagune (Dahomey) x N'Dama on
palm plantation
(Kolo Ranch, Zaïre)

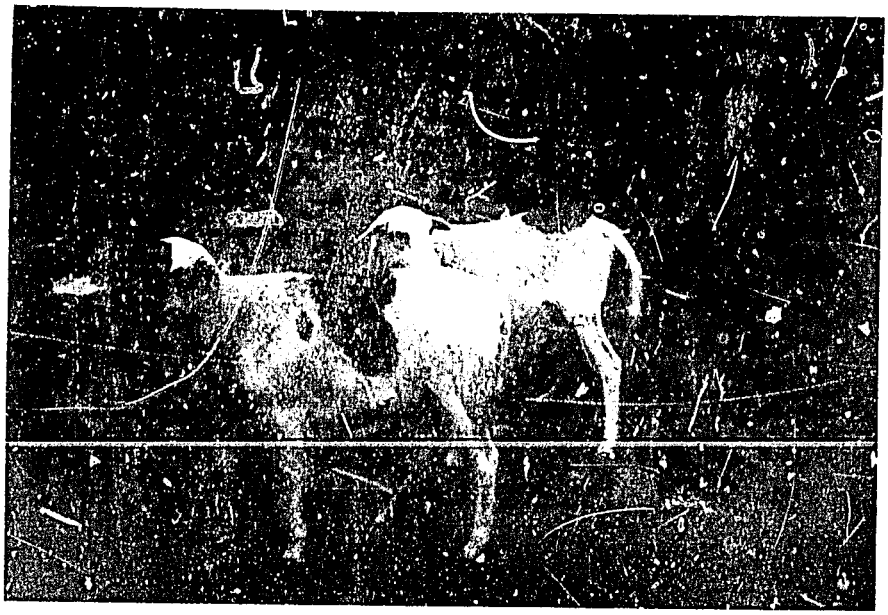
OVINS — *SHEEP*

3.70
Bélier Djallonké du type de forêt
(Kibélémoussia, Congo)
Djallonké ram, forest type
(Kibelemoussia, Congo)

3.71
Bélier Djallonké : type du savane
(Upper River Division, Gambie)
Djallonké ram, savanna type
(Upper River Division,
The Gambia)



3.72
Brebis Djallonké à ventre noir
(près de Mayumba, Gabon)
Djallonké ewes, black belly
(near Mayumba, Gabon)

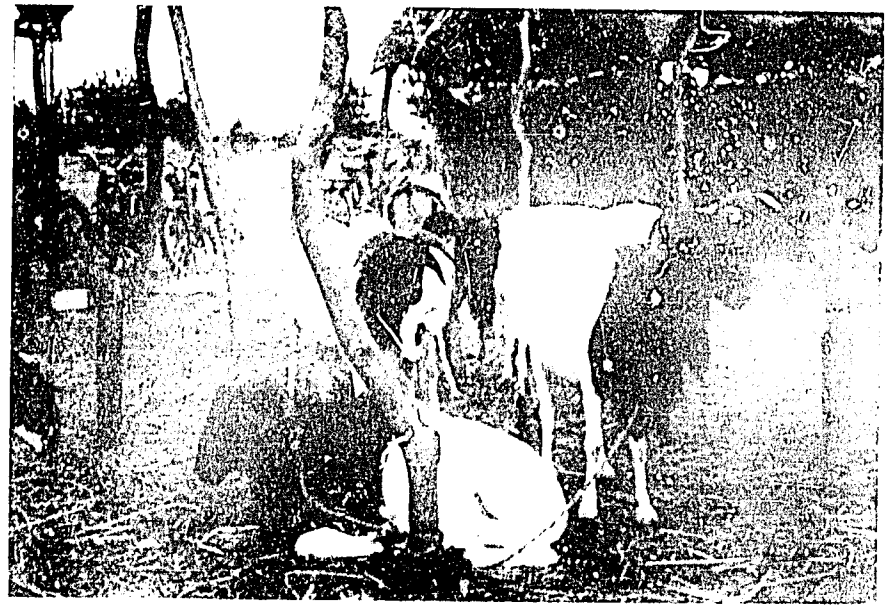


3.73
Brebis Djallonké
(près de Rumsiki, Cameroun)
Djallonké ewes
(near Rumsiki, Cameroon)

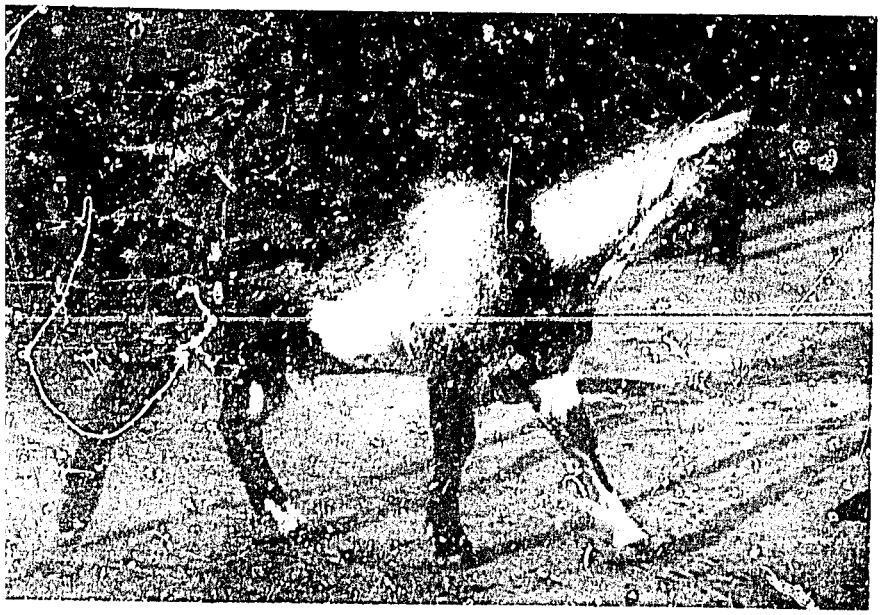
3.74
Brebis et agneau Djallonké
(Northern Province, Sierra Leone)
Djallonké ewe and lamb
(Northern Province, Sierra Leone)

3.75
Troupeau Djallonké
(Bignona, Sénégal)
Djallonké herd
(Bignona, Senegal)

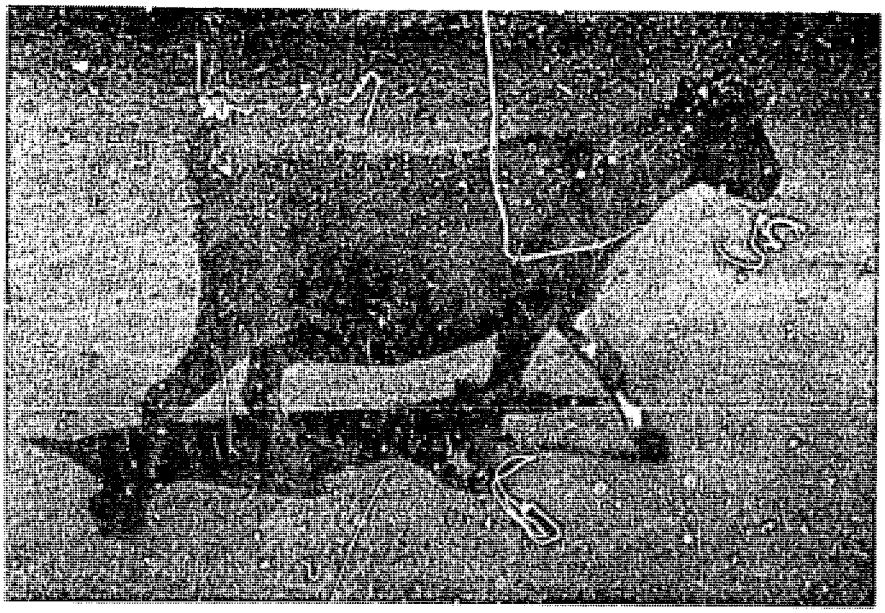
3.76
Béliers Djallonké du type Mossi
(Ouagadougou, Haute-Volta)
Djallonké rams, Mossi type
(Ouagadougou, Upper Volta)



3.77
Djallonké et métis sahéliens
(Bamako, Mali)
Djallonké and Sahelian crossbreds
(Bamako, Mali)

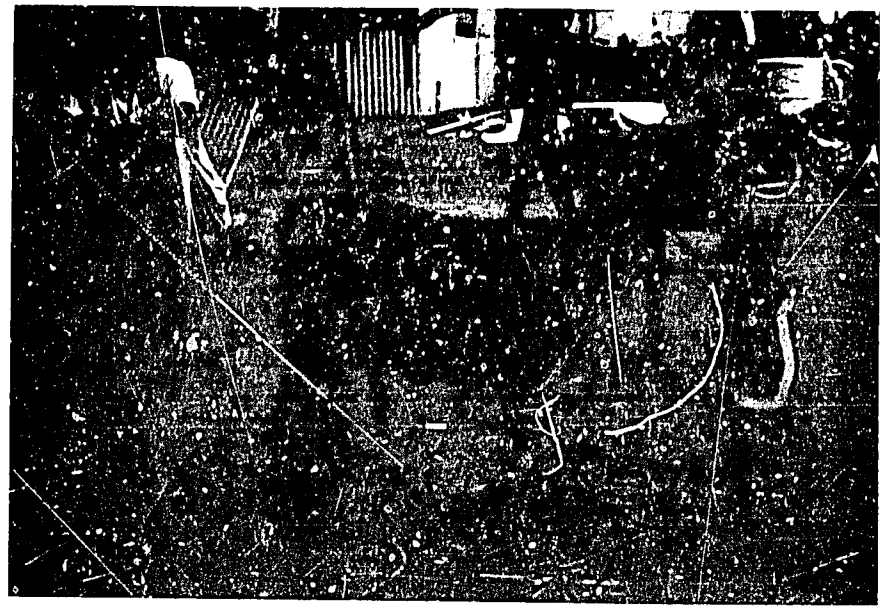


3.78
Bouc nain d'Afrique Occidentale
(près de Bambari,
République Centrafricaine)
Dwarf West African male goat
(near Bambari,
Central African Republic)



3.79
Chèvre naine
d'Afrique Occidentale
(près de Nikki, Bénin)
Dwarf West African female goat
(near Nikki, Benin)

3 . 80
Chèvre naine
d'Afrique Occidentale
âgée de 15 mois, mesurant 45 cm
au garrot
(Ghokotown, Nigéria)
Dwarf West African female goat,
15 months, 40 cm at withers
(Ghokotown, Nigeria)

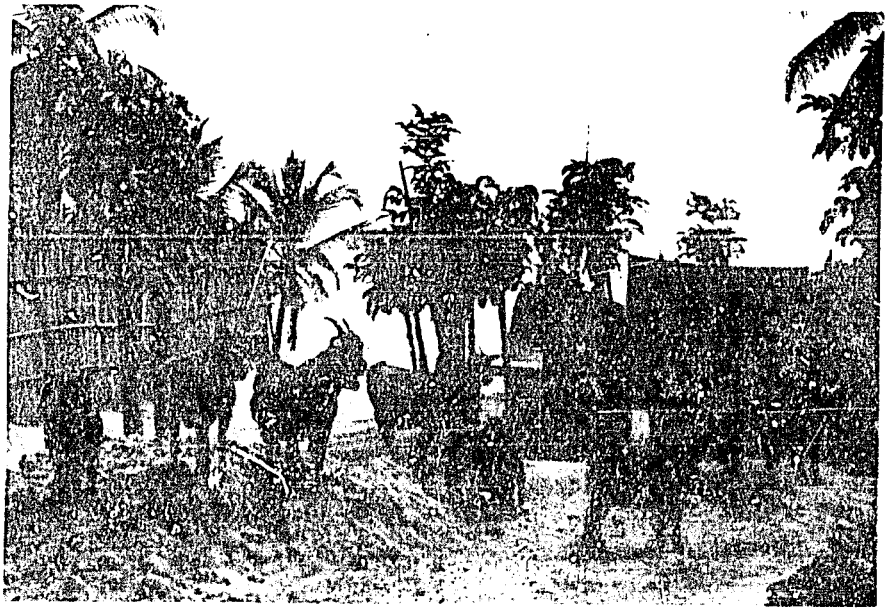


3 . 81
Chevreaux nains
d'Afrique Occidentale
(près de Kinshasa, Zaïre)
Dwarf West African young goats
(near Kinshasa, Zaïre)

3 . 82
Chèvre naine
d'Afrique Occidentale
mesurant 35 cm au garrot
(près de Calabar, Nigéria)
Dwarf West African female goat
35 cm at withers
(near Calabar, Nigeria)

3 . 83
Caprins nains
d'Afrique Occidentale
(près de Ziguinchor, Sénégal)
Dwarf West African goats
(near Ziguinchor, Senegal)

3 . 84
Caprins nains
d'Afrique Occidentale :
troupeau villageois
(près de Nikki, Bénin)
Dwarf West African goat
village herd.
(near Nikki, Benin)



3 . 85
Caprins nains
d'Afrique Occidentale :
troupeau villageois
(Monogaga, Côte d'Ivoire)
Dwarf West African goat
village herd
(Monogaga, Ivory Coast)

CHAPTER 4

PRODUCTIVITY OF TRYPANOTOLERANT LIVESTOCK

A major problem in using animal production data from Africa is how to make maximum use of results produced in isolation. The Report of the first FAO Expert Consultation on Research on Trypanotolerance and Breeding of Trypanotolerant Animals (FAO, 1976) concluded that, although considerable work was being undertaken on the productivities of trypanotolerant cattle types, little comparative information had become available. For this reason it was stressed that the emphasis should be on comparisons between animal breeds or types in given environments, rather than on measures of absolute value only. However, to build up accurate animal production information even in isolation is expensive and takes time. For this reason, gathering, evaluating and comparing those data which have been produced are of utmost importance.

4.1 EVALUATION APPROACH

For each country discussed in Volume 2, estimates of the main production traits required to build up a productivity index are given wherever sufficient information is available. The environmental and management conditions under which these basic productivity levels were achieved are also indicated. In the case of cattle, the traits evaluated are reproductive performance, cow and calf viability, milk production, growth and cow body weight. These have then been used to build up an index of the total weight of one-year-old calf plus the liveweight equivalent of milk produced, both per cow per year and finally per 100 kg of cow maintained per year. The steps in the calculations are laid out in Table 4.1.

This final index is the most meaningful way to compare the actual productivities of the wide range of cattle types found in the study area, given the level of information available. Its merit lies in relating all the more important production traits back to the actual weight of breeding cows that has to be supported, which is

closely connected with maintenance costs. The traits and productivity indices have been derived for two basic management systems, in villages and on ranches or stations, and for four levels of trypanosomiasis risk designated as zero, low, medium and high. As trypanotolerance is not an absolute but a relative characteristic, liable to break down if the level of trypanosome infection is high enough, it is important from a land-use and development point of view to know the likely level of trypanosome infection in livestock to be brought into a given area. This level is a function of several factors, such as density of tsetse infestation, species of tsetse present (some species are more effective transmitters than others), infection rate in the flies, density of all potential hosts and climatic conditions. The role of other biting flies which are capable of transmitting infection must also be considered. For this reason, the term trypanosomiasis risk is used to describe all the factors which influence the level of trypanosome infection, rather than tsetse challenge or tsetse risk which were commonly used in the past. The four levels of trypanosomiasis risk designated have been defined rather arbitrarily, as very little actual information on the contributing factors is available.

Table 4.1. Steps in the calculation of productivity indices.

Parameter	Code	Calculation
Cow mortality during year (%)	A	
Calving percentage (%)	B	
Calf mortality to 1 year (%)	C	
Percent of calves reaching 1 year (%)	D	$B(100 - C) \div 100$
Calf weight at 1 year (kg)	E	
Annual milked-out lactation yield (kg)	F	
Percent of cows completing a lactation (%)	G	$100 - (C \div 2)$[a]
Total liveweight equivalent of milked-out yield (kg)	H	$F(G \div 100) \div 9$[b]
Total weight of 1-year-old calf produced per cow (kg)	I	$E(D \div 100)$
Weight of 1-year-old calf plus liveweight equivalent of milk produced per cow maintained (kg)	J	$(I + H) \div \left[\left[100 - (A \div 2)\right] \div 100\right]$[c]
Average cow body weight (kg)	K	
Weight of 1-year-old calf plus liveweight equivalent of milk produced per 100 kg of cow maintained annually (kg)		$J \times 100 \div K$

a. A cow whose calf dies during the lactation period is considered on average to have actually produced milk during half the period.
b. Conversion factors constructed from Drewry et al (1959).
c. Cows dying during the year are considered on average to have been maintained for half a year.

Source: Compiled by authors.

Production information is particularly scarce for trypanotolerant sheep and goats. However, similar production indices have been built up wherever possible, based on weight of 5-month-old progeny produced per 10 kg of breeding female maintained per year.

The synthesis and comparison of the data available on cattle are carried out in three steps. First, all the situations in each country are combined where productivities of the two main trypanotolerant groups, N'Dama and West African Shorthorn, are available, to compare the two groups and illustrate the effects of management systems and trypanosomiasis risk. Next, the few situations are considered where productivity data on crosses between Zebu and humpless cattle are available, and finally the equally few situations are examined where productivity figures on Zebu cattle in the study zone have been obtained. In the case of data on sheep and goats, all available production data are combined and summarized.

4.2 PRODUCTIVITY OF N'DAMA AND WEST AFRICAN SHORTHORN CATTLE GROUPS

Thirty individual situations in 12 countries were identified where production indices under known management systems and estimated trypanosomiasis risk could be calculated. These are presented in Table 4.2.

Table 4.2 Distribution of 30 trypanotolerant cattle production situations by country, breed group, management system and trypanosomiasis risk.

Breed group	Management system	Trypanosomiasis Risk			
		Zero	Low	Medium	High
N'Dama	village		4, 5, 7, 10	2, 2, 6	1, 4
	ranch/ station	3, 4	1, 1, 2, 5, 11, 12	2, 3	1, 6
Shorthorn	village		3	1, 2, 2, 8	
	ranch/ station	3	2, 3	9	

1 = Zaire, 2 = Ivory Coast, 3 = Nigeria, 4 = Gambia, 5 = Senegal, 6 = Mali, 7 = Guinea, 8 = Central African Republic, 9 = Benin, 10 = Guinea Bissau, 11 = Sierra Leone and 12 = Togo.

Source: Compiled by authors.

The traits examined in these 30 situations were calving percentage, calf viability to one year, calf weight at one year, mature cow weight, productivity

index per cow per year, and productivity index per 100 kg of cow maintained per year. Least squares analyses were carried out on all traits separately (Harvey, 1960), fitting constants for breed group, management system, trypanosomiasis risk and country. The least squares means for breed group, production system and level of trypanosomiasis risk are presented in Table 4.3 and the analyses of variance in Table 4.4. As the data on which these analyses are based were very limited, it was not possible to examine the interactions which are likely to exist among the variables.

Table 4.3 indicates no significant difference between N'Dama and West African Shorthorn for the major index of productivity per 100 kg of cow maintained. The actual values are 28.7 kg per annum for N'Dama and 28.3 kg for Shorthorn. The only significant differences in individual traits leading to this index are weight of 1-year-old calf and weight of mature cow, with the N'Dama group very much heavier in each case. The higher calf weight leads to a higher index per cow for the N'Dama, but the higher mature cow weight lowers the index per 100 kg of cow maintained to a level similar to that of the Shorthorn.

The effect of village management, compared with management on ranches or stations, is clearly illustrated in Table 4.3. Approximately 14% lower calving rates, 15% lower viability and 20% lower calf weight at one year result in a 38% lower productivity index per cow from the village compared with the ranch or station. Six percent lower mature cow weights lead to a 30% lower productivity index per 100 kg of cow maintained.

An indication of the effect of the level of trypanosomiasis risk is also illustrated in Table 4.3. Zero risk is confounded with very intensive feeding and management, thus only low, medium and high risk can be directly compared. When productivity levels under medium trypanosomiasis risk are compared with those achieved under low risk, calving is 18% lower, calf viability 5% lower and calf weight 1% lower, resulting in a 30% lower productivity index per cow and a 27% lower productivity index per 100 kg of cow maintained per year. Similarly, when productivity levels under high trypanosomiasis risk are compared with those achieved under low risk, calving is 17% lower, calf viability 17% lower and calf weight 5% lower, resulting in a 56% lower productivity index per cow and a 41% lower productivity index per 100 kg of cow maintained per year.

The data presented in Volume 2 show clearly the tremendous range of productivity levels occurring among both the N'Dama and Shorthorn under different production systems and levels of trypanosomiasis risk. In both breed groups the range extends from about 15 kg of 1-year-old calf plus liveweight equivalent of milk produced per 100 kg of cow maintained per year under village conditions in a high trypanosomiasis risk area to about 50 kg under improved ranch or station conditions and low trypanosomiasis risk.

Table 4.3. Least squares means for production traits of trypanotolerant cattle groups under different management systems and levels of trypanosomiasis risk.

Variable	Number	Calving %	Calf viability %	Calf weight (kg)	Cow weight (kg)	Index/Cow (kg)	Index/100 kg cow (kg)
Overall mean	30	69.1	78.4	96.4	205	58.7	28.5
Breed							
N'Dama	21	70.1	79.9	113.7a	248a	72.3a	28.7
Shorthorn	9	68.1	76.9	79.1b	162b	45.1b	28.3
System							
Ranch/station	16	76.4a	85.8a	107.1a	212	72.3a	33.7a
Village	14	61.8b	71.0b	85.7b	198	45.1b	23.3b
Trypanosomiasis risk							
Zero*	3	92.4a	81.5	97.7	216	89.8a	40.1a
Low	13	73.1b	84.6	98.1	212	68.2b	31.9b
Medium	10	54.8c	79.7	96.7	200	47.2c	23.2c
High	4	56.1c	67.8	93.1	192	29.6d	18.8c

* Zero trypanosomiasis risk is confounded with very high levels of feeding and management.
a - d. Any values within a subgroup with different subscripts are significantly different ($P < 0.01$).

Source: Data from situations listed in Table 4.2.

Table 4.4. Analyses of variance for production traits of trypanotolerant cattle groups.

Source of variation	d.f.	Mean Squares					
		Calving %	Calf viability	Calf wt at 1 year	Cow mature wt	Index/ cow	Index/ 100 kg cow
Breed group	1	14	37	4647	28349**	2955**	2
Management system	1	919**	944**	1989**	845	3131**	448**
Trypanosomiasis challenge	3	698**	190	17	344	1601**	213**
Country	8[a]	279	113	305**	704*	630*	65**
Residual	16	110	79	89	237	100	15

* Significant at $P < 0.05$.

** Significant at $P < 0.01$.

a. Data from Guinea, Guinea Bissau and Sierra Leone were grouped under one region, Togo and Benin under another.

Source: Data from situations indicated in Table 4.2.

4.3 PRODUCTIVITY OF ZEBU X HUMPLESS CATTLE GROUPS

Two locations in Nigeria and Benin were identified where productivity indices for Keteku and Borgou cattle could be derived and compared with N'Dama and Shorthorn respectively. Management in both cases was under ranch conditions and trypanosomiasis risk was medium with no prophylactic treatment against trypanosomiasis. Production levels and indices are given in Table .5. In neither

Table 4.5. Productivity of trypanotolerant and Zebu x trypanotolerant crossbred cattle on two ranches under medium trypanosomiasis challenge.

Parameter	Nigeria		Benin	
	N'Dama	Keteku	Shorthorn	Borgou
Cow viability (%)	99	99	95	88
Calving percentage	58	57	58	33
Calf viability to 1 year (%)	95	95	76	72
Calf weight at 1 year (kg)	156	142	85	119
Productivity index[a] per cow per year (kg)	86.4	77.3	38.4	30.1
Cow weight (kg)	260	260	152	226
Productivity index[a] per 100 kg cow maintained per year (kg)	32.2	29.7	25.3	13.3

a. Total weight of one-year-old calf plus liveweight equivalent of milk produced.

Source: Based on productivity figures presented in Volume 2.

case was there any indication that the productivity of the Zebu x trypanotolerant crossbreds surpassed that of the trypanotolerant group.

4.4 COMPARISON WITH ZEBU CATTLE

Three locations, in Nigeria, Ivory Coast and Central African Republic, were identified where productivity of Zebus under known management conditions and trypanosomiasis risk could be compared with that of trypanotolerant types. Additionally, one location was identified in Mali where preliminary production figures for Zebu and N'Dama under feedlot conditions were available. Production levels and indices are shown in Table 4.6 and feedlot data in Tables 4.7 and 4.8.

Table 4.6. Productivity of trypanotolerant and Zebu cattle in three locations under zero, light and medium trypanosomiasis risk.

Parameter	Nigeria/ zero risk/station management			Ivory Coast/ low risk/village management		Central African Republic/medium risk/village management	
	N'Dama	Short-horn	Zebu	Short-horn	Zebu	Short-horn	Zebu
Cow viability (%)	100	100	100	98	96	96	95
Calving percentage	100	96	91	70	72	68	63
Calf viability to 1 year (%)	97	95	100	55	60	80	65
Calf weight at 1 yr (kg)	131	101	200	75	90	90	120
Annual milked out yield (kg)	-	-	-	70	144	-	71
Productivity index[a] per cow per year (kg)	128	92	181	36.9	55.4	50.0	58.1
Cow weight (kg)	266	183	343	200	270	190	320
Productivity index[a] per 100 kg cow maintained per year (kg)	48.1	50.2	52.8	18.5	20.5	26.3	18.2

a. Total weight of one-year-old calf plus liveweight equivalent of milk produced.

Source: Based on productivity figures presented in Volume 2.

Table 4.6 indicates virtually no difference between the trypanotolerant and Zebu groups for the major index of productivity per 100 kg of cow maintained per year: the trypanotolerant groups were on average 0.3 kg or 1% lower. The higher weight of 1-year-old calf for the Zebu led to a 40% higher Zebu productivity index per cow, but the correspondingly higher mature cow weight resulted in very similar group productivity indices per 100 kg of cow maintained. Similarly, Tables 4.7 and 4.8 showing feedlot performances indicate that while the Zebu was superior to the N'Dama in terms of absolute daily liveweight gain, the daily liveweight gains per 100 kg body weight maintained were virtually identical.

Table 4.7. Feedlot performance data for 49 Zebu and 49 N'Dama over a 65-day period.

Parameter	Breed	
	Zebu	N'Dama
Daily liveweight gain (g)	667	542
Mean body weight (kg)	223	172
Daily liveweight gain/100 kg body weight (g)	300	311

Source: Data from Mali, Service de l'Elevage.

Table 4.8. Analysis of variance for feedlot performance.

Source of variation	d.f.	Mean squares (x 10^{-2})		
		Daily liveweight gain	Mean body weight	Daily liveweight gain/100 kg body weight
Between feedlots	1	3960**	70*	1760**
Between breeds	1	3810*	630**	30
Residual	95	669	7	61

* Significant at $P < 0.05$.
** Significant at $P < 0.01$.

Source: Calculated by authors.

The data presented in the three tables do not suggest that Zebu are superior to trypanotolerant cattle in any of these situations, even though they are all characterized by relatively low trypanosomiasis risk.

4.5 PRODUCTIVITY OF SHEEP

Table 4.9 summarizes the nine situations for which productivity data on trypanotolerant sheep were available, as described in Volume 2.

Table 4.9. Means and standard errors for production traits of trypanotolerant sheep in nine situations under a variety of management systems and levels of trypanosomiasis risk.

Parameter	Mean	Standard Error
Ewe viability (%)	86.0	6.2
Lambing percentage	179.0	4.4
Lamb viability to 5 months (%)	68.0	4.9
Lamb weight at 5 months (kg)	11.5	0.4
Productivity index[a] per ewe (kg)	15.1	1.1
Ewe weight (kg)	23.6	0.4
Productivity index[a] per 10 kg ewe maintained per year (kg)	6.4	0.4

a. Total weight of 5-month-old lamb produced per year.

Source: Based on productivity figures presented in Volume 2.

The nine situations summarized in Table 4.9 are spread over six countries. The data are not adequate to allow the effects of management systems and levels of trypanosomiasis risk to be estimated, as was possible with trypanotolerant cattle. From these data, the best estimate of productivity of trypanotolerant sheep for the study area as a whole is 6.4 kg of 5-month-old lamb produced per 10 kg of ewe maintained per year.

4.6 PRODUCTIVITY OF GOATS

Table 4.10 summarizes the three situations for which productivity data on trypanotolerant goats were available, as described in Volume 2. The three situations summarized in this table are in three different countries. As with sheep, there are too few data to allow any estimates of the effects of management or levels of trypanosomiasis risk. From these data the best estimate of the productivity of trypanotolerant goats in the study area as a whole is 6.9 kg of 5-month-old kid produced per 10 kg of adult female maintained per year.

Table 4.10. Means and standard errors for production traits of trypanotolerant goats in three situations under village conditions and medium trypanosomiasis risk.

Parameter	Mean	Standard Error
Adult female viability (%)	88	3.4
Kidding percentage	224	23.4
Kid viability to 5 months (%)	77	0.6
Kid weight at 5 months (kg)	7.5	0
Productivity index[a] per adult female (kg)	14.8	1.1
Adult female weight (kg)	21.3	1.9
Productivity index[a] per 10 kg adult female maintained per year (kg)	6.9	0.4

a. Total weight of 5-month-old kid produced per year.

Source: Based on productivity figures presented in Volume 2.

4.7 CONCLUSIONS

All the productivity data on N'Dama and Shorthorn cattle groups and their comparisons with Zebu x humpless and Zebu groups identified in the study zone have been evaluated. These indices make it possible to compare more objectively the productivity of trypanotolerant cattle with that of indigenous groups in the tsetse-free areas of Africa. It has only been possible to build up a very rough estimate of the productivity of trypanotolerant sheep and goats.

On the basis of the index of total weight of one-year-old calf plus the live-weight equivalent of milk produced per 100 kg of cow maintained per year, no significant differences are found between the two main trypanotolerant groups, the N'Dama and the Shorthorn. The mean value for both groups combined is 28.5 kg. No indication has been found from the limited data available that either the Zebu x humpless crossbreeds or the Zebu are significantly more productive than the two trypanotolerant groups in the study zone. However, Zebu and Zebu x humpless types are not often found alongside humpless cattle, and thus field-level comparative data are scarce. The limited data on Zebu and Zebu crosses generally relate to favourable situations (i.e. light trypanosomiasis risk and a high level of veterinary care) and are not representative of the situation in the study area as a whole. General impressions of experience with the introduction of Zebu in these areas since the beginning of the century and the generally poor condition of the Zebu observed suggest that the trypanotolerant groups could have even greater potential production advantages over the Zebu than the limited available data indicate.

Little objective information has been found on the draught and milking capabilities of the trypanotolerant breeds, though they are widely used as draught animals in most of the study area. While the importance of crossbreeding to produce larger draught animals is often mentioned, in practice the choice of a draught animal generally depends on good condition and lack of disease problems, rather than on size and weight alone. It has been observed in several regions that N'Dama, and even the smaller West African Shorthorn, are preferred as draught animals over the larger breeds, and the natural amenability to training of trypanotolerant oxen is often stressed.

It has been mentioned on several occasions that Zebu and crossbred cattle produce more milk than trypanotolerant cattle even under traditional husbandry conditions. However, objective information is not available to compare milk production of the different breeds, taking account of important parameters such as body weight, reproductive performance and viability.

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CHAPTER 5

POTENTIAL, UTILIZATION AND CONSERVATION OF TRYPANOTOLERANT LIVESTOCK

5.1 BACKGROUND

The study area represents 15% of the total area of Africa, with 26% of the total human population, but only 9% of the cattle and 9% of the sheep and goat populations. There are 26 kg of livestock biomass (cattle, sheep and goats) per inhabitant in the study area, compared with 136 kg for the remainder of Africa south of the Sahara, and 79 kg for the continent as a whole. However, the study area has a very high potential in terms of animal feed availability. FAO (1974a) estimates the average potential carrying capacity of the study area in the 18 countries at 20 head of cattle/km^2, compared to 3.4 head/km^2 actually found.

Additionally, the Sahelian countries which at present export livestock to these humid and subhumid zones are unable to match anticipated increases in demand in these areas and will have to cater for their own population increases in the near future. Consequently, there is a major, expanding shortfall in meat and milk availability in the study area. International, bilateral and multilateral aid agencies are already responding to this problem. A study of the livestock development projects in West and Central Africa financed by the major aid agencies (ILCA, 1978d) shows that the funds for livestock development in the humid and subhumid zones have increased from US $ 27 million for the period 1961-1965 to US $ 150 million for 1971-1975. Furthermore, these zones received 70% of the total funds allocated to livestock projects in West and Central Africa in 1971-75, compared with only 25% in 1961-1965.

The increased utilization of trypanotolerant livestock could make a major contribution in this context. The results presented in Volume 2 of this report and the situation summarized in Chapters 2, 3 and 4 of Volume 1 show that it is biologically possible to maintain trypanotolerant cattle, sheep and goats in areas infested with trypanosomiasis and to establish cattle in areas where they have not previously been bred. Trypanotolerant livestock can undoubtedly attain varying degrees of productivity under medium or heavy trypanosomiasis risk conditions which preclude the maintenance of non-trypanotolerant types except possibly under continuous chemical prophylaxis.

Cattle productivity figures presented in Chapter 4 indicate that, even under only light trypanosomiasis risk conditions, trypanotolerant breeds can be as productive as the non-trypanotolerant Zebu or crosses between the two. It now has to be determined how trypanotolerant breeds compare in general with non-trypanotolerant breeds throughout Africa, as their further utilization will greatly depend on their relative productivity. Possibilities for their expanded use in development projects also need close examination, and, finally, any requirements for conservation of breeds in danger of extinction or absorption must be carefully considered.

This chapter starts by reviewing the evidence on the productivity of trypanotolerant breeds and then comparing this with data for other breeds in Africa. In the case of cattle, the productivity of trypanotolerant breeds is first compared with that of other breeds in tsetse-free zones within the study area, then with that of other breeds in tsetse-free zones elsewhere in Africa. In the case of sheep and goats, the few production data available on trypanotolerant breeds are compared with other information available from tsetse-free zones outside the study area.

In virtually all the production situations examined, it was impossible to find sufficient information to allow precise evaluation of both animal productivity and the degree of trypanosomiasis risk. A case study will be presented in detail of the approach taken in the analysis of a situation in Benin where basic data on degree of trypanosomiasis risk and animal productivity are relatively complete.

Possibilities for further evaluation and research to fill the many gaps in knowledge that remain now have to be considered. It has to be demonstrated, for example, whether it is in fact economically more desirable to raise trypanotolerant cattle than to maintain larger non-trypanotolerant breeds under chemoprophylaxis. If so, it then remains to convince present breeders that a smaller animal may actually be a better economic proposition than a larger one, which may be difficult. In other areas, the demonstration of the biological and commercial success of the trypanotolerant breeds could open the way for their introduction into wide stretches of savanna which are at present almost empty of cattle. Therefore, recommendations and possible locations are presented for cooperative programmes to evaluate both the potential and further utilization of trypanotolerant livestock.

Finally, as the Dwarf West African Shorthorn appears to be nearly extinct in several countries and rapidly declining in others, concrete measures are suggested for conservation of some interesting breeds which are in danger of disappearing and for more efficient exploitation of others whose value has been demonstrated.

5.2 PRODUCTIVITY OF TRYPANOTOLERANT LIVESTOCK RELATIVE TO OTHER GROUPS IN AFRICA

One major aim of this study was to make as much use as possible of all the general production information on trypanotolerant livestock available in West and

Central Africa. In the past, observations on the productivity of trypanotolerant livestock mostly concerned specific performance traits, such as reproductive performance, growth or mortality, measured in isolation. In addition, these observations were usually based on animals maintained under a medium or heavy trypanosomiasis risk. Information collected on non-trypanotolerant breeds was similarly limited.

Turning first to cattle, Table 5.1 summarizes from Chapter 4 the basic productivity data of the N'Dama and West African Shorthorn groups maintained under ranch and station management conditions and exposed to light trypanosomiasis risk. Direct comparisons with Zebu x humpless groups and with Zebu are also presented. Cow and calf weights of trypanotolerant animals are, as expected, significantly lower than those of either crossbred or Zebu. However, there are no indications that either the crossbred or the Zebu are significantly superior to the trypanotolerant breeds, either in terms of the basic index of productivity per unit weight of cow maintained per annum or of the individual components of this index except for body weights.

Table 5.1. Summary of comparative production traits of trypanotolerant, crossbred and Zebu cattle in the study zone.

	Trypanotolerant cattle groups - absolute values[a]	Crossbred relative to trypanotolerant[b]		Zebu relative to trypanotolerant[c]	
		Units	%	Units	%
Cow viability (%)	98	- 3	- 3	- 1	- 1
Calving percentage	80	-13	-22	- 4	- 5
Calf viability (%)	92	- 2	- 2	0	0
Calf weight at 1 year (kg)	109	+10	+ 8	+ 53	+53
Cow weight (kg)	219	+37	+18	+109	+52
Index[d]/cow (kg)	81.8	- 8.7	-14	+ 42.2	+55
Index[d]/100 kg cow (kg)	37.1	- 7.3	-25	+ 0.3	+ 1

a. Constructed from constants presented in Table 4.3 for N'Dama and Shorthorn groups under ranch or station conditions and light trypanosomiasis risk.
b. Constructed from data presented in Table 4.5.
c. Constructed from data presented in Table 4.6.
d. Total weight of one-year-old calf plus liveweight equivalent of milk produced per year.

Sources: Same as for Tables 4.3, 4.5 and 4.6.

The most valuable comparisons between trypanotolerant and other livestock are those carried out in a single given environment, as summarized in Table 5.1. However, the collection and analysis of precise data of this kind take a long time

Table 5.2. Production traits of Zebu cattle maintained in tsetse-free areas of the countries studied for meat or meat and milk production under station management.

Breed	Source	Production Traits							
		Cow viability (%)	Calving %	Calf viability (%)	Calf weight at 1 year (kg)	Annual milked-out yield (kg)	Cow weight (kg)	Index/ cow (kg)	Index/ 100 kg cow (kg)
Gobra (meat)	1	97	78	85	144	-	364	96.9	26.6
Sokoto Gudali (meat)	2	97	83	85	144	-	335	103.1	30.8
Wadera (meat)	3	97	69	85	145	-	270	86.3	32.0
White Fulani (meat)	4	97	84	85	209	-	340	151.5	44.6
Maure (meat and milk)	5	97	78	81	122	471	322	129.8	40.3
Peul (meat and milk)	5	97	77	79	118	413	302	118.1	39.1
Mean		97	78	83	147	-	322	114.3	35.6
Trypanotolerant group	6	98	80	92	109	-	219	81.8	37.1

Sources: 1 = Denis and Valenza, 1971; 2 = Wheat and Broadhurst, 1972; 3 = Wheat, 1975;
4 = Wheat and Broadhurst, 1968; 5 = ILCA, 1978c; 6 = Same as for Tables 4.3, 4.5 and 4.6.

and require substantial funding. For this reason, available data collected in isolation must also be fully utilized. Six situations are shown in Table 5.2 in which data are available on production traits of Zebu cattle in tsetse-free areas of the countries under study. These data were collected under a wide range of climatic, management and nutrition regimes. They show that the cow and calf weights and thus the productivity index per cow are significantly higher for the Zebu in tsetse-free areas of the study zone than for trypanotolerant animals in similar situations. However, the average Zebu index of productivity per unit weight of cow maintained per annum is not superior to the trypanotolerant group index.

Table 5.3 is based on another ten situations where data are available on production traits of Zebu and Sanga cattle in tsetse-free areas of Africa outside the study zone. Again, these data have been collected under a wide range of climatic, management and nutritional regimes. They indicate that the productivity of the Zebu and Sanga cattle surveyed is very similar to that of the trypanotolerant cattle groups maintained under low trypanosomiasis risk in the study zone.

The overall estimates of productivity for the 16 situations where Zebu or Sanga are kept under ranch or station conditions in the tsetse-free areas as described in Tables 5.2 and 5.3 are 136.6 kg of one-year-old calf plus liveweight equivalent of milk produced per cow maintained per year and 38.9 kg per 100 kg of cow maintained per year. Compared with the estimates of 81.8 kg and 37.1 kg under ranch or station conditions in low trypanosomiasis risk situations, the Zebu and Sanga estimates represent a 67% higher level of productivity per cow, but only a 5% higher level per 100 kg of cow maintained per annum.

Turning to sheep and goats, Table 5.4 presents 21 situations where data are available on production traits of indigenous sheep and goats in tsetse-free areas of Africa outside the study zone. This table indicates wide ranges in the productivity of sheep and goats in Africa outside the study area and no evidence that trypanotolerant animals are generally less productive.

The results presented here indicate that the productivity of trypanotolerant cattle under low trypanosomiasis risk per unit weight of cow maintained is only 5% less than that of a wide range of indigenous Zebu and Sanga types in tsetse-free areas throughout Africa. This suggests, first, that the productivity of trypanotolerant cattle may be much higher relative to that of other indigenous types than previously assumed, second, that in certain circumstances plans for increased utilization of trypanotolerant cattle might well be immediately justified and, third, that there is a serious need for more accurate evaluation of productivity in relation to the degree of trypanosomiasis risk.

In the case of trypanotolerant sheep and goats, it is suggested that the productivity per unit weight of female maintained is at least as high as that of a range of other indigenous types kept in tsetse-free areas throughout Africa. Thus, as with cattle, increased utilization and more accurate evaluation of productivity would appear to be justified.

Table 5.3. Production traits of Zebu and Sanga cattle maintained in tsetse-free areas of Africa outside the study zone for meat or meat and milk production under station or ranch management.

Breed	Source	Production Traits							
		Cow viability (%)	Calving %	Calf viability (%)	Calf weight at 1 yr (kg)	Annual milked-out yield (kg)	Cow weight (kg)	Index/cow (kg)	Index/100 kg cow (kg)
Ankole Longhorn (meat)	1	98	81	89	153	-	348	111.4	32.0
Boran (meat)	1	98	81	89	176	-	340	128.2	37.7
E.A. Zebu (meat)	1	98	74	89	146	-	271	97.1	35.8
Africander (meat)	2	98	64	90	225	-	450	130.9	29.1
Tswana (meat)	2	98	74	93	238	-	430	165.4	38.5
Tuli (meat)	2	98	32	93	233	-	410	179.5	43.8
Boran (meat)	3	98	88	91	203	-	400	164.2	41.4
Sahiwal (meat)	3	98	93	92	202	-	400	174.6	43.6
E.A. Zebu (meat and milk)	4	96	95	83	130	504	280	159.5	57.0
Sahiwal (meat and milk)	3	96	82	79	202	520	380	190.1	50.0
Mean		98	81	89	189	-	371	150.1	40.9
Trypanotolerant group	5	98	80	92	109	-	219	81.8	37.1

Sources: 1 = Trail et al, 1971; 2 = Trail et al, 1977; 3 = ILCA, 1979; 4 = Stobbs, 1967; 5 = Same as for Tables 4.3, 4.5 and 4.6.

Table 5.4. Production traits of indigenous sheep and goats maintained in tsetse-free areas of Africa outside the study zone.

Breed	Source	Production Traits						
		Breeding female viability	Lambing/ kidding %	Progeny viability (%)	Progeny weight at 5 mo (kg)	Breeding female weight (kg)	Index/ female (kg)	Index/10 kg female (kg)
Sheep								
Sahel (Mali)	1	90	133	70.0	16.3	34.6	16.0	4.6
Mossi (Upper Volta)	2	93	104	80.8	10.9	22.5	9.5	4.2
Peul (Upper Volta)	2	95	106	66.3	16.7	32.5	12.0	3.7
Sahel (Chad)	3	95	104	80.5	21.5	46.0	18.5	4.0
West African Dwarf (Chad)	3	95	172	71.3	10.8	31.0	13.6	4.4
Sudan Desert	4	95	146	69.0	20.6	40.2	21.3	5.3
African Fat-Tailed (Ethiopia)	5	90	120	70.0	15.3	30.0	13.5	4.5
East African Blackheaded (Uganda)	6	95	167	84.3	14.3	28.0	10.6	7.4
Masai (Kenya)	7	95	94	80.0	12.5	32.5	9.6	3.0
Tswana (Botswana)	8	93	86	87.0	16.1	33.7	12.5	3.7
Mean		94	123	75.9	15.3	33.1	14.7	4.5
Comparative trypanotolerant group		86	179	68.0	11.5	23.6	15.1	6.4
Goats								
Sahel (Mali)	1	90	150	70.0	12.9	31.0	14.3	4.6
Mossi (Upper Volta)	2	93	121	76.2	7.5	18.0	7.2	4.0
Sahel (Upper Volta)	2	93	141	70.3	9.0	22.5	9.2	4.1
Sahel (Chad)	3	96	113	71.1	9.5	32.0	7.8	2.4
Small Forest (Chad)	3	96	202	55.8	8.8	26.0	10.1	3.9
Sudan Desert (Sudan)	10	95	208	73.0	13.5	34.0	21.0	6.2
Afar (Ethiopia)	5	90	115	70.0	8.8	25.0	7.5	3.0
Mubende (Uganda)	11	95	164	68.2	11.6	28.0	13.3	4.8
Small East African (Kenya)	7	95	118	70.0	10.5	30.2	8.9	2.9
Tswana (Botswana)	8	92	105	75.0	13.7	37.0	11.8	3.2
Small East African (Zambia)	12	95	190	74.0	9.8	24.0	14.1	5.9
Mean		94	148	70.7	10.5	28.0	11.4	4.1
Trypanotolerant group	13	86	224	77.2	7.5	21.3	14.8	6.9

Sources: 1 = ILCA, 1979a; 2 = Dumas and Raymond, 1974; 3 = Dumas, 1977; 4 = Wilson, 1976a; 5 = Wilson, 1975; 6 = Sacker and Trail, 1966a; 7 = ILCA, 1979b; 8 = APRU, 1975; 9 = same as for Table 4.9; 10 = Wilson, 1976b; 11 = Sacker and Trail, 1966b; 12 = Quartermain, 1975; 13 = same as for Table 4.10.

Sources: See notes.

5.3 EVALUATION OF PRODUCTIVITY AND TRYPANOSOMIASIS SITUATION - A CASE STUDY

In virtually all the production situations examined, it was impossible to obtain sufficient information to allow a precise evaluation of animal productivity and the degree of trypanosomiasis present. During the country visits, however, a situation was identified in Benin where relatively complete basic data had been collected over a two-year period as part of an FAO project (BEN 72/015). A case study has been made of this situation, using the data collected to illustrate an approach to analysing and evaluating productivity in relation to degree of trypanosomiasis present. The actual situation was not ideal and the available data were rather limited, though more complete than in other situations observed (Lazic, 1978).

A herd of Lagune cattle at Samiondji and a herd of Borgou at M'Betecoucou were maintained and basic production information recorded from January 1976 to December 1977. Lagune cattle, a Dwarf Shorthorn breed, are considered trypanotolerant, while the Borgou are a stabilized cross between the Somba (West African Shorthorn) and the White Fulani (West African Zebu). The two herds were situated 50 km apart, at an altitude of 80 - 100 m, in areas with an annual rainfall of 1200 mm occurring primarily from March to June and to a lesser extent from September to November. General management conditions were very similar. Various surveys have indicated that the Lagune herd was under a heavier tsetse challenge than the Borgou. The composition of the two herds is presented in Table 5.5 as of 31 December 1977. In order to assess the relative productivities of the animals, no preventative or curative treatment was carried out. Each month over the two-year period, the presence or absence of trypanosomes was determined by blood smears, and body weights were recorded for each animal. In addition, abortion, stillbirth and calving dates were noted.

Table 5.5. Lagune and Borgou herd composition on two research stations in southern Benin.

Class	Number	
	Lagune	Borgou
Mature males	6	3
Mature females	46	38
Heifers	26	35
Young bulls	7	6
Male calves	11	15
Female calves	14	14
Oxen	2	-
Total	112	111

Source: Analysis of project information.

In analysing these situations, first the degree of trypanosomiasis present in each herd was determined, among both young and mature stock, as indicated by the monthly blood smears. Reproductive performance, viability and growth were then analysed separately from the calving, mortality and monthly weight records of individual animals. A composite picture of productivity was built up in this way, based on reproductive performance, cow and calf mortality, growth and mature cow weight and presented as weight of one-year-old calf produced per 100 kg cow maintained per year.

Table 5.6 indicates that over the two-year period 86.3% of the Borgou cows were diagnosed positive for trypanosomiasis at some time, compared to only 51% of the Lagune. The Borgou cows showed 11.5% positive animal/months, compared to only 4.2% for the Lagune.

Table 5.7 indicates that over the two-year period 18.2% of the Borgou calves were diagnosed positive for trypanosomiasis at some time compared with 9.5% of the Lagune, though this difference was not significant, probably due to the very small numbers involved. The Borgou showed 2.7% positive animal/months and the Lagune 1.4%, again not a significant difference.

Table 5.6. Degree of trypanosomiasis in mature Lagune and Borgou cows as indicated by monthly blood smears.

	Lagune			Borgou		
	1975	1976	Total	1975	1976	Total
Number of animals positive	20	6	26	21	42	63
Total number of animals	42	9	51	25	48	73
Percentage of animals positive	47.6	66.6	51.0	84.0	87.5	86.3
Number of animal months positive	34	13	47	61	120	181
Total number of animal months	986	135	1121	567	1007	1574
Percentage of animal months positive	3.5	9.6	4.2	10.8	11.9	11.5

Source: Analysis of FAO project information.

The annual calving percentages, based on the number of calves born per cow year, are presented in Table 5.8. The Lagune had a calving percentage of 57.8%, significantly higher than the Borgou with 32.8%.

The annual abortion rate among the Borgou was 4.6%, not significantly

Table 5.7. Degree of trypanosomiasis in Lagune and Borgou calves to one year as indicated by monthly blood smears.

	Lagune	Borgou
Number of animals positive	4	10
Total number of animals	42	55
Percentage of animals positive	9.5	18.2
Number of animal months positive	4	11
Total number of animal months	283	410
Percentage of animal months positive	1.4	2.7

Source: Analysis of FAO project information.

Table 5.8. Annual calving percentage for Lagune and Borgou cows.

	Lagune	Borgou
Number of births	54	43
Number of cow years	93.4	131.2
Annual calving percentage	57.8	32.8

Source: Analysis of FAO project information.

different from the 8.6% for the Lagune. Mortality rates from birth to one year were 27.9% among the Borgou and 24.1% among the Lagune, again not significantly different. Annual cow mortality due to trypanosomiasis was 12.2% among the Borgou which was significantly greater ($P < 0.05$) than mortality due to trypanosomiasis among the Lagune which was 5.4%, as shown in Table 5.9.

At all stages, the Borgou weighed significantly more than the Lagune. At birth they were 68% heavier, at 6 months 60%, at 12 months 40% and at maturity 48%, as shown in Table 5.10.

On the basis of weight of 1-year-old calf per 100 kg of cow maintained per year, the productivity of the Lagune, at 24.6 kg, was 96% higher than that of the Borgou, at 12.5 kg (see Table 5.11).

The aim of this case study is to present one approach to analysing and evaluating animal productivity and trypanosomiasis information, rather than to produce results for a specific situation from rather limited data. In this case, monthly blood smears suggested that a much higher proportion of the Borgou were positive to trypanosomiasis than the Lagune. The importance of up-to-date techniques to

Table 5.9. Mortality rates for Lagune and Borgou.

	Lagune	Borgou
Pre-parturition (abortions)		
Number of abortions	8	6
Number of cow years	93.4	131.2
Annual abortion rate (%)	8.6	4.6
Pre-weaning (birth to 1 year)		
Number of deaths	13[a]	12[b]
Number of births	54	43
Mortality rate (%)	24.1	27.9
Cow mortality due to trypanosomiasis		
Number of deaths	5	16[c]
Number of cow years	93.4	131.2
Annual mortality rate (%)	5.4	12.2

a. Five of the 13 (38%) occurred when the dam was positive for trypanosomiasis.
b. Seven of the 12 (58%) occurred when the dam was positive for trypanosomiasis.
c. These 16 deaths among the Borgou included cases which were treated with Berenil and sold when it was considered that they would otherwise have died.

Source: Analysis of FAO project information.

Table 5.10. Body weights of Lagune and Borgou breeds (kg).

Age	Male			Female			Total		
	No	Mean	SE	No	Mean	SE	No	Mean	SE
Birth									
Lagune	17	9.9	0.5	18	9.5	0.6	35	9.7	0.4
Borgou	26	16.6	0.6	15	15.8	1.0	41	16.3	0.5
6 months									
Lagune	9	48.8	4.5	11	47.1	4.0	20	47.9	2.9
Borgou	18	85.8	3.9	16	66.4	4.3	34	76.7	3.3
12 months									
Lagune	5	82.6	4.9	6	87.3	6.8	11	85.2	4.2
Borgou	12	129.7	3.9	17	112.1	5.8	29	119.3	4.0
Mature females (3 years)									
Lagune	-	-	-	51	152.0	2.9	-	-	-
Borgou	-	-	-	73	225.7	5.3	-	-	-

Source: Analysis of FAO project information.

Table 5.11. Productivity of Lagune and Borgou breeds expressed as weight of 1-year-old calf per unit weight of cow maintained per year.

	Lagune	Borgou
Cow viability (%)	94.6	87.8
Calving percentage	57.8	32.8
Calf viability to 1 year (%)	75.9	72.1
Calf weight at 1 year (kg)	85.2	119.3
Productivity index[a] per cow per year (kg)	37.4	28.2
Cow weight (kg)	152.0	225.7
Productivity index[a] per 100 kg cow maintained per year (kg)	24.6	12.5

a. Weight of 1-year-old calf produced.

Source: Analysis of FAO project information.

allow more accurate diagnosis and distinction between new and continued infections is obvious. When the main production traits of reproduction performance, viability and growth are examined, the Lagune show a superior calving rate, pre-parturition and pre-weaning mortality rates are similar for the two breeds, cow mortality due to trypanosomiasis is lower among the Lagune and growth rate and mature body size are much higher among the Borgou. When combined to provide an estimate of productivity based on weight of 1-year-old calf produced per 100 kg of cow maintained per year, these traits yield a 96% higher productivity estimate for the Lagune than for the Borgou, illustrating the importance in such comparisons of simultaneously recording all important factors. Generally, this comparative study would suggest the importance of objective assessments of the productivities of different trypanotolerant types under various conditions, such as levels of trypanosomiasis risk, management systems, nutritional environments and chemoprophylactic and chemotherapeutic regimes. In such situations, a clear specification of the most valuable data required and use of the best practical techniques are obviously essential in order to maximize information return.

5.4 POTENTIAL OF TRYPANOTOLERANT LIVESTOCK

5.4.1 RECOMMENDATIONS FOR EVALUATION

While the general productivity levels that have been determined indicate the significant production potential of trypanotolerant livestock, it is clear that more data are required on their comparative performance under different systems of management and under different degrees of trypanosomiasis risk before convincing

recommendations can be made for their future use. In order to obtain recommendations for technical studies, ILCA brought together three consultants in March 1978 to work with the scientists who had visited the first seven countries included in this study. Based on the information collected at that time, the consultants (Allonby, Spooner and Vercoe) prepared a report including recommendations for a research programme covering the use and potential of trypanotolerant livestock (ILCA, 1978a). The next step was the critical assessment of this proposed programme by representatives of the international organizations actually engaged in or concerned with work in this field. Representatives of FAO, ILRAD, UNEP, IBAR and GTZ were brought together for two days to review the suggested programme and its relation to their own operations (ILCA, 1978b). This section on recommendations for evaluation includes the recommendations of Allonby, Spooner and Vercoe together with the additional inputs and modifications considered necessary by the international organizations operating in this field. During the country visits, preliminary enquiries were also made to government stations and institutions, universities, commercial ranches, village groups and other organisations with suitable interests and facilities concerning their possible willingness to cooperate in further work on the use and potential of trypanotolerant livestock.

A characteristic of trypanotolerant breeds is that they are all small, whereas in Africa, as in other parts of the world, large cattle have generally been considered more desirable. However, it has been proven that large animals are not necessarily more efficient, either biologically or economically. Small size is advantageous for survival in harsh environments, and it could well be that the small size of trypanotolerant breeds is relevant to their tolerance. Moreover, as already shown, they can be as productive or more productive than larger breeds when considered in terms of total annual offtake per unit weight of animal maintained. It is thus clearly essential to have comparative data on the biological and economic productivity of trypanotolerant and other breeds in environments with and without trypanosomiasis risk. At the present time such objective comparative data are not available, in spite of a number of investigations that have been carried out in the past. It is impossible to compare accurately productivity or susceptibility data on one breed in one location with those on another breed in another place. The trypanosomiasis risk and other environmental factors, such as nutrition, other diseases, parasitism and the work load of oxen, must be precisely defined and made comparable. The only alternative is to compare breeds maintained together in the same environment. This is the rationale of the approach recommended in this section, which is to compare the biological and economic productivity of trypanotolerant and other breeds kept together under a variety of management systems and levels of trypanosomiasis risk. Such comparisons would provide the only basis for a meaningful assessment of trypanotolerance.

5.4.1.1 Productivity Studies Among Cattle Breeds

Critical comparisons of the productivity of three classes of livestock (trypanotolerant, semi-trypanotolerant and susceptible), exposed to various degrees of trypanosomiasis risk (none, light, moderate and heavy) under both village and

ranching or station management in different locations (to account for variations in the nutritional, climatic and parasitic environments) would be ideal. Once the interactions with trypanosomiasis levels, management systems and other environmental variables have been assessed, the breed differences could be evaluated. However, the data available at present are less than ideal and information on cattle breeds and their interactions with levels of trypanosomiasis risk, management systems and environments must be obtained in a piecemeal fashion from various sources. Depending on the number of sites included in future studies, measurements of productivity and trypanotolerance should take three to five years. Replication over time, to ascertain yearly variation, can to some extent compensate for a small number of study sites. The information collected should include a full description of the management system, productivity data, trypanosomiasis status and degree of trypanotolerance, disease status, including helminthiasis, fascioliasis, babesiosis and anaplasmosis, tick burden, streptothricosis and reproductive diseases determined by clinical and post-mortem examinations, and economic data.

These measurements will make it possible to establish and interpret the interrelations between productivity and trypanosome infection in various situations. The frequency of measurements will depend on individual situations. Weights and levels of trypanosome infection should be recorded at least on a two-monthly basis; helminthiasis could be measured for individual animals in small herds but perhaps only for groups in large herds, and at strategic times rather than routinely. In some cases, control with anthelmintics may be considered.

5.4.1.2 Productivity Studies within Cattle Breeds

Although comparative data among breeds are most valuable, productivity data from individual ranches or villages with only one breed can provide reference points to gauge levels of productivity and trypanotolerance. Such information can also lead to changes in management practices in particular areas, especially if the reasons for low productivity can be identified, for example, causes of high neonatal mortality. Information from ranches or villages can also provide the first step towards improved performance, and recording and collecting such information can also serve as a training exercise for technical staff at research centres. Where such information exists and can be analysed with a modest input, consideration should be given to cooperating in an analysis exercise with the centres involved.

5.4.1.3 Productivity Studies of Sheep and Goats

Comparative studies on the productivity of sheep and goats should be initiated and stimulated in view of their major role in protein production throughout the region and the lack of information available. These should include, wherever possible, comparative production data equivalent to those outlined for cattle, together with analyses of the economics of protein production, both between and within trypanotolerant and susceptible small ruminant breeds. Unfortunately, resources for this type of study are less readily available than for cattle. ILCA, through its small ruminants programme, should be

able to play a central role in coordinating the collection of data on sheep and goats, which at present are even more fragmentary than those on cattle. Despite widespread observations on the ability of goats to thrive in conditions of high tsetse challenge, goats have been the subject of even less quantitative research than sheep. However, recent studies in East Africa have demonstrated the marked tolerance of some indigenous breeds to both field and experimental trypanosome challenge and have indicated that trypanotolerance may be an even more marked phenomenon among goats than among cattle (Allonby, 1978, personal communication).

5.4.1.4 Specific Experimental Investigations

Answers to some of the main practical questions concerning the productivity of trypanotolerant livestock can only come from studies of the breeds interacting with various levels of trypanosomiasis challenge. Do different breeds react relatively differently, in terms of productivity, to different levels of trypanosome challenge? The reasons for interactions under field conditions will be impossible to interpret unless some of the possible causes of interactions have been investigated under controlled experimental conditions. In turn, interactions which come to light under controlled experimental conditions can be further examined using the data collected in the field.

A major factor that should be studied under controlled conditions is the relation between production potential and trypanotolerance. Since all the trypanotolerant breeds are small compared with their susceptible counterparts, it could be that small size is an integral part of tolerance. Selection for growth rate under field conditions could lead to an increase in size and other correlated factors and perhaps to a decline in the degree of trypanotolerance (for more detailed discussion see ILCA, 1977b). The effects of chemotheraphy on trypanotolerant livestock under different trypanosomiasis challenges is another important aspect of any evaluation of their production potential. It is possible that responses of economic significance could occur under certain trypanosomiasis risk conditions. This information could be collected as part of a major comparative study: where susceptible cattle are kept in moderate challenge areas under chemotherapy, similar treatment could be applied to part of the trypanotolerant herd.

This information might be obtained by providing funds for university and government research institutes in Africa. There is a training component to this approach, since a number of these studies could be carried out as part of postgraduate work. ILCA might assume responsibility for coordinating work amongst a number of institutions carrying out this research whilst ILRAD would be a logical organization to carry out studies of factors affecting the interaction between breeds and levels of trypanosomiasis challenge, particularly where pathophysiological effects are to be measured. The main focus of any studies supported by ILCA should be comparative investigations. Possible lines of research are summarized as follows:

a. Factors affecting the interaction of breeds and levels of trypanosomiasis

risk. Nutrition, physiological status, work load (for oxen) and other stresses, such as parasites, should be investigated;

b. Relationship between production potential and trypanotolerance. Correlations between production potential, measured under trypanosome-free conditions, with susceptibility and pathogenicity to artificial or natural challenge should be investigated;

c. The effects of chemotherapy on trypanotolerant breeds;

d. Research on genetic applications. Selection in tolerant breeds for rate of gain and/or mature size with identification of correlated responses in terms of tolerance. Estimation of heritability for all possible measurements of tolerance. Estimation of tolerance among breeds, their crossbred offspring and further descendants to discover hereditary patterns of tolerance.

In section 5.4.2, institutions or projects in the 18 countries under study will be identified where future evaluation work might usefully be discussed. These are places where the facilities and personnel are adequate to carry out such work and where a willingness to cooperate has been expressed.

5.4.2 POSSIBLE LOCATIONS FOR EVALUATION

Table 5.12 shows the locations identified in the study zone where future evaluation activities might be possible. These include possible sites for productivity studies comparing cattle breeds under various levels of trypanosomiasis risk and management systems, for productivity studies of single cattle breeds, for productivity studies of sheep and goats and for specific experimental investigations. Each of these four types of studies will be discussed separately.

5.4.2.1 Possible Locations for Productivity Studies Comparing Cattle Breeds

Possible locations for studies of the interactions between breed, management system and level of trypanosomiasis risk are listed in Table 5.13, and explanatory notes are given in Table 5.14. In discussing these possibilities, the aim would be to build up a network of locations where work could be undertaken over a three- to five-year period. International, multilateral and bilateral organizations, such as the World Bank, FAO/UNDP and the aid agencies of the EEC, Belgium, France, the Federal Republic of Germany, the UK and the USA, are already involved in several of these operations and the possibilities for their further involvement in a network of research sites should be considered.

5.4.2.2 Possible Locations for Productivity Studies of Specific Cattle Breeds

All the locations mentioned in Table 5.12 could also supply information on the productivity of specific cattle breeds. Table 5.15 indicates locations where

data already exist and might be analysed with relatively small additional inputs.

Table 5.12. Possible locations for evaluation of trypanotolerant livestock.

Country	Location	Breeds and Numbers		Trypanosomiasis Risk	Management System
		Cattle	Sheep and Goats		
Senegal	Kolda	N'Dama: 400	Djallonké: 300	L-M	Station
	Kolda	N'Dama	Djallonké	L-M	Village
	Velingara	Djakoré		O-L	Village
	Tambacounda	N'Dama		O-L	Village
	Kaolack	N'Dama, Djakoré: 400		L-M	Village
The Gambia	Yundum	N'Dama: 100		O-L	Station
	Yundum	N'Dama	Djallonké	O-L	Village
	Koneba	N'Dama } 1 000	Djallonké	M-H	Village
	Sapu	N'Dama }	Djallonké	L-M	Village
	Basse	N'Dama, Djakoré		O-L	Village
Guinea Bissau	Bissau	N'Dama: 100		L-M	Station
	Bissau	N'Dama		L-M	Village
	Bissora	N'Dama: 150		L-M	Station
Guinea	Various	N'Dama		Varied	Village
Sierra Leone	Toko	N'Dama: 85; Sahiwal: 32; N'Dama x Sahiwal: 70		L-M	Station
	Musaia	N'Dama: 120		L-M	Station
	Koinadugu District	N'Dama		L-M	Village
Liberia	Surkoko	N'Dama: 150	Djallonké: 20, Dwarf goats: 20	L-M	Station
	LAC	N'Dama: 360		L-M	Rubber Plantation
	Sinoe County	Muturu		L-M	Village
Mali	Yanfolila	N'Dama: 1 000	Djallonké: 200	L-M/M-H	Ranch
	Yanfolila	N'Dama	Djallonké	L-M/M-H	Village
	Sikasso	N'Dama: 170		O-L	Farm
	Sikasso	N'Dama, Méré, Zebu		O-L	Village
Upper Volta	Samandeni	WAS: 103; N'Dama: 30		L-M	Station
	Matourkou	N'Dama: 80, Azaouak, Zebu: 115		L-M	Station
	Banfora ORD	Shorthorn, Zebu, Méré		O-L/L-M	Village
	Kaya-Koupah and Fada Regions	Shorthorn, Mere		O-L	Village
Ivory Coast	Bouaké	N'Dama: 250; Baoulé: 500		O-L	Station
	Bouaké	N'Dama, Baoulé	Djallonké	O-L/L-M	Village
	Bouaké/Foro		Djallonké: 500, Dwarf goat: 50	L-M	Station
	Abokouamekro	N'Dama: 4 000		L-M	Ranch
	Sipilou	N'Dama: 5 000		L-M	Ranch
	La Marahoue	N'Dama: 2 000		M-H	Ranch
	Korhogo	Baoulé, Zebu, Mere: 1 500		O-L	Village
	SODEPALM	N'Dama, Baoulé, N'Dama x Baoulé: 2 500		O-L	Palm Plantation
	Béoumi		Djallonké: 1 000	L-M	Ranch

Table 5.12. cont.

Country	Location	Breeds and Numbers: Cattle	Breeds and Numbers: Sheep and Goats	Trypanosomiasis Risk	Management System
Ghana	12 Animal Husbandry Stock Farms	Shorthorn, N'Dama, Sanga, Zebu: 2 755		Varied	Station
	Shai Hills	All local breeds: 1 100		O-L	Ranch
	Ejura		Djallonké, Sahelian: 630 Dwarf goat: 40	C-L	Ranch
Togo	Avetonou	N'Dama, local breeds, N'Dama crosses: 760		L-M/M-H	Station
	Dzogbegan	Wakwa, local x Wakwa: 60		L-M	Station
Benin	Samiondji	Lagune: 110		M-H	Ranch
	M'Betecoucou	Borgou: 112		L-M	Ranch
	M'Betecoucou	Borgou		L-M	Village
	Okpara	N'Dama: 150; Borgou: 750		L-M	Station
	Porto Novo	Borgou		O-L	Village
	SOBEPALH	Lagune, Borgou, N'Dama crosses: 2 800		O-L	Village
Nigeria	Ado Ekiti	N'Dama: 300; Keteku: 100 Muturu: 60; crosses: 200		L-M	Station
	Fashola	N'Dama: 420; Keteku and crosses: 320		L-M	Station
	Upper Ogun	N'Dama: 3 200; Keteku and crosses: 1 100		L-M	Ranch
	University of Ibadan		Dwarf sheep: 300, Dwarf goats: 100	O-L	Farm
	University of Ife		Dwarf sheep: 170, Dwarf goats: 55	O-L	Farm
	University of Nigeria, Nsukka		Dwarf sheep; 80 ewes; Dwarf goats: 30 females	O-L	Farm
	Ubiadja		Dwarf goats and crosses: 150	O-L	Farm
Central African Republic	Kidjigra	Baoulé: 200	Djallonké: 200 Dwarf goats: 200	L-M	Village
Gabon	Okouma	N'Dama: 377; Nguni: 163, N'Dama x Nguni: 310		O-L	Ranch
	Franceville		Djallonké x exotic sheep: 250 ewes	O-L	Ranch
Congo	Boueza	N'Dama, Lagune		M-H	Village
	La Dihesse	N'Dama: 3 500; Zebu: 250		L-M	Ranch
	Odziba		Djallonké: 310	O-L	Farm
	Kibelemoussia		Djallonké: 150	L-M	Farm
	Mvouti		West African Dwarf sheep and goats: 600	M-H	Village
Zaire	Gimbi	Lagune: 60; N'Dama: 150 Lagune x N'Dama: 65		L-M	Station
	Gimbi	Lagune: 50; N'Dama: 40		L-M/M-H	Metayage
	Mbanza-Ngungu	N'Dama: 4 300		L-M	Metayage
	Kolo	N'Dama: 32 000	Djallonké: 300	L-M	Ranch
	Mushie	N'Dama: 12 000		M-H	Ranch
	Lombo	N'Dama, Nuri: 8 000		M-H	Ranch
	Kikwit	N'Dama: 1 300		L-M	Ranch
	Kikwit	N'Dama: 250		L-M	Metayage
	Idiofa	N'Dama: 6 500		L-M/M-H	Metayage
	Mvuazi	N'Dama: 350	Djallonké: 100	L-M	Station

Source: Compiled by authors.

gramme and its potential carrying capacity and finally whether the return from livestock production under pastoralism, village systems or ranching in a given area would justify the costs of tsetse control (Jahnke, 1976). Are the secondary effects of tsetse control, notably the environmental effects, known and evaluated? Can the results of the different tsetse eradication measures be considered permanent, and if not, what are the projected costs of continuous control? Is the internal political and financial situation stable enough to allow continuous tsetse control at appropriate times and to implement an adequate long-term land-use policy which will avoid reinfestation with tsetse or reinvasion by wildlife? Is the external political situation stable enough to allow the coordination of tsetse control across national boundaries? Are the control measures also effective against other possible trypanosomiasis vectors, so that the disease will not continue in a latent state leading to possible outbreaks at a later time?

Table 5.13. Possible locations for comparative studies of breeds (B), management systems (S), levels of trypanosomiasis risk (T) and their interactions (BS, BT).

Location	Ref. No.	Breed							System			Trypanosomiasis risk		
		N'Dama	Short-horn	Short-horn crosses	Trypano-tolerant crosses	Zebu x N'Dama	Zebu x Short-horn	Zebu	Village	Ranch	Station	O-L	L-M	M-H
Senegal, The Gambia	B.1	X				X			X			X		
	B.2	X				X		X(?)	X				X	
	S.1	X							X		X	X		
	S.2	X							X		X		X	
	T.1	X							X			X	X	X
	T.2	X									X	X	X	
Sierra Leone Liberia, Guinea Bissau	B.1	X				X(?)		X(?)			X		X	
	B.2	X				X		X			X		X	
	S.1	X							X		X		X	
	S.2	X								X	X		X	
	S.3	X							X		X		X	
Mali, Upper Volta	B.1		X				X	X	X			X		
	B.2	X	X					X			X		X	
	S.1	X							X	X				X
	S.2		X						X		X		X	
	T.1	X								X		X	X	X
	T.2		X						X			X	X	
	T.3						X		X			X	X	
	BT.1		X				X		X			X	X	
Ivory Coast	B.1	X	X						X				X	
	B.2		X				X	X	X			X		
	B.3	X	X								X	X		
	B.4	X	X		X					X		X		
	S.1	X							X	X			X	
	S.2		X						X	X	X	X		
	S.3	X								X	X	X		
	T.1	X								X			X	X
	T.2		X						X			X	X	
	BT.1	X	X							X	X	X		

Table 5.13, cont.

Location	Ref. No.	Breed							System			Trypanosomiasis risk		
		N'Dama	Short-horn	Short-horn crosses	Trypano-tolerant crosses	Zebu x N'Dama	Zebu x Short-horn	Zebu	Village	Ranch	Station	O-L	L-M	M-H
Togo, Benin	B.1			X	X		X		X			X		
	B.2	X			X						X		X	
	B.3	X					X				X		X	
	B.4			X			X				X		X	
	S.1						X		X		X		X	
	S.2			X					X		X		X	
	T.1	X									X		X	X
	T.2						X		X			X	X	
	BT.1	X			X						X		X	X
Nigeria	B.1	X	X		X		X				X		X	
	B.2	X			X		X			X			X	
	S.1	X								X	X		X	
	S.2						X			X	X		X	
	S.3				X					X	X		X	
	BS.1	X			X		X			X	X		X	
Central African Republic, Gabon, Congo, Zaire	B.1	X	X	X					X				X	
	B.2	X		X	X						X		X	
	B.3	X						X		X				X
	B.4	X				X		X		X		X		
	B.5	X						X(?)		X			X	
	B.6	X		X					X					X
	S.1	X							X	X			X	
	S.2	X							X	X				X
	S.3	X							X		X		X	
	S.4			X					X		X		X	
	T.1	X								X			X	X
	T.2	X							X				X	X
	T.3			X					X				X	X
	BS.1	X		X					X	X	X		X	
	BT.1	X		X					X				X	X

Source: Compiled by authors.

Table 5.14. Explanatory notes on possible locations for comparative studies of interactions between breeds, management systems and levels of trypanosomiasis risk.

Country	Type of Comparison	Reference Number	Remarks
Senegal, The Gambia	Breeds	B.1	N'Dama vs Djakoré under village conditions and very low trypanosomiasis risk (O-L) in Basse Region of eastern Gambia and Velingara and Tambacounda in Senegal. Herds still have to be identified.
	Breeds	B.2	N'Dama vs Djakoré under village conditions and low to medium trypanosomiasis risk in Kaolack, Sine Saloum Region, Senegal. Note: Possibly Zebu could be incorporated.
	Management Systems	S.1	Village vs station conditions with N'Dama under very low trypanosomiasis risk (O-L) at and near Yundum Station, western Gambia.
	Management Systems	S.2	Village vs station conditions with N'Dama under low to medium trypanosomiasis risk at and near Kolda Station, Senegal.
	Trypanosomiasis Risk	T.1	Low vs low to medium vs medium to high trypanosomiasis risk with N'Dama under village conditions in Keneba and Sapu, The Gambia.
	Trypanosomiasis Risk	T.2	Low vs low to medium trypanosomiasis risk with N'Dama under station conditions at Yundum, The Gambia and Kolda, Senegal.
			Note: Various agencies are involved in integrated livestock operations in these regions: EDF in Casamance and World Bank in Sine Saloum in Senegal, USAID, ODM and ILRAD in The Gambia. Their possible interest should be investigated.
Guinea-Bissau, Guinea, Sierra Leone, Liberia	Breeds	B.1	N'Dama, Sahiwal and Sahiwal x N'Dama under station conditions and low to medium trypanosomiasis risk at Musaia, Sierra Leone. Note: Dependent on Sahiwal being introduced at Musaia Station.
	Breeds	B.2	N'Dama, Sahiwal and Sahiwal x N'Dama crosses under station conditions and low to medium trypanosomiasis risk at Teko Station, Sierra Leone.
	Management Systems	S.1	Village vs station conditions with N'Dama under low to medium trypanosomiasis risk in Koinadugu District and Musaia and/or Teko Stations in Sierra Leone.
	Management Systems	S.2	Station vs ranch conditions with N'Dama under low to medium trypanosomiasis risk at Suakoko and LAC in Liberia.
	Management Systems	S.3	Village vs station conditions with N'Dama under low to medium trypanosomiasis risk in Bissau District and Bissau and Bissora Stations, Guinea-Bissau.
			Note: Some villages in Guinea could easily be identified and incorporated into the comparisons. FAO and World Bank are involved in livestock operations in Liberia and EDF in Sierra Leone; FAO and World Bank are involved in the Suakoko Central Agricultural Experimental Station; and EDF is involved in developing Musaia Cattle Station and in livestock surveys. Their possible interest should be investigated.

Table 5.14, cont.

Country	Type of Comparison	Reference Number	Remarks
Mali, Upper Volta	Breeds	B.1	Shorthorn, Méré and Fulani Zebu under village conditions and very low (O-L) trypanosomiasis risk in Kaya, Koupah and Fada Regions in eastern Upper Volta, in Sikasso Region in Mali and in Banfora ORD in Upper Volta. Herds have to be identified.
	Breeds	B.2	N'Dama, Shorthorn, Azaouak Zebu under station conditions and low to medium trypanosomiasis risk at Samandeni (Shorthorn, N'Dama) and Matourkou (N'Dama, Zebu) Stations in Upper Volta.
	Management Systems	S.1	Village vs ranching conditions with N'Dama under medium to high trypanosomiasis risk at and near Yanfolila Ranch in Mali.
	Management Systems	S.2	Village vs station conditions with Shorthorn under low to medium trypanosomiasis risk in Banfora ORD and Samandeni Station in Upper Volta.
	Trypanosomiasis Risk	T.1	Very low vs low to medium vs medium to high trypanosomiasis risk with N'Dama under ranching conditions at Sikasso Farm in Mali, Samandeni Station in Upper Volta and Yanfolila Ranch in Mali.
	Trypanosomiasis Risk	T.2	Low vs low to medium trypanosomiasis risk with Shorthorn under village conditions in Banfora ORD and Kaya, Koupah and Fada Regions in Upper Volta.
	Trypanosomiasis Risk	T.3	Low vs low to medium trypanosomiasis risk with Mere under village conditions in Banfora ORD and Kaya, Koupah and Fada Regions in Upper Volta.
	Breeds by Trypanosomiasis Risk	BT.1	Shorthorn and Méré under very low trypanosomiasis risk (O-L) and low to medium trypanosomiasis risk under village conditions in Banfora ORD and in Kaya, Koupah and Fada Regions in Upper Volta. Note: Village herds have to be identified.
			Note: Possible interest should be investigated of such agencies as EDF, involved in Banfora ORD, Yanfolila Ranch and Elevage Mali Sud Projects; USAID, involved in village livestock projects in Upper Volta; World Bank, involved in the western Upper Volta livestock project; and IEMVT/GTZ, involved in Bobo Dioulasso Centre de Recherches sur les Trypanosomiases Animales and possibly Samandeni Station.
Ivory Coast	Breeds	B.1	N'Dama vs Baoulé under village conditions and low to medium trypanosomiasis risk in Bouaké Region.
	Breeds	B.2	Baoulé vs Zebu vs Zebu x Baoulé crosses under village conditions and very low trypanosomiasis risk (O-L) in Korhogo Region.
	Breeds	B.3	N'Dama vs Baoulé under station conditions and very low trypanosomiasis risk (O-L) at CRZ Minankro at Bouaké.
	Breeds	B.4	N'Dama vs Baoulé vs crosses under ranching (palm tree plantation) conditions and very low trypanosomiasis risk (O-L) at SODEPALM in Coastal Region.
	Management Systems	S.1	Village vs ranching conditions with N'Dama under low to medium trypanosomiasis risk in Bouaké Region (see B.1) and on SODEPRA ranches in Abakouamekro and Sipilou.

Table 5.14, cont.

Country	Type of Comparison	Reference Number	Remarks
Ivory Coast, cont.	Management Systems	S.2	Village vs station vs ranching (palm tree plantation) conditions with Baoulé under very low trypanosomiasis risk (O-L). See B.2, B.3 and B.4.
	Management Systems	S.3	Station vs ranching (palm tree plantation) conditions with N'Dama under very low trypanosomiasis risk (O-L) at CRZ Minankro and SODEPALM.
	Trypanosomiasis Risk	T.1	Low to medium vs medium to high trypanosomiasis risk with N'Dama under ranching conditions on SODEPRA ranches at Abokouamekro and/or Sipilou vs in Marahoué.
	Trypanosomiasis Risk	T.2	Low to medium vs medium to high trypanosomiasis risk with Baoulé under village conditions in Bouaké Region.
	Breeds by Management Systems	BS.1	N'Dama and Baoulé under station and ranching (palm tree plantation) conditions and very low trypanosomiasis risk (O-L). See S.2 and S.3.
			Note: Three main organizations are responsible for or are dealing with the installations described. The Ministere de la Recherche Scientifique and its specialized organization, the Institut des Savanes, are responsible for the Research Station at Minankro (CRZ) and for the surveys of village cattle. SODEPPA is responsible for the ranching operations (on the savannas) and extension work in Central and North Regions. SODEPALM is responsible for the ranching operations on palm tree plantations. Interest and possibilities for cooperation should be investigated. These organizations are already carrying out or intend to carry out the survey and data recording required. If agreement is reached, the work would consist mainly of cooperation in data analysis. These organizations have close contacts with IEMVT and various agencies involved in livestock development, such as FAC, GTZ, Belgian assistance, USAID, World Bank and EDF. Various possibilities for future cooperation should be investigated.
Togo, Benin	Breeds	B.1	Lagune vs Borgou vs N'Dama crosses under village conditions and very low trypanosomiasis risk (O-L) in villages and SOBEPALH in the Coastal Region of Benin. Some village herds have yet to be identified.
	Breeds	B.2	N'Dama vs N'Dama x exotic vs local breed crosses under station conditions and low to medium trypanosomiasis risk at Avetoncu CERTT in Togo.
	Breeds	B.3	N'Dama vs Borgou under station conditions and low to medium trypanosomiasis risk at Okpara in Benin.
	Breeds	B.4	Lagune vs Borgou under station conditions and medium trypanosomiasis risk at Samiondji and M'Bétécoucou Stations in Benin.
	Management Systems	S.1	Village vs station conditions with Borgou under low to medium trypanosomiasis risk on and near M'Bétécoucou Station in Benin. Village herds have to be identified.
	Management Systems	S.2	Village vs Station conditions with Lagune under medium trypanosomiasis risk at Samiondji Station and nearby villages in Benin. Village herds have to be identified.
	Trypanosomiasis Risk	T.1	Low to medium vs medium to high trypanosomiasis risk with N'Dama under station conditions at Avetoncu Research Centre in Togo. The latter challenge possibility is related to the expressed intention to extend cattle facilities into a higher challenge location.
	Trypanosomiasis Risk	T.2	Very low vs low to medium trypanosomiasis risk with Borgou under village conditions in Porto Novo and M'Bétécoucou Region in Benin.

Table 5.14, cont.

Country	Type of Comparison	Reference Number	Remarks
Togo, Benin, cont:	Breeds by Trypanosomiasis Risk	BT.1	N'Dama and N'Dama x exotic and local breed crosses under station conditions and low to medium and medium to high trypanosomiasis risk at Avetonou. Note: The Avetonou CERTT in Togo is maintained by German bilateral assistance. FAO is involved in the Borgou and Lagune ranches (M'Bétécoucou and Samiondji) in Benin and its interest in village surveys should be investigated.
Nigeria	Breeds	B.1	N'Dama vs Keteku vs Muturu vs their crosses under ranching conditions on artificial pastures and low to medium trypanosomiasis risk at Ado-Ekiti Livestock Production Centre in Ondo State and Fashola Stock Farm in Oyo State.
	Breeds	B.2	N'Dama vs Keteku vs their crosses under extensive ranching conditions at Upper Ogun Ranch under low to medium trypanosomiasis risk.
	Management Systems	S.1	Improved ranching (station) vs extensive ranching conditions with N'Dama under low to medium trypanosomiasis risk at Ado-Ekiti, Fashola and Upper Ogun.
	Management Systems	S.2	Improved ranching (station) vs extensive ranching conditions with Keteku under low to medium trypanosomiasis risk at Ado-Ekiti, Fashola and Upper Ogun.
	Management Systems	S.3	Improved ranching (station) vs extensive ranching conditions with N'Dama x Keteku crosses under low to medium trypanosomiasis risk at Fashola and Upper Ogun.
	Breeds by Management Systems	BS.1	N'Dama, Keteku and their crosses under improved (station) and extensive ranching conditions and low to medium trypanosomiasis risk at Fashola, Upper Ogun, and Ado-Ekiti (for N'Dama and Keteku only). Note: Operations on these three ranches would consist mainly of data analysis. Further work could be carried out at Ado-Ekiti if this beef cattle station is not transformed into a dairy operation in the next few years, as is intended. The data from Fashola and Upper Ogun have been or are being analysed by Nigerian scientists. Data from Ado-Ekiti have been partly analysed.
Central African Republic, Gabon, Congo, Zaire	Breeds	B.1	Baoulé vs Lagune vs N'Dama under village conditions and low to medium trypanosomiasis risk at Kidjigra in Central African Republic and near Gimbi and Mbanza-Ngungu in Zaire.
	Breeds	B.2	Lagune vs N'Dama vs N'Dama x Lagune crosses under station conditions and low to medium trypanosomiasis rik at Gimbi Station in Zaire.
	Breeds	B.3	Ituri Zebu vs N'Dama under extensive ranching conditions and medium to low trypanosomiasis risk at Lombo Ranch in Zaire. Note: Different chemoprophylactic treatments against trypanosomiasis are used on Zebu and N'Dama.
	Breeds	B.4	Nguni vs N'Dama vs Nguni x N'Dama crosses under intensive ranching conditions and very low trypanosomiasis risk (O-L) at Okouma Ranch in Gabon.
	Breeds	B.5	N'Dama vs Fulani Zebu under ranching conditions and low to medium trypanosomiasis rick at La Dihessé Ranch in Congo. Note: Fulani Zebu will soon be imported from Cameroon.

Table 5.14, cont.

Country	Type of Comparison	Reference Number	Remarks
Central African Republic, Gabon, Congo, Zaire, cont.	Breeds	B.6	N'Dama vs Lagune under village conditions and medium to high trypanosomiasis risk in Bouenza Region in Congo. Note: Herds still have to be identified.
	Management Systems	S.1	Village vs ranching conditions with N'Dama under low to medium trypanosomiasis risk in villages at Mbanza-Ngungu GER, Idiofa and Kikwit and at Kolo and Kikwit Ranches in Zaire.
	Management Systems	S.2	Village vs ranching conditions with N'Dama under medium to high trypanosomiasis risk in villages at Idiofa and on Mushie Ranch in Zaire. Note: Village herds still have to be identified.
	Management Systems	S.3	Station vs village conditions with N'Dama under low to medium trypanosomiasis risk at and near Gimbi Station in Zaire.
	Management Systems	S.4	Station vs village conditions with Lagune under low to medium trypanosomiasis risk at and near Gimbi Station in Zaire.
	Trypanosomiasis Risk	T.1	Low to medium vs medium to high trypanosomiasis risk with N'Dama under ranching conditions at Kolo and Mushie Ranches in Zaire and at La Dihessé Ranch in Congo.
	Trypanosomiasis Risk	T.2	Low to medium vs medium to high trypanosomiasis risk with N'Dama under village conditions in Idiofa Region in Zaire.
	Trypanosomiasis Risk	T.3	Low to medium vs medium to high trypanosomiasis risk with Lagune under village conditions near Gimbi in Zaire. Note: Same possibility in Congo, but herds have to be identified.
	Breeds by Management Systems	BS.1	Lagune and N'Dama under village, station and ranching conditions and low to medium trypanosomiasis risk at and near Gimbi and on Kolo Ranch in Zaire.
	Breeds by Trypanosomiasis Risk	BC.1	Lagune and N'Dama under low to medium and medium to high trypanosomiasis risk under village conditions in Idiofa Region (mainly N'Dama) and near Gimbi in Zaire and possibly in Bouenza Region in Congo. Note: Although the two first locations are about 1 000 km apart environments are similar.
			Note: Possible interest of various agencies operating in these countries should be investigated. The Kidjigra study is directly related to aid requested from EDF by Central African Republic for metayage projects. The Mbanza-Ngungu GER in Zaire which was formerly financed by EDF, has proved successful but is now running out of funds. EDF is financing two ranches in Congo and could possibly be interested in village livestock operations. Belgian assistance could possibly be interested in sheep operations at the Gimbi and Mvuazi Stations and the GER operation in Zaire. Belgium, together with Misereor (German Fed. Rep.), is financing the metayage operations at Idiofa in Zaire. The La Dihessé Ranch in Congo is financed by World Bank and receives technical assistance from IEMVT/FAC.

Source: Compiled by authors.

Table 5.15. Locations where data exist for further analysis of productivity within cattle breeds.

Country	Location	Breed	Notes
Senegal	CRZ Kolda	N'Dama	250 cows x 4 yrs
The Gambia	Yundum	N'Dama	100 cows x 10 yrs
Sierra Leone	Teko	N'Dama, Sahiwal N'Dama x Sahiwal	ILCA requested to analyse data
Liberia	LAC	N'Dama	200 cows x 7 yrs
Ivory Coast	SODEPALM	N'Dama, Baoulé N'Dama x Baoulé	2500 cows x 3 yrs
Togo	Dzogbegan	mixed	70 cows x 10 yrs
Benin	Samiondji	Lagune	46 cows x 2 yrs } Analysed by ILCA in case study
Benin	M'Betecoucou	Borgou	38 cows x 2 yrs } Analysed by ILCA in case study
Nigeria	Ado Ekiti	N'Dama, Keteku Muturu, crosses	250 cows x 10 yrs Data already partially analysed
Nigeria	Fasola	N'Dama, Keteku, N'Dama x Keteku	300 cows x 10 yrs Data being analysed
Gabon	Okuma	N'Dama, Nguni, crosses	300 cows x 3 yrs
Congo	La Dihessé	N'Dama	450 cows x 4 yrs
Zaire	Mbanzangungu	N'Dama	300 head x 15 yrs } Data by type of animal and age class
	Kolo	N'Dama	23000 head x 25 yrs } Data by type of animal and age class
	Mushie	N'Dama	10000 head x 4 yrs } Data by type of animal and age class
	Lombo	N'Dama, Zebu, Ituri	7000 head x 4 yrs } Data by type of animal and age class

5.4.2.3 Possible Locations for Productivity Studies of Sheep and Goats

Table 5.16 indicates possible locations for future studies on sheep and goats within the study zone, with supporting explanatory notes. As there are few possible locations for sheep and goat studies in the study zone, compared with possibilities for cattle, opportunities for work in other areas would be particularly valuable. One possibility is the UNDP/FAO sheep and goat project in Kenya, with facilities extending over the high-rainfall coastal belt including areas of high and low trypanosomiasis risk.

5.4.2.4 Possible Locations for Specific Experimental Investigations

Specific experimental investigations basically require some livestock facilities, good laboratory support and a high level of scientific and technical supervision. For this reason, suitable sites are usually linked with laboratories, research centres or universities. Close scientific supervision requires the involvement of

Table 5.16. Possible locations for productivity studies with sheep and goats.

Country	Species	Type of Comparison	Remarks
Senegal, The Gambia	Sheep	Management Systems	Under station and village conditions and low to medium trypanosomiasis risk at and near Kolda Station in Senegal. Note: A flock of 300 sheep is kept at Kolda Station and has been recorded for two years. Village flocks have to be identified. Further investigation is necessary.
Sierra Leone, Liberia	Sheep	Management Systems	The Mano River Union Project, a joint project of Sierra Leone and Liberia, will include a study of bio-parameters at Suakoko CAE Station in Liberia under low to medium trypanosomiasis risk. Work with village flocks could be envisaged.
Mali, Upper Volta	Sheep (Goats)	Management Systems	A flock of about 200 sheep is kept on the Yanfolila Ranch in Mali. The sheep farm is under low to medium trypanosomiasis risk. The possibility of extending the work to village flocks and goats should be studied further. Possible interest of EDF should be investigated.
Ivory Coast	Sheep (Goats)	Management Systems	a. The Centre National Ovin at Beoumi in Centre Region is developing a sheep flock with the assistance of EDF. There are 1 000 head at present for selection and multiplication under improved management and low to medium trypanosomiasis risk. b. SODEPRA Centre in Centre Region is operating with village flocks. c. The Mimankro Research Station at Bouaké keeps a flock of 500 sheep under low to medium trypanosomiasis risk. The 50 Dwarf goats maintained at present may be increased.
Ghana	Sheep, Goats	Management Systems, Trypanosomiasis Risk, Breeds	On Ejura Farm, a flock of 830 Sahelian and Djallonké sheep is kept under low trypanosomiasis risk. A flock of 40 West African Dwarf goats is also kept. Distribution would lead to the possibility of comparing these with village flocks.
Nigeria	Sheep, Goats	Breeds, Management Systems, Trypanosomiasis Risk	Work on small ruminants could be carried out at the University of Ife in Oyo State, the University of Nigeria, Nsukka, the University of Ibadan, and at Ubiadja Goat Farm in Bendel State. These organizations have farms stocked with sheep and goats and/or have staff interested in this field. The work would cover Dwarf and Djallonké varieties under village and station conditions and various levels of trypanosomiasis risk. Contacts are being developed by ILCA's small ruminants programme. Possible interest of CDM in the Kaduna laboratory should be investigated.
Central African Republic, Gabon, Congo, Zaire	Sheep, Goats	Breeds, Management Systems, Trypanosomiasis Risk	In Central African Republic, if proposal B.1 for cattle in Kidjigra village is implemented, it would be possible to obtain fair results for sheep and goats under village conditions and low to medium trypanosomiasis risk with a rather modest additional input. Possibilities in other situations should be investigated further. In Gabon the Bergerie de Franceville and the Okouma Ranch study crossbreeds between West African and exotic sheep and goats. The possibility of keeping West African Dwarf flocks on these well-equipped stations should be investigated further. In Congo, the Odziba Sheep Farm near Brazzaville is developing a flock of 310 West African Dwarf sheep. The APN Farm, run by the army at Kibelemoussia, is developing a flock of 150 West African Dwarf sheep. The Mvouti village in Koulou Region has a flock of about 800 sheep, including some of the Blackbelly variety. In Zaire, the Mvuazi Station in Bas-Zaire Region intends to develop metissage with sheep. The Kolo Ranch keeps a flock of 300 sheep, but not the pure West African Dwarf variety.

Source: Compiled by authors.

scientists at the site, while scientific coordination and assistance could possibly be arranged through institutions such as ILCA, ILRAD, the Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture or GTZ. This section indicates some possible locations for specific experimental work in West and Central Africa.

Senegal: The Laboratoire National d'Elevage et de Recherches Vétérinaires (LNERV) in Dakar Hann has substantial facilities and has already undertaken experiments on trypanotolerance. This laboratory is also in charge of the CRZ Kolda in Casamance Region where experimental work could be carried out.

The Gambia: In spite of staffing and equipment shortages, a great deal has already been achieved at Keneba. Continued and expanded research work is possible at this location.

Sierra Leone: The Animal Science Department of Njala University College operates a small farm where feeding trials are conducted and a small veterinary laboratory carries out some analyses.

Liberia: The Central Agricultural Experimental Station (CAES) in Suakoko has already carried out work on trypanosomiasis in livestock. Participation of the College of Agriculture and Forestry could also be envisaged.

Mali: The Centre National de Recherches Zootechniques (CRNZ) at Sotuba near Bamako has worked with N'Dama and their crosses for more than 35 years. This centre seems particularly well equipped for nutrition trials. The Laboratoire Central de Recherches Veterinaires (LCRV), also near Bamako deals with trypanosomiasis in cooperation with a team from Texas A&M University as part of a USAID project.

Upper Volta: The Centre d'Elevage et de Recherches sur la Trypanosomiase (CERT) in Bobo Dioulasso is a sophisticated research centre working on trypanosomiasis and trypanotolerance. French and German inputs have enlarged the research programmes and the Samandeni Station provides field-trial facilities.

Ivory Coast: The Centre de Recherches Zootechniques (CRZ) of Minankro-Bouaké, with programmes both at the station and in the field, could undertake specific controlled experimental work. This centre was established in 1949-50, specifically to study the production of N'Dama cattle in a tsetse-free zone. The Laboratoire de Pathologie Animale at Bingerville, with an oustation in Korhogo, provides laboratory support. The Animal Production Department of the Ecole Nationale Supérieure d'Agronomie (ENSA) has good facilities and plans to carry out nutrition trials.

Ghana: At the University of Ghana, with its three agricultural research stations, and the University of Kumasi, with its farm, experimental work is undertaken by students under the supervision of the teaching staff. The Achimota Animal Research Institute concentrates more on the veterinary aspects of trypanosomiasis. Facilities in Pong Tamale are also suitable for specific experiments.

Togo: The Centre d'Elevage et de Recherches sur la Trypanosomiase et la Trypanotolérance (CERTT) could be a major centre for specific experimental work in West Africa. The German Fed. Rep. aid agency is providing excellent laboratory and animal husbandry facilities. The University of Benin in Lomé also has facilities and plans to work in particular with sheep and goats.

Nigeria: The Universities of Ibadan, Ife and Nsukka, with their farms, seem equipped to carry out experimental work. The Nigerian Institute of Trypanosomiasis Research (NITR) outstation in Vom is already involved in growth trials with different breeds under various levels of trypanosomiasis risk and nutrition.

Congo: The Veterinary Laboratory of Brazzaville, established in 1977, is making a list of animal diseases, including trypanosomiasis, and estimating their importance. Some analysis work could be carried out there.

Zaire: The Progrès Populaire of Idiofa is a large agricultural project with a trypanotolerant animal component, working at the village level with excellent laboratory support and scientific supervision. This project could carry out specific experiments focussing on village production. The Veterinary Laboratory of Kinshasa is equipped to analyse samples from the field. Some of the stations of the Institut National pour l'Etude et la Recherches Agronomique (INERA) could undertake specific experiments if laboratory equipment and staffing were strengthened.

5.5 FURTHER UTILIZATION OF TRYPANOTOLERANT LIVESTOCK

5.5.1 RECOMMENDATIONS FOR EVALUATION

5.5.1.1 Cattle

During the country visits, it became apparent that the governments of the countries in the study area are generally very interested in the development of trypanotolerant cattle, especially the N'Dama, on a long-term basis. The aims are both to reduce the domestic shortage of meat and to promote export of slaughter stock, and also export of breeding stock at prices which are already high and still rising.

Livestock development includes several operations: the development and extension of basic animal production, diversification (e.g. draught oxen and milk production), stratification (e.g. fattening by smallholders and on feedlots) and improved organization, such as the development of roads, markets, meat processing administrative services and training. The development and extension of basic production is carried out both through the improvement of traditional husbandry systems and the introduction or expansion of ranches; these two aspects may be

planned jointly or separately. The importance of basic production activities is reflected in the fact that they receive most of the funding made available by the major aid agencies for livestock development in these zones. A study of the funds allocated to 'pure' livestock development projects in Africa (ILCA, 1978d) indicates a rise from US $ 27 million for the period 1961-1965 to US $ 150 million for the period 1971-1975 for the humid and subhumid zones of West and Central Africa. Funds allocated to operations in the traditional sector represent about 35% of the total funds allocated to livestock development. The funds allocated to establishing and extending ranches have increased considerably, both in absolute and relative terms: in 1961-65 this component accounted for about 10% of the total funds, in 1971-75 for about 44%. This new orientation can be explained by the fact that the limited availability of trypanotolerant breeding stock is seen as the most important constraint on the large-scale development of cattle production based on trypanotolerant animals. Of the funds allocated to ranches in these zones, 70% finances large ranches using trypanotolerant breeds, generally N'Dama, to develop rapidly a substantial supply of breeding stock for the traditional systems and to provide a regular supply of slaughter stock for the towns. These operations tend to be recent, having been financed for ten years or less. The more important are the Yanfolila Ranch in Mali, the three SODEPRA ranches in Ivory Coast, the three ranches of the Ghana Livestock Company, the five ranches of the Western Livestock Company in Nigeria, the Dihessé Ranch in Congo and the Lola Ranch in Zaire. Other ranching operations are planned, notably in The Gambia, Guinea, Sierra Leone, Togo, Gabon and Zaire.

In West Africa, the improvement and extension of cattle husbandry at the village level usually involves encouraging improved management, introducing veterinary care packages and supplying improved breeding stock from ranches (most commonly N'Dama). In Central Africa where cattle production in villages is not a traditional occupation, development starts with lending foundation breeding stock from ranches, followed up by similar support activities. This operation is called metayage (see section 3.1.4.2).

Three different phases of economic analysis will be necessary to evaluate the future use of trypanotolerant cattle in the study zone and their contribution to the overall development of cattle production. Complete economic evaluation will require both micro-level case studies and regional and national-level studies.

The first phase, based on case studies, will include an assessment of village and ranch production in the different areas of the study zone. These case studies will take account of all relevant inputs and outputs at the producer level and will provide descriptions of the larger environments in which production takes place. Factors considered will include all production parameters, costs and quantities of various inputs and the quantities and values of intermediate and final products.

The results of these case studies will provide a major input to regional and national studies which will determine the macro-level potential for the economic development of production systems based on trypanotolerant cattle. In this second phase, the studies will take into account differences between countries in terms of

their development objectives for the livestock sector. Cost-benefit analysis techniques and econometric models will be used and secondary data will also be analysed, for example, time-series data, prices, supply and demand.

It can be expected that research will continue with non-trypanotolerant cattle which will produce results comparable with the results of the first and second phase economic studies outlined above. Phase three will be undertaken when these micro- and macro-level studies on both trypanotolerant and non-trypanotolerant livestock systems are completed. This phase will involve a comparative study of livestock development based upon trypanotolerant and non-trypanotolerant cattle.

The urgency of meat supply problems in the study area, combined with the limited availability of trypanotolerant breeding stock, lead to the use of non-trypanotolerant animals to various extents. The development of production from non-trypanotolerant animals in this zone usually involves their establishment under chemoprophylaxis and therapy, with or without tsetse control programmes and possibly including the introduction of a degree of trypanotolerance through cross-breeding.

This study is not directly concerned with the evaluation of chemoprophylactic and tsetse control programmes. However, to allow objective comparisons with development based on trypanotolerant cattle, the evaluation of programmes based on non-trypanotolerant animals must include a careful examination of the practicability of the large-scale and long-term use of drugs and tsetse control measures, as well as the costs at both the individual producer and national level. In comparing the technical and economic feasibility of these different approaches to livestock development, a clear distinction must also be made between the subhumid Sudano-Guinean zone at the northern limit of the tsetse belt, which traditionally has had almost no sedentary cattle, and the more humid Guinean zone, which is the natural environment of the trypanotolerant breeds. As pressure on land increases in the subhumid zone, due to rising human populations and expanded cultivation, the traditional extensive transhumant cattle production system will have to be developed to ensure both adequate meat and milk supplies for growing national populations and the wellbeing of local producers. A successful transition towards more sedentarized production systems among pastoralist producers in these areas will require effective control of clinical trypanosomiasis. In the short term at least, this control is likely to be largely dependent on chemoprophylaxis and tsetse control, but, subject to availability, trypanotolerant cattle have a role to play and, in the longer term, this role could become a major one. In the humid Guinean zone which is the major focus of this report, large-scale tsetse-control programmes are as yet technically infeasible and small-scale production operations based on continuous chemoprophylaxis and therapy have often failed.

To evaluate tsetse eradication or control measures, information is required on the direct costs of the different methods of tsetse control, the time which must elapse between tsetse control measures and subsequent cattle production, the area of land which can be brought into production following a given tsetse control pro-

gramme and its potential carrying capacity and finally whether the return from livestock production under pastoralism, village systems or ranching in a given area would justify the costs of tsetse control (Jahnke, 1976). Are the secondary effects of tsetse control, notably the environmental effects, known and evaluated? Can the results of the different tsetse eradication measures be considered permanent, and if not, what are the projected costs of continuous control? Is the internal political and financial situation stable enough to allow continuous tsetse control at appropriate times and to implement an adequate long-term land-use policy which will avoid reinfestation with tsetse or reinvasion by wildlife? Is the external political situation stable enough to allow the coordination of tsetse control across national boundaries? Are the control measures also effective against other possible trypanosomiasis vectors, so that the disease will not continue in a latent state leading to possible outbreaks at a later time?

Information is needed on whether available chemotherapy and chemoprophylaxis measures are effective in situations where trypanosomiasis risk is very high or where animals are subject to stress or overwork. The cost of providing these measures and the maintenance of an efficient veterinary infrastructure to ensure conscientious application must also be determined, as well as the consequences of the development of drug-resistant strains of trypanosomes. It must be determined whether the costs of drugs are within the means of a pastoral or a village producer, as well as the cost incurred from weight losses and productivity decreases which are unavoidable even with a well-organized treatment system. Finally, the desirability of basing long-term, large-scale cattle development on continuous drug application must be considered.

Evaluation of the use of non-trypanotolerant cattle on a large scale must also take into account that exotic and Zebu cattle might be more susceptible to other health problems in these areas where they are not well adapted. If this is the case, it must be considered whether the costs of treatment and losses can be borne by local pastoral or village producers. Finally, although the problems of supplying large numbers of trypanotolerant breeding stock have been mentioned, the problems of supplying Zebu breeding stock from traditional cattle-producing countries in the next two decades must also be considered.

5.5.1.2 Sheep and Goats

The sheep and goat populations of the study area are much larger than the cattle population. However during the country visits, government livestock and veterinary services seemed less concerned with sheep and goats than with cattle production. This situation has arisen for a number of reasons. For one thing national governments have responded to an urgent demand for beef in these areas where cattle production was traditionally almost non-existent, whereas the demand for sheep and goat meat has always been partly satisfied. A study of the livestock development projects in Africa (ILCA, 1978d) indicates that only about 1% of the funds allocated by the major aid agencies to the livestock sector in the humid and subhumid zones of West and Central Africa finances activities aimed at sheep and goat production.

Sheep and goats are generally produced under diverse traditional management systems and environments, with trypanosomiasis only one aspect of a much more complex disease situation. This is seen as the main constraint to development of sheep and goat production. Practical methods of disease control are often not available: the control measures which do exist tend to be complex and expensive to implement in the field, requiring substantial veterinary and laboratory support.

To improve this situation will require major financial and organizational efforts from national governments and poses the question of whether the necessary changes in husbandry practices will be acceptable and feasible at the village level. In view of these problems, research on sheep and goats has not been strongly encouraged and little progress has been achieved, especially with goats. However, interest in sheep and goat development is now increasing and numerous operations, involving experimental breeding stations, village surveys and veterinary control, have recently been launched. The main research and multiplication activities are found at Kolda in Senegal, as part of the Mano River Union Project in Sierra Leone and Liberia, at Yanfolila in Mali, at Ejura in Ghana, at Beoumi and Bouaké in Ivory Coast, at the universities and the Ubiadja Goat Farm in Nigeria, at Franceville and Okouma in Gabon, at Odziba in Congo and at Mvuazi in Zaire. Two large veterinary control operations are also being carried out in Upper Volta and Benin.

If further studies confirm the preliminary finding that the trypanotolerant breeds have levels of productivity similar to other breeds (see section 5.2), future efforts to develop sheep and goat production in the study area are likely to be based on trypanotolerant animals. Sufficient numbers of trypanotolerant sheep and goats are available to provide a basis for further large-scale development. Various experiments to introduce larger Sahelian sheep and goats into the area where trypanotolerant breeds predominate have suggested that the disease problem in general would be more complex and acute if larger breeds were used. The observation that many fewer Sahelian sheep and goats migrate into the humid zone than Zebu cattle tends to confirm the impression that they are even less well adapted to these areas. While the development of sheep and goat production will largely be carried out at the village level, the use of unadapted animals would require regular, sophisticated veterinary control with its high associated costs, which would imply a radical change in traditional village life and husbandry.

The economic evaluation of trypanotolerant sheep and goat production can be envisaged in two phases. The first phase would include preliminary surveys and micro-economic case studies. Although major work would focus on village production systems, intensive management systems should also be studied which could provide improved stock to villages and meat to the towns and in some cases for export. Little is known about trypanotolerant sheep and goat breeds, and preliminary studies, as outlined in this report, should examine their productivity under village and intensive management conditions, the effects of selection, better veterinary care and management on their productivity, the inputs of veterinary care and management needed to reach certain levels of productivity and their related costs,

the feasibility and acceptability of these measures at the village level, the actual and potential role of sheep and goats in social and economic village life (e.g. use of crop residues and damage to crops) and the basic marketing organization. Preliminary studies should provide data on the present production of each species and economic aspects under village and intensive management conditions, as well as the economics of improved veterinary care and management at the village level.

The second phase, based on macro-economic studies, would use the information obtained from the first phase of work to evaluate the role of each species under village and intensive husbandry systems in terms of regional and national production levels, taking account of specific national goals. These studies would provide basic information relevant to similar studies elsewhere in Africa.

5.5.1.3 Conclusions

The micro- and macro-economic studies of trypanotolerant cattle and sheep and goats described here would provide valuable information on the economics of maintaining trypanotolerant animals under actual management systems. They would also provide basic information and specific planning data on which to determine appropriate strategies for developing cattle and sheep and goat production under ranching and village systems in the humid and subhumid zones of tropical Africa. It should also be possible to assess the feasibility of introducing and extending the use of trypanotolerant cattle, sheep and goats elsewhere in Africa, and comparing the advantages of such a strategy with those of alternative production systems. In general, these studies will facilitate comparison between a wide variety of developing activities and allow suitable packages of recommendations to be formulated for implementation.

5.5.2 POSSIBLE LOCATIONS FOR EVALUATION

Section 5.5.1.1 recommends that economic comparisons be carried out of N'Dama cattle development based on ranching and village production systems in both West and Central Africa. A number of possible locations have been indicated, including Ivory Coast in West Africa and Zaire in Central Africa where large-scale development operations already have data and results available.

In Ivory Coast, extension work with village herds, some of which include N'Dama cattle, is carried out by the Société de Développement des Productions Animales (SODEPRA), as part of its Centre and Nord operations, and by the Centre de Recherches Zootechniques (CRZ) of Minankro-Bouaké. Information on individual animals is recorded on a regular basis. SODEPRA also carries out large-scale N'Dama ranching operations in a savanna environment. Some of these ranches are operating and some are still being developed. Ranch and village herds are found with comparable environments and levels of trypanosomiasis risk. These operations are described in more detail in the chapter on Ivory Coast in Volume 2.

In Zaire, the main metayage operations are carried out by the Groupement d'Economie Rurale (GER) in the Bas-Zaire Region and by the Bureau Diocésain de Développement at Kikwit and the Progrès Populaire d'Idiofa in the Bandundu Region. Several ranches are operating or are being developed, and ranch and metayage herds are found with comparable environments and levels of trypanosomiasis risk. Details of these operations are given in the chapter on Zaire in Volume 2.

Further investigation is needed to evaluate the possibilities for cooperation with SODEPRA and organizations in Zaire, as well as the interest of EDF, FAO and Belgian, French and German Fed. Rep. aid agencies involved in operations in Zaire and/or Ivory Coast. Opportunities for analysing data which are already available must also be assessed, as well as opportunities for studying various ranch and village herds. These investigations can be carried out simultaneously with the establishment of a network to collect productivity information.

Section 5.5.1.2 recommends that economic studies of sheep and goat production under village and intensive management conditions be carried out, including the identification of possible improvements at the village level. The suitability of locations for economic studies will depend on the practicability of introducing technical innovations whose economic impact can then be investigated.

ILCA's small ruminant programme in Nigeria will include studies of proposed innovations under both village and research station conditions. ILCA's team has already solicited the cooperation of a number of universities and livestock services in the region, has identified village flocks to be surveyed and has established contacts with the villagers.

In Ivory Coast, the SODEPRA Centre is carrying out extension work with the cooperation of FAO to develop the production of sheep and goats in village flocks. The Centre National Ovin at Béoumi is building up a sheep flock in cooperation with EDF. The Station Ovine of Fero managed by the CRZ Minankro maintains a flock of 500 sheep. These three operations are located in Centre Region, and possibilities for integrating them into this study should be investigated.

5.6 CONSERVATION OF TRYPANOTOLERANT LIVESTOCK

5.6.1 RECOMMENDATIONS FOR CONSERVATION MEASURES

This study has described two main groups of trypanotolerant cattle - the N'Dama and the West African Shorthorn. Although there are differences among varieties in different countries, the N'Dama is effectively a single breed. There are about 3.4 million overall, and their numbers appear to be increasing in spite of some crossbreeding on the northern boundary of their area of distribution. No special measures for conservation appear to be necessary.

The situation of the West African Shorthorn is quite different. There are still substantial populations of the larger, Savanna type in Ghana, Upper Volta and Ivory Coast and smaller populations in Togo, Nigeria and Benin, totalling about 1.7 million. However, in all these countries crossbreeding with Zebu is widespread and measures must be taken on an urgent basis if substantial numbers of purebred animals are to be maintained. The justification for doing this lies in the high productivity figures calculated for this breed in section 4.2. East of these large populations, there are two small isolated pockets of Shorthorn in Cameroon which are in urgent need of study and conservation measures.

The Dwarf West African Shorthorn is in a more precarious situation, with a total population of only 0.1 million. Although fairly large populations still remain in Nigeria, Benin and Liberia, they are under heavy pressure from both N'Dama and Zebu. There are also quite a number in Zaire and Congo. In other countries, there are relict populations, but since their numbers are so low and there is so little interest in them, and their characteristics do not appear to differ from those of the larger populations, separate conservation measures do not appear to be justified. Conservation measures combined with improved utilization should be directed towards the larger groups.

The concept of conservation does not appear to be appropriate for the various crossbred groups (Djakoré, Méré, Borgou and Keteku). As they have been produced relatively recently from a cross between humped and humpless cattle, they do not represent any unique genetic resources and, provided the original breeds are available, they can be recreated at will.

As for sheep and goats, they are both numerous and widespread. Attempts at crossbreeding have been few and most have failed. For these species, further evaluation is important, as well as more efficient commercial exploitation, but conservation measures are unnecessary.

At a meeting on the conservation of genetic resources held in Madrid in 1974, grave doubt was cast on the economic benefit of any policy to preserve rare breeds in Europe (e.g. relict herdbook breeds) on the chance that their genes might at some time be useful to improve the breeds which have replaced them (FAO, 1974b). In the developing world, on the other hand, a rather different situation was thought to exist, where local breeds might be declining because of indiscriminate crossing with exotic breeds for a variety of reasons. Preservation without exploitation would be impracticable; the most immediate and urgent need expressed was for more information on possibilities for exploitation as a basis for deciding which threatened breeds merited conservation efforts.

Methods for conserving rare breeds might include gene-pool herds where several endangered breeds are kept together so that the various genes, but not the breeds in pure form, are conserved. Stores of frozen semen, eggs or embryos might also be kept or flocks or herds of pure breeds maintained. This report on

trypanotolerant livestock shows that it is biologically possible to exploit the Savanna and Dwarf West African Shorthorn cattle breeds which appear to be the only ones in need of conservation measures. Whether the usual methods of conservation will by themselves lead to increased utilization of these breeds is doubtful, however. The reasons behind their present large-scale crossbreeding with other types must be understood before preservation and utilization measures can be successfully implemented.

The remainder of this section deals with the group for which conservation measures appear necessary. It is taken for granted that conservation and evaluation (especially on a comparative basis) must go hand in hand.

5.6.2 POSSIBLE LOCATIONS FOR CONSERVATION MEASURES

5.6.2.1 Savanna Shorthorns

In this group, the only two breeds in real danger of extinction or absorption are the Doayo and Kapsiki in Cameroon. These breeds are isolated from each other and from the main Shorthorn cattle zone. They are kept by two well-defined tribes with social habits and customs in which the cattle play an important role. The 3 000 head of Kapsiki at present exist in a tsetse-free area, the rather smaller number of Doayo in an infested area. A third breed in Cameroon, the Bakosi, is also disappearing, now numbering only a few hundred head, but the study team considers this breed already lost and no programme of conservation justifiable.

Among the Doayo and Kapsiki, crossbreeding with Zebu has started and if these populations are to be saved action must be taken on an urgent basis. Since they are not exploited commercially and since they are in a Zebu area where official activities are devoted to that breed, government action without outside support cannot be expected - a project based on external aid will be required. So little information is available on these breeds that it is premature to suggest establishing breeding herds, even assuming that this is the best method of conservation. A project should be set up consisting of one research worker based in Garoua, a town from which both areas are accessible, with the Kapsiki area 200 km to the north and the Doayo area 150 km to the southwest. The project would include obtaining exact information on numbers, breed characters, management and use of these cattle. The source of bulls, the purity of the herds and the reasons for using Zebu bulls would be of particular interest. Hopefully there would also be the possibility of influencing breed purity. The researcher could be a zootechnician, veterinarian, sociologist or anthropologist. The project should indicate the desirability of saving one or both of these breeds, as well as a plan for doing so.

In the case of the other Savanna Shorthorn breeds, the immediate action required is mainly to warn governments and breeders of the value of the Shorthorn, so that crossbreeding can be kept under control. Additionally, locations should be identified where the productivity of each breed can be evaluated more precisely so

that within the Shorthorn group the different breeds can be ranked under different management systems and levels of trypanosomiasis risk. Suggestions for individual breeds are given here.

Somba: This is the dominant breed in Togo and is also found in Benin. At present, it has not been studied and there are no centres maintaining the breed or attempting to evaluate its productivity. A purebred herd should be maintained and studied in at least one of the centres in Togo in the traditional Somba distribution area. The Somba might also perhaps be added to the FAO project in Benin dealing with Lagune and Borgou at M'Betecoucou and Samiondji. However, as with the Borgou, the Somba is at the limit of its natural distribution in these stations.

Savanna Muturu: This breed is found on only 4 of the 13 state ranches and livestock stations listed in the chapter on Nigeria in Volume 2. However, the Third National Development Plan for 1975-80 envisages the expansion of trypanotolerant breeds in tsetse-infested areas. Maintaining the Muturu as a pure breed in these locations should be encouraged, using the productivity figures given in this report, and the collection of additional productivity information under different levels of trypanosomiasis risk and management systems should also be initiated.

Ghanaian Shorthorn: Of the five research stations in Ghana, three have herds of Shorthorn. The Ministry of Agriculture has 12 stock farms, 5 with Shorthorn. Using the productivity figures given in this report, the universities and the government should be persuaded of the intrinsic value of the pure Shorthorn. Research should be directed towards an exact comparison of the productivity of the Shorthorn with that of other breeds. The stock farms should be encouraged to maintain and record herds of pure Shorthorn, especially the farm at Wa where it is said the least crossbreeding with Zebu has occurred.

Baoulé: If the Méré of Upper Volta are combined with the Baoulé of Ivory Coast, they constitute the largest population of Savanna Shorthorn. A small population of Baoulé is also found in Central African Republic where it was imported in the 1950s. In both Upper Volta and Ivory Coast, infrastructure and facilities exist to allow evaluation and conservation work. In Upper Volta at present, however, there is little work on this breed, though at Bobo Dioulasso French and German aid agencies have started a new programme on the immunology of trypanosomiasis and plan to use the Samandeni Station for field work. Facilties are available to keep Méré as a pure breed and compare their overall productivity with that of N'Dama and crossbreeds under station conditions with a high level of laboratory support. Extension of this work to village conditions can also be reasonably envisaged.

In Ivory Coast, the Baoulé breed is being studied by the Centre de Recherches Zootechniques of Bouaké under station and village conditions and could be compared with N'Dama kept under the same conditions. At the same time, SODEPRA, as part of its Nord operations, is carrying out a project to increase the number of trypanotolerant cattle in the north. These two programmes appear to cover all the necessary work on this breed.

5.6.2.2 Dwarf Shorthorns

With only 1% of the total trypanotolerant population, the Dwarf Shorthorns are the group most in need of conservation measures. Three breeds can be distinguished, and only five countries have sufficient numbers to justify studies or preservation programmes (Table 2.3).

Liberian Dwarf: This is found in the eastern part of Liberia under village conditions. Liberia is one of the few countries with an indigenous population of both N'Dama and Dwarf Shorthorns which will allow direct comparative studies of both breeds. Some means must be found to establish a herd of Liberian Dwarf under controlled conditions, if possible in different management systems, under different levels of trypanosomiasis risk and preferably where they can be directly compared with the N'Dama. Such conditions could be provided at the Ministry of Agriculture Research Station at Suakoko where good laboratory support is available, at the College of Agriculture Farm outside Monrovia, or possibly on rubber tree plantations managed by the Liberian Agricultural Company.

Forest Muturu: The only state cattle ranch within the Forest Muturu area appears to be Pota in Nigeria's Lagos State. A purebred Muturu herd should be kept under the same management conditions as N'Dama or crossbreds and individual recording should be reinstated so that comparative studies can be carried out.

Lagune: The only country in the Lagune area of origin with significant numbers is Benin. However, two other countries, Zaire and Congo, have significant numbers of Lagune due to importation and multiplication. In Benin, an FAO/UNDP project aimed at developing livestock production is being carried out at three stations, one of which, at Samiondji, is devoted to the Lagune breed. A comparison between the Lagune and Borgou breeds has already been carried out (see pilot study in section 5.3), but future comparisons must be made more rigorously, randomizing the location of the two breeds over the stations.

Lagune cattle might also be studied in their natural environments in Benin, working with SOBEPALH, a company with headquarters in Porto Novo which produces palm oil and supervises 21 cooperatives. Each of these comprises several villages along the coast where Lagune herds are kept under palm trees. Some crossbreeding trials with N'Dama and Borgou are going on and it may be important to study not only the productivity of the animals, but also the sociological issues to understand exactly what the villagers think of their Lagune cattle and the benefits of crossbreeding. Only when the value of the Lagune and reasons for keeping them are understood might conservation plans be fruitful.

In the Bas-Zaire Region of Zaire, villagers keep Lagune herds in a forest environment which were introduced through metayage operations. Gimbi Research Station also maintains some pure Lagune (called Dahomey in Zaire). A comparison of productivity between station and village conditions or among villages under different levels of trypanosomiasis risk could easily be carried out and could provide justification for maintenance of the Lagune breed.

5.5.2.2 Dwarf Shorthorns

With only 1% of the total trypanotolerant population, the Dwarf Shorthorns are the group most in need of conservation measures. These breeds can be distinguished, and only five nucleus herds are sufficient numbers to justify studies or preservation programmes (Table 2.3).

Liberian Dwarf: This is found in the eastern part of Liberia under village conditions. Liberia is one of the few countries with an indigenous population of both N'Dama and Dwarf Shorthorns which will allow direct comparative studies of both breeds. Some areas need be found to establish a herd of Liberian Dwarf under controlled conditions. It presents in different management systems, under different levels of trypanosomiasis risk and probably where they can be directly compared with the N'Dama. Such conditions could be provided at the Ministry of Agriculture Research Station at Suakoko where good laboratory support is available, at the College of Agriculture farm outside Monrovia, or possibly in rubber tree plantations managed by the Liberian Agricultural Company.

Taurus Muturu: The only area cattle race within the Forest Zaïrian area appears to be Ivoin in Nigeria's Lagos State. A purebred Muturu herd should be kept under the same management conditions as N'Dama or crossbreeds and individual recording should be maintained so that comparative studies can be carried out.

Lagune: The only country in the Lagune area of origin with significant numbers is Benin. However, two other countries, Zaïre and Congo, have significant numbers of Lagune due to importation and multiplication. In Benin, an FAO/UNDP project aimed at developing livestock production is being carried out at three stations, one at Avlekete, at Bantindji, is devoted to the Lagune breed. A similar project between the Lagune and Borgou breeds has already been carried out (see pilot study in section 5.3). But future comparations must be made more rigorously, considering the location of the two breeds over the stations.

Lagune cattle might also be studied in their natural environments in Benin, working with SONEPALH, a company with headquarters in Porto Novo which produces palm oil and supervises 21 cooperatives. Each of these cooperatives covers villages along the coast where Lagune herds are kept under pasto treés. Some crossbreeding trials with N'Dama and Borgou are going on and it may be important to study not only the productivity of the animals, but also the sociological issues to understand exactly what the villagers think of their Lagune cattle and the benefits of crossbreeding. Only when the merits of the Lagune and reasons for keeping them are understood might conservation plans be initiated.

In the Bas-Zaïre Region of Zaïre, villagers keep Lagune herds in a forest environment which were introduced from Portuguese operations. Could research stations maintain some pure Lagune herds under laboratory in Zaïre? A comparison of productivity between station and village conditions or among villages under different levels of trypanosomiasis risk could easily be carried out and could provide justification for maintenance of the Lagune breed.

SUMMARY

Trypanotolerant cattle, sheep and goat populations are described, covering an area of 4.67 million km^2 in 18 countries of West and Central Africa. Animal numbers include approximately 3.4 million N'Dama cattle, 1.8 million West African Shorthorn, 2.4 million Zebu x N'Dama or West African Shorthorn crosses, 11.5 million sheep and 15 million goats. Groups, breeds and varieties are classified and numbers, distribution, environment, breed characters, husbandry systems and performances are described. The N'Dama group appears to be increasing in numbers and the Savanna Shorthorn seem to be declining fairly slowly and the Dwarf Shorthorn more rapidly, both mainly through crossbreeding over the last decade, resulting in an increase in crossbred cattle types. Sheep and goat populations appear relatively static overall.

The descriptive and performance data clearly show that it is biologically possible to maintain trypanotolerant cattle, sheep and goats in tsetse-infested areas and to establish them in areas where cattle have not previously been bred. Trypanotolerant livestock attain varying degrees of productivity under medium or heavy trypanosomiasis risk which preclude the natural maintenance of non-trypanotolerant types.

In each chapter of Volume 2, whenever sufficient information is available the main production traits are used to build up an index of the total weight of progeny, plus the liveweight equivalent of milk produced in the case of cattle, both per breeding female per year and per unit weight of breeding female maintained per year. On the basis of the index of total weight of one-year-old calf produced plus the liveweight equivalent of milk produced per 100 kg of cow maintained per year, no significant differences are found between the two main trypanotolerant cattle groups, the N'Dama and the West African Shorthorn. The mean value for both groups is 28.5 kg. The influence of management systems and levels of trypanosomiasis risk is also clearly shown: productivity is 30% lower under village conditions than on ranches or stations, and 27% lower under medium trypanosomiasis risk and 41% lower under high risk than in a low-risk situation. No indication has

been found from the limited data available that either Zebu or Zebu x humpless crossbreds are significantly more productive than the two trypanotolerant groups under traditional management and low trypanosomiasis risk. Furthermore, the productivity of trypanotolerant cattle under low trypanosomiasis risk appears from available information to be only 5% lower per unit weight of cow maintained than a wide range of indigenous Zebu and Sanga types maintained in tsetse-free areas of Africa outside the study zone. This suggests, first, that the productivity of trypanotolerant cattle relative to other indigenous types may be much higher than previously assumed, second, that in certain circumstances plans for increased utilization of trypanotolerant cattle may well be immediately justified and, third, that more accurate evaluation is needed of productivity in relation to degree of trypanosomiasis risk and the economic implications. In the case of trypanotolerant sheep and goats, the results suggest that productivity per unit weight of female maintained may be at least as high as that of a range of other indigenous types in tsetse-free areas throughout Africa. Thus, as with cattle, increased utilization and more accurate evaluation of productivity would appear well justified.

Possibilities are suggested for further evaluation and research to fill the many gaps in knowledge that remain. In virtually all the production situations examined, the information available is not sufficient to allow accurate evaluation of animal productivity or the degree of trypanosomiasis risk. A case study is presented of a situation in Benin where some basic data have been collected simultaneously on degree of trypanosomiasis and animal productivity. Recommendations and possible locations are presented for cooperative programmes to evaluate the potential and further utilization of trypanotolerant livestock. Conservation requirements are also discussed and measures suggested for conserving some breeds which are in danger of disappearing.

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Wilson, R T (1978b). 'Studies on the livestock of southern Darfur, Sudan. IV: Productive traits in goats'. Trop. Anim. Hlth. Prod. 8, pp. 223-232.

LIST OF ACRONYMS

APN	Armée Populaire Nationale (Congo)
APRU	Animal Production Research Unit (Botswana)
CAES	Central Agricultural Experimental Station (Liberia)
CERT	Centre d'Elevage et de Recherches sur la Trypanosomiase (Upper Volta)
CERTT	Centre d'Elevage et de Recherches sur la Trypanosomiase et la Trypanotolérance (Togo)
CNRA	Centre National de Recherches Agronomiques (Senegal)
CNRZ	Centre National de Recherches Zootechniques (Mali)
CRZ	Centre de Recherches Zootechniques (Ivory Coast)
EAAP	European Association for Animal Production
EDF	European Development Fund
EEC	European Economic Community
ENSA	Ecole Nationale Supérieure d'Agronomie (Ivory Coast)
FAC	Fonds d'Aide et de Coopération (France)
FAO	Food and Agriculture Organization of the United Nations
GER	Groupement d'Economie Rurale (Zaire)
GTZ	Geselleschaft für Technische Zusammenarbeit (German Fed. Rep.)
HMSO	Her Majesty's Stationery Office (United Kingdom)
IAEA	International Atomic Energy Agency
IBAR	Interafrican Bureau for Animal Resources
IEMVT	Institut d'Elevage et de Médecine Vétérinaire des Pays Tropicaux (France)
ILCA	International Livestock Centre for Africa
ILRAD	International Laboratory for Research on Animal Diseases
INERA	Institut National pour l'Etude et la Recherche Agronomique (Zaire)
LAC	Liberian Agricultural Company
LCRV	Laboratoire Central de Recherches Vétérinaires (Mali)
LNERV	Laboratoire National d'Elevage et de Recherches Vétérinaires (Senegal)
NITR	Nigerian Institute of Trypanosomiasis Research
OAU	Organization of African Unity
ODM	Overseas Development Ministry (United Kingdom)
OIE	Office International des Epizooties
ORD	Office Regional de Développement (Upper Volta)
PPR	Peste des Petits Ruminants
SEDES	Société d'Etudes et de Développement Economique et Social (France)
SOBEPALH	Société Béninoise de Palmeraies à Huile (Benin)
SODEPALM	Société de Développement du Palmier à Huile (Ivory Coast)
SODEPRA	Société de Développement des Productions Animales (Ivory Coast)
STRC	Scientific and Technical Research Commission (Organization of African Unity)
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
WAS	West African Shorthorn
WHO	World Health Organization

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EAAP	European Association for Animal Production
EDF	European Development Fund
EEC	European Economic Community
ENSA	Ecole Nationale Supérieure d'Agronomie (Ivory Coast)
FAC	Fonds d'Aide et de Coopération (France)
FAO	Food and Agriculture Organization of the United Nations
GIER	Groupement d'Economie Rurale (Zaire)
GTZ	Gesellschaft für Technische Zusammenarbeit (German Fed. Rep.)
HMSO	Her Majesty's Stationery Office (United Kingdom)
IAEA	International Atomic Energy Agency
IBAR	International Bureau for Animal Resources
ISPTT	Institut d'Elevage et de Médecine Vétérinaire des Pays Tropicaux (France)
ILCA	International Livestock Centre for Africa
ILRAD	International Laboratory for Research on Animal Diseases
INERA	Institut National pour l'Etude et la Recherche Agronomique (Zaire)
LAC	Liberian Agricultural Company
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NITR	Nigerian Institute of Trypanosomiasis Research
OAU	Organization of African Unity
ODNI	Overseas Development Ministry (United Kingdom)
OIE	Office International des Epizooties
ORD	Office Régional de Développement (Upper Volta)
PPR	Peste des Petits Ruminants
SEDES	Société d'Etudes et de Développement Economique et Social (France)
SOMIPALH	Société Mixte de Palmeraies à Huile (Benin)
SODEPALM	Société de Développement de Palmier à Huile (Ivory Coast)
SODEPRA	Société de Développement des Productions Animales (Ivory Coast)
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