International Livestock Centre for Africa
Subhumid Zone Programme
PMB 2248, Kaduna, Nigeria.

SYSTEMATIC AERIAL RECONNAISSANCE FLIGHTS AND RELATED GROUND-SURVEYS IN THE NIGERIAN SUB-HUMID ZONE

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MARCH 1986.

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PREFACE

RIM was requested by ILCA to prepare a review of air and ground surveys of the Subhumid Zone (SHZ), incorporating both work performed directly under its auspices and other relevant data. Much of this material is contained in previous reports, but these are dispersed through a wide variety of agencies and not all easily accessible. Additional ground material from unpublished field materials is also presented here for the first time.

The structure of the report is as follows; the first section reviews the background to the work in the Subhumid Zone, synthesizing available materials on livestock and land-use, and detailing the different surveys performed either by RIM or ILCA. These are set in context by an outline of current knowledge on agricultural and livestock production systems in the SHZ. This is followed by a section on the identification of national and regional trends. The third section provides a detailed examination of earlier ground and air surveys in the SHZ and the integrated ground-air surveys of the ILCA case-study areas are presented in a final form. These demonstrations of the integration of ground and air data are intended to throw light on the national trends identified in second section. The concluding section summarises the major findings and considers certain key topics worthy of further investigation.

ACKNOWLEDGEMENTS

RIM is grateful to the ILCA Field Staff in Kaduna, in particular the Team Leader, Ralph von Kaufmann, Wolfgang and Anne Bayer, Mark Powell and Ellen Taylor-Powell, Dr. E. Otchere, Dr. M. Saleem and Alh. Habibu Suleman for their assistance and hospitality whilst in the field. Those who assisted in the preparation of the other reports synthesized here are separately acknowledged in the prefaces to those reports. We are also grateful to NLPU, BSADP, & APMEPU for permission to incorporate some of the findings of ground and air surveys commissioned by them into the body of this report.

Much of the original research that has been compiled into this report was performed under the guidance of the late Dr. Kevin Milligan. We greatly regret that he was unable to see the final synthesis of this material.

In addition, we are grateful to all the Village and District heads who offered the ground survey team hospitality while in the field. Mallam Babuwa Tubra of the Federal Department of Pest Control Services, Ganye, proved an invaluable assistant and interpreter throughout the collection of ground data.

The following individuals worked on the preparation of data contained in this report:

Roger Blench	-	Social Analyst
David Bourn	-	Environmental Biologist
William Campbell	-	Computer Analysis and Mapping
Neil MacDonald	-	Animal Production
Kevin Milligan	-	Aerial Survey Co-ordinator (deceased)
Fil Rayson	-	Observor and Data Preparation
William Wint	-	Ecologist

ACRONYMS

ADP	Agricultural Development Project
APMEPU	Agricultural Projects Monitoring Evaluation and Planning Unit
BICOT	Biological Control of Tsetse
BSADP	Bauchi State Agricultural Development Project
CEEMAT	Centre d'Etudes et d'Experimentation du Machinisme Agricole Tropical
CRED	Centre for Research on Economic Development, University of Michigan
FAO	Food and Agriculture Organisation of the United Nations
FDF	Federal Department of Forestry
GU	Grazing Unit
IAI	International Africa Institute
ILCA	International Livestock Centre for Africa
LADP	Lafia Agricultural Development Project
LDF	Livestock Development Focus
LRD	Land Resourse Division (of the Overseas Development Administration)
NAPRI	National Animal Production Research Institute
NLPU	National Livestock Production Unit (Formerly LPU)
ODA(M)	Overseas Development Administration (Ministry), United Kingdom
RIM	Resource Inventory Management Limited
SHZ	Subhumid zone
SLAR	Side-Looking Airborne Radar
SRF	Systematic Reconnaissance Flights
UTM	Universal Transverse Mercator

ORTHOGRAPHY

Throughout this report, ethnic groups are referred to by their names for themselves, although toponyms use official Nigerian Government orthography. Thus Fulani appears as 'FulBe' and Chawai as 'Atsam'. Orthography of Fulfulde terms follows Swift et al. (1984).

SECTION 1: REVIEW OF CURRENTLY AVAILABLE DATA

1.1 Previous Case Studies of the SHZ

Recent data on livestock and land-use in the SHZ are available from two principal sources; aerial survey results prepared at the request of ILCA and ground-surveys intended to complement such work; and air/ground surveys undertaken by RIM at the request of NLPU and other multi-lateral agencies. Map 1 shows the locations of all study areas that have been surveyed at least once by air since 1979.

During the past six years, 34 aerial surveys of 15 sites have been conducted in Nigeria by ILCA or RIM personnel. These cover a total area of some 80,400 square kilometers at high intensity and 356,500 at low intensity. Each study area has been flown at least twice, once in the wet season and once in the dry, and three zones have been flown four times. The total coverage is thus some 888,400 square kilometers.

These surveys have been performed for different purposes, ranging from the evaluation of patterns and densities of livestock in relation to selected land-use parameters to complete resource inventories of livestock and land-use with a complementary ground survey integrated into the project design.

The aerial surveys have been designed to answer a variety of questions, based on the estimation of population levels and patterns of distribution of livestock, primarily cattle, pastoral and arable farmers' dwellings, and the degree and distribution of selected environmental and land-use parameters such as cultivation, dry season water availability, vegetation density, erosion patterns. These can then be related to cartographically derived features such as drainage, administrative regions, access, ecological land systems and topography.

Baseline data has been used in several ways; to assess seasonal and longer-term changes in livestock populations, to identify zones of livestock concentration; to assess the potential and actual use of grazing reserves; to target ground surveys towards those areas where livestock are most abundant; to provide numerical data to target potential sites for development intervention; and to analyse possible relationships between livestock and land-use.

1.1.1 ILCA Studies

The most intensive work undertaken by ILCA in the SHZ of Nigeria to date has been in relation to the case-study areas of Kurmin Biri and Abet. Apart from internal papers prepared by ILCA staff (see Section 3.1.2) these regions were surveyed by air in 1979 and again in 1984. A separate report (Milligan, Bourn & Chachu, 1979) analyses this data, and also Mariga and Lafia. They were flown again in 1984 (Milligan et al. 1984, and Bourn et al. 1985) (cf. also Section 2) and comparative

tables of abundance and distribution of livestock populations, arable and pastoral habitation and land-use were prepared.

Other study areas that have been flown seasonally are Ganawuri, Giwa, Pambeguwa, Funafuna and the Minna/Tegina block and Lafia (Map 1). ILCA staff groundwork has begun in Ganawuri, but no reports are yet available; however, a brief sociological survey was made by RIM in May-June 1984 (see Section 3.1.5). Groundwork was also undertaken in Giwa, Pambeguwa, Funafuna, Mariga, and Tegina/Minna so that the findings could be set alongside the more detailed material available for Abet and Kurmin Biri. Long-term sociological work by the staff of NAPRI may eventually provide a more complete picture of the ground situation in the Giwa case-study area.

A survey of the Jos Plateau, mapping cattle numbers and distributions and relating them to environmental and land-use parameters was carried out for FLD in 1980 (ILCA, 1980). Finally, a low-intensity aerial survey of the entire SHZ was conducted in the wet and dry seasons of 1983 (Bourn & Milligan, 1984) and some general hypotheses advanced about the long-term trends in cattle production systems in the SHZ.

1.1.2 RIM Studies

A series of aerial surveys and combined air/ground surveys have been conducted under the auspices of the National Livestock Project Unit (NLPU). The most important of these, in terms both of the area surveyed and the use of a combined air/ground methodology was the study of the Toungo Block in southern Gongola State (RIM, 1984c). Based on integrated aerial and ground surveys in 1983 and 1984 a coherent picture of the livestock production systems in the Toungo Block was presented, together with development recommendations and an appropriate financial analysis.

In addition to this, seasonal surveys of three grazing reserves, Sorau, Garkida and Wawa Zangi in Gongola and Bauchi States were conducted for NLPU (Wint, Bourn and Wint, 1985). No ground surveys were conducted in relation to these surveys. A major survey of agricultural land-use in Bauchi State (RIM, 1984b) presents an overall picture of pastoral and arable habitation in this region. A more detailed survey of cropping and land-use patterns in the Azare region of Bauchi state (RIM, 1984a) also included data on land-use patterns, habitation and cattle densities, and some of its results are therefore incorporated into this report. The broad features of land-use patterns in the SHZ can be clearly seen on the series of SLAR vegetation maps (FDF, 1978) prepared for the whole country (synthesized in Bourn & Milligan, 1984).

1.1.3 Other Studies

There are no overall land-use surveys of the entire region, but substantial parts have been covered in the studies prepared by the Directorate of Overseas Surveys (e.g. Bawden & Tuley, 1966, LRD, 1976, 1978 & Blair Rains, 1978) and in Grove (1956). Individual studies such as Tiffen (1976) of peasant enterprise in the Gombe region can help to illuminate the findings of the aerial surveys. Buchanan & Pugh (1955) and Barbour et al. (1982) provide geographical overviews of the whole country. Finally, there are a number of consultants' reports on specific topics. Oxby (1985) for example, has prepared a short sociological survey on the grazing reserve at Wawa Zangi for FAO.

1.2 Background

1.2.1 The SHZ in West Africa

The Sub-Humid Zone (SHZ) is defined as that region of West-Central Africa within which the growing season varies from 170-255 days (ILCA, 1979b:10). However, in Nigeria, the generally agreed definition includes the region between the 180 days line and the boundary between forest and derived savannah (Nord, 1982). A distinctive feature of the SHZ is the wide variety of environments and populations together a diversity of modes of subsistence. The potential for growing both humid and semi-arid zone crops has created a broad range of farming systems throughout West Africa.

Although ethnic fragmentation occurs throughout the zone the overall higher population densities of Nigeria tend to highten the contrast with the semi-arid zone, for example. Standard sources such as Murdock (1959) make plain that the SHZ has a greater density of ethnic groups than elsewhere, with a corresponding diversity of the modes of production. Both arable and pastoral production are widespread, although the extensive adoption of Ndama humpless cattle by the farming communities of Guinea and nearby countries (ILCA, 1979a,1:41) has meant that this type of mixed farming is far more prevalent than in Nigeria.

Although in Nigeria the foci of the major commercial networks have been located in the semi-arid zone, in West Africa generally the SHZ has long been an important region of internal trade and communications. The presence of a network of railways and roads linking Mali with Dakar and Upper Volta with Ivory Coast and the lack of road access from the SHZ to the coasts of Sierra Leone and Liberia illustrates the tendancy for communications routes to traverse the savannahs. One reason for this is undoubtly the place of the Gambia river as the focus of the coastal trade for over four centuries. The tradition of long-distance trade-routes between the kingdoms of the savannah has in turn affected the modern pattern of internal communications within West Africa.

1.2.2 The Nigerian Environment

As a geographical region of Nigeria, the northern SHZ or 'Middle Belt', as it is called in the earlier literature, also includes a number of high-altitude grasslands, most notably the Jos and Mambila plateaux, but also including a number of small grasslands in the regions southwest of the Niger-Benue confluence. Information concerning them is included in this study because work in Gongola State (RIM, 1984c) showed conclusively that their livestock production systems could not be considered in isolation.

The principal environmental features of the Nigerian SHZ are summerized in ILCA (1979b) & Nord (1982) and they may be briefly recapitulated;

1. Rainfall 900/1000-1500 mm. annually

2. Rainy season 140-225 days.

3. Growing season 170-255 days.

4. Mainly ferruginous tropical soils.

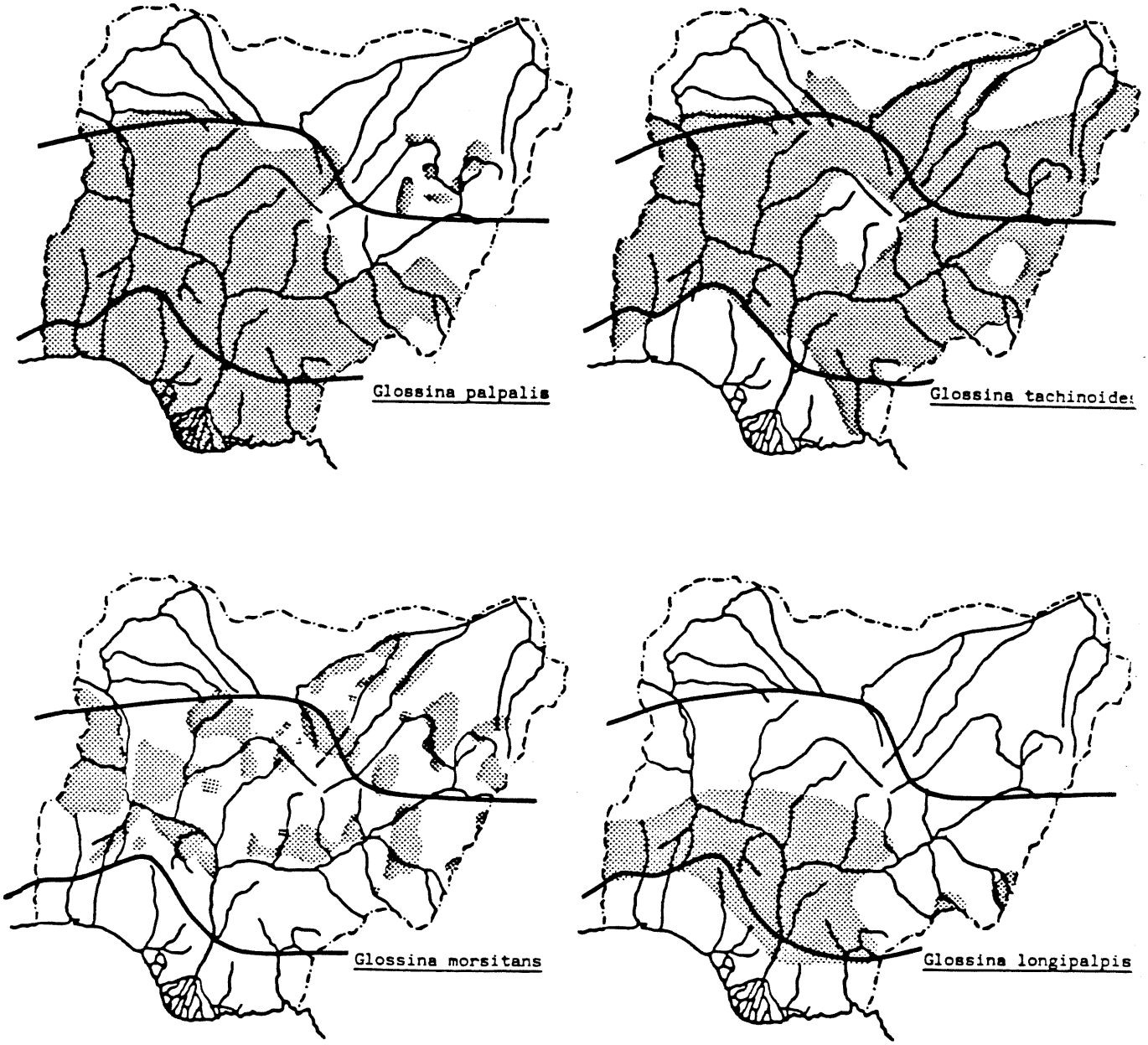
5. Vegetation of savannah, savannah woodland and forest.

Another important environmental feature of the SHZ in relation to the distribution oflivestock is the presence of tsetse flies, especially G. morsitans. Map II shows the conjectural distributions of the four major tsetse species in Nigeria and the SHZ. Increasing human settlement and cultivation over the last fifty years, and the consequential decline in wildlife hosts and natural tsetse habitats, combined with a prolonged and extensive tsetse eradication programme, restricted largely to regions north of the SHZ, has radically reduced the extent of morsitans belts throughout Nigeria (Bourn, 1983). However, the overall impact of these changes on local livestock production systems has not been throroughly investigated.

1.2.3 People

In contrast to the semi-arid zone, where ethnic diversity is restricted, the SHZ is characterised by large numbers of separate ethnic groups and a variety of modes of production (Ballard, 1971; & Hansford et al. 1976). A rough estimate for the SHZ in Nigeria, based on Hansford et al. suggests a figure of about 250 different peoples. The Ethnographic Survey of Africa, prepared by the IAI in London, provides a convenient review of the archival sources on this region (cf. Bradbury, 1957; Gunn, 1953 & 1956; Gunn & Conant, 1960; Forde et al., 1955). Despite this, the SHZ north of the Niger-Benue river has historically been underpopulated by comparison with regions further north and south. This is generally attributed to persistent

MAP II. PRESUMED DISTRIBUTIONS OF TSETSE IN NIGERIA



slave-raiding in the eighteenth and nineteenth centuries, although the prevalence of sleeping-sickness due to tsetse-fly infestation has also been suggested as a contributory cause.

It is often considered that this diversity is a consequence of ecological variation, but this is contraindicated by the numerous ethnic groups inhabiting the semi-arid region north of Bauchi. It seems more credible to attribute uniformity to the expansion of state-like structures, such as the Hausa emirates or the Nupe kingdom, although the case of arable farming groups such as the Tiv (Bohannon, 1954) suggests that expansion of farming into previously uncultivated regions for the production and sale of surplus staples can also play a part.

An important effect of this ethnic diversity is the evolution of many interlocking modes of production. It is therefore difficult if not impossible to generalize about the 'SHZ farmer'. For example, there are groups specialised in livestock-rearing, fishing, trade and craft-production. Pastoral groups include mixed farmers, transhumant pastoralists and pastoral nomads. Farming groups may be divided into savannah and forest, upland and lowland, shifting cultivators and intensive farmers. The existence of these interlocking modes of production reflects the patterns of trade and exchange. Specialised fishing peoples sell their smoked fish to the farmers and buy their pottery from the pot-making groups.

An effect of the limited size of most of these groups is that there are few societies with elaborate authority structures, with the exception of the Nupe and the Jukun. Most groups pride themselves on their independance from their neighbours, and emphasize the economic independance of individuals within society. However, within this broad framework there is considerable diversity; many peoples, such as the Igbo and Tiv, have a complex clan organization whilst other groups such as the Gbari are fragmented into small lineages.

In the pre-colonial period, most of the peoples in this region had their own traditional beliefs; however, over the last century, there has been considerable pressure from both Christianity and Islam on many communities. As a result, most young people today feel the need to adhere to one or the other of the world religions. Both of these religions come as part of a cultural 'package' that includes dress, attitudes to money and social relations, and specific food preferences. For example, pigs are forbidden to Muslims but have been encouraged by Christian missionaries. Pigs therefore, tend to spread in Christian areas. Similarly, the important role that the sacrifice of sheep plays in Islamic ceremonies has encouraged the breeding of sheep throughout the northern SHZ.

1.2.4 Trade and Communications

In the nineteenth century, the principal trade axes through the SHZ ran North-South, particularly bringing cola nuts and European trade goods from the coastal ports to the northern Emirates, and sending

cloth, horses, spices and onions in return (Ogunremi, 1982: passim & Map 2). There was very little in the way of craft and cash-crop production in the SHZ itself, partly because the dispersal of many of its peoples into fortified hill settlements has disinclined them to enter trade relations with the erstwhile raiders. As a result, the peoples of this region tended to raid the caravans of goods passing along these routes rather than trade with them.

Markets themselves were uncommon north of the Niger-Benue, although they were an established feature further south in parts of Igbo and Idoma country as well as along the Niger. However, this did not prevent a considerable amount of exchanges of local produce; oils, vegetables, spices, fish, cloth, pots, iron, antimony and salt are commonly mentioned in earlier sources. The region was characterised by long-distance trade routes running north-south, and short exchange networks dispersed in many directions.

During the colonial period, the noticeable underpopulation of the northern SHZ stimulated considerable efforts on the part of the authorites both to bring down the hill-peoples to the plains and to interest them in cash-crop production. This process, initially resisted, was almost complete by the begining of the 1980's. For example, the Kofyar (Netting, 1968) who were practising intensive hill agriculture on the Dimmuk escarpment south of the Jos Plateau in the early 1960's have now begun commercial pig-breeding on a large scale on the plains below.

Similarly the encouragement of cash-crop production and high urban demand, coupled with a booming economy stimulated the expansion of a broad variety of smaller crops. For example, yams, oranges, bananas, spices, ginger and tomatoes have all increased considerably since the 1950's, a period that saw a gradual decline of production of surplus staples, due to the importation of cereal grains. This has lead to the remarkable expansion of certain towns; Lafia, for example, has become one of the principal foci of the yam trade with the north, a development of the post-independence period. Bourn & Milligan (1984: Fig.3) provide a convenient summary of the growth of the road network (1950-1983). In their study of interregional cash-flows in Nigeria in 1964, Hay and Smith (1970) indicate clearly that by far the greatest volume of goods was then travelling along the north-south axes.

Although the SHZ remains less developed than other regions of Nigeria, internal communications have been considerably improved since Independence in 1960. Plateau State, in particular has a dense network of roads, and the establishment of other foci of population is leading to further infrastructural development, for example in southern Zaria. The development of the Federal Capital Territory in the wake of the creation of the new Federal Capital at Abuja should stimulate a growth of the communications network.

The present operation of the Nigerian livestock trade remains poorly known, and as there have been no studies of the trade such as have been undertaken in the francophone countries of West Africa (e.g. Staatz, 1979 for Ivory Coast), analyses must largely depend on anecdotal material. Moreover, even older statistics collected at government control posts and official slaughterhouses only represent a

fraction of the total livestock trade. The informal sector has expanded, reflecting the increased urban demand for meat since the mid-1960's. RIM (1984) contains a systematic tabulation of livestock prices in southern Gongola State recorded in mid-1984 - as this was subsequent to the rinderpest epidemic of 1983-4 these represent crisis rather than 'normal' price-structures. Average prices in Naira for cattle, sheep and goats in the three development regions were as follows;

Region	Bull	Barren Female	Calf	Male Goat	Female Goat	Male Sheep	Female Sheep
Ganye	750	-	-	50	50	77	45
Mambila	822	331	331	57	37	85	42
Benue Lowlands	519	138	329	54	47	77	47

The decline of wild sources of meat over the last century, through the growth and expansion of human population and increased more extensive hunting, has created a considerably greater demand for domestic livestock. Bayer (1984a:3) calculates that sheep and goats together contribute about 35% of Nigeria's total meat supply. Until recently, camels played a negligible part in the meat trade in Nigeria, but drought in the arid zone since 1983 has lead to destocking further north in Niger and increased availability of camel meat. Beef still forms the most important element of the internal trade, because of the relatively high amount of meat from carcases and because of the possibility of trekking cattle from producing regions to markets.

The evidence suggests that the cities create the principal demand for beef, and that the wealth of particular regions will reflect that demand. Thus all the trade cattle from Gongola State are destined for the markets of the south, particularly Enugu; few cattle are directed towards Kano, which is supplied from pastoral resources that are closer to hand. In the West, cattle tend to converge on Ibadan as the princial marketing centre.

In the pre-colonial period, cattle were trekked to marketing-points. With the construction of railways, they were often trekked to markets at the railhead, and this continues today. However, the major revolution in cattle marketing has occured through the introduction of large trucks or trailers that will transport up to 30 animals. Such trailers are quicker, more flexible and only marginally more expensive than railways. They avoid subjecting stock to the stress that almost inevitably results in the death of one or more animals during trekking.

Cattle trailers only reached certain regions quite recently: in Gongola State, for example, they have only been in regular use since 1981. Even so, major cattle-producing areas such as the Mambila Plateau remain inaccessible to trailers. Rising costs of maintaining

such vehicles on the road may cause a certain decline in their use in the next decade. Cattle-trailers are rarely owned by cattle-producers; they are almost inevitably controlled by entrepreneurs with connections at the market end.

Small stock, sheep, goats and pigs are regularly transported by means of mammy-wagons and pick-ups in the same way as cattle. However, the absolute volume of TLU moved in this way would appear to be substantially less than cattle - partly because goats and sheep are more regularly slaughtered and consumed in the areas where they are produced. Pigs are usually produced only for sale in the northern SHZ, and many producers will not eat their flesh, in contrast with the Christian areas further south where they form an important element in the diet.

In parts of the SHZ, the low price of dairy products in relation to grain has compelled FulBe pastoralists to sell part of their stock every year. The percentage offtake has been increasing gradually since 1975. In the Benue Lowlands of southern Gongola State (RIM, 1984c), pastoralists estimated that from 10-15 animals had to be sold every year to maintain an average family in staple cereals, irrespective of the size of herd owned by an individual. The unusually large average herd size in this region (182) implies that there will rarely be an irreversible decline in herd size; but this state of affairs is undoubtedly rare in the SHZ as a whole. This situation has probably been the single most potent force in the sedentarization of pastoralists in the SHZ over the past decade. ILCA (1979b) and FAO (1983:13 ff.) discuss some of the other proximate causes of settlement, such as loss of herds through drought and disease, and encroachment of arable farmers.

1.2.5 Types of Agriculture

The diverse systems of agricultural production in the SHZ can be categorized in a number of ways:

a). Savannah, forest and montane grassland.

b). Arable farming, agro-pastoralism and 'pure' pastoralism.

c). Upland and lowland, i.e. river-valley based.

d). Cash crop-based and subsistence based.

e). Shifting cultivation and intensive methods.

f). Tuber and cereal-based agriculture.

Ruthenberg (1980) provides a more extended description of these systems in relation to tropical agriculture as a whole. Norman et al. (1982) provide an overview of cropping systems in the northern SHZ and the LRD reports (1976, 1978) cover the central region og the SHZ. Powell (1984) describes the cropping systems in the ILCA Case-Study

areas Kurmin Biri and Abet, where fallow systems are tending to give way to permanent cultivation. The specifically Nigerian features of these farming systems are described briefly in the sections below.

1.2.5.1 Savannah, forest anbd montane grasslands

Savannah agriculture, practised both north of the Benue, and the regions of derived savannah south of the rivers concentrates on seasonal cropping, with an emphasis on cereals, especially maize, sorghum, millet and fonio. The use of animal manures is common, and in many areas, shifting agriculture is practiced. Tree crops, such as the locust bean (Parkia clappertoniana) and Canarium schweinfurthii are exploited as food supplements. Mono-cropping or a variety of crop mixtures are commonly found.

Forest agriculture, practised further south, is also usually shifting agriculture, and depends on a mixture of tubers and tree-crops, particularly yams, cocoyams and the oil-palm. Animal manures are not normally required.

In the montane grasslands, such as the Mambila Plateau, where the rainy season is very extended, agriculture is usually not based on shifting cultivation. Either river-valleys are cropped intensively, and soil fertility maintained by the use of green manures, as on the Mambila, or else the plots are manured by cattle. Crop mixtures of varying complexity are characteristic of this type of agriculture (LIDECO, 1972 & Rehfisch, 1974:18).

1.2.5.2 Arable farming, agro-pastoralism and 'pure' pastoralism.

Almost all peoples of the SHZ keep some form of small livestock, most usually goats and chickens. Bayer (1984a:4) calculates that the ratio of goats to sheep in the SHZ is of the order of 7:1 with 90% of households keeping goats, with an average flock size of 5 animals. Sheep are more common further north and in Islamic areas, while pigs are found sporadically throughout this region in non-Muslim communities. Therefore, 'mixed farming' is practised in some measure throughout the Zone. However, the contribution to subsistence of small livestock in most areas is small, and arable farming is by far the most significant mode of production.

When arable farmers begin to herd cattle, and pastoralists settle and begin to farm, 'mixed farming' or agro-pastoralism is the result (FAO, 1983). In some regions this is characterised by a close integration of livestock and agriculture; for example in Bauchi and Gombe (Tiffen, 1976), cattle owned by farmers are used as draught animals for carts and to draw ploughs. However, elsewhere, among the Samba of Gongola State, they are herded as a store of wealth and not generally used on the farms. It is generally held that most of the cattle are owned by the FulBe pastoralists (Agboola, 1979; Barbour et al., 1979:68), although this situation is changing.

These changing patterns have important consequences for the observable house-types associated with different modes of production. The general pattern, observed both in the Toungo Block and in Kurmin Biri and Abet, is for the type of house built by pastoralists to be correlated with the length of time its inhabitants intend to stay in one place. Thus nomadic pastoralists, and transhumant pastoralists on the move, built hastily constructed shelters, with large sheets of plastic covering them. A larger, well-built 'beehive' ruga is made both by recently settled FulBe and by nomads who expect to spend a long period in one place; for example the migrant groups who live along the shores of the Benue river for eight months each year.

FulBe who expect to settle permanently build circular houses with grass roofs, but after they have been resident in one place for more than ten years they tend to build square houses with tin roofs. On the Mambila Plateau, for example, almost all FulBe dwellings were of this pattern, reflecting both the tine-depth of FulBe settlement and their comparative wealth. Corrals and crop may be associated with these buildings, but this association is linked to overall arable farmer densities. If the FulBe are recent settlers in a densely populated area they may only be permitted to keep their cattle and fields away from the homestead.

In Nigeria, as elsewhere in West Africa, the FulBe people are the principal group depending on livestock, especially cattle, for subsistence. Classic ethnographies of this group (e.g. Dupire, 1962 and 1970; or Stenning, 1959 and 1971) tend to give the impression that the majority of nomads depend on their herds entirely for subsistence. This may have been the case in the past, but its validity has been questioned in the last decade in relation to the Nigerian SHZ (Van Raay, 1975, ILCA, 1979b), where the majority of pastoralists are settled.

1.2.5.3 Upland and lowland farming

Although intensive irrigated farming is common in the semi-arid zone, particularly in the 'fadama' gardens of Sokoto and Kano States, with a few exceptions, it remains rare in the SHZ. Only rice (probably Oryza glaberrima), traditionally grown by Nupe farmers along the Niger, constitutes a major staple; the Tiv began the clearing of the Benue banks for rice-fields in the 1950's. Even today, some riverine regions of the SHZ, such as the Benue above Ibi, and the Niger from Jebba to Kainji, are little-used, partly because of the risks of trypanosomiases and river-blindness, and partly for the lack of the appropriate skills to exploit them most effectively. The spread of cash-crops, such as tomatoes, onions and tobacco, predominant in the North-South trade, into the SHZ is gradually accelerating, but remains at low levels. Certain of the montane grasslands, such as the Jos and Mambila plateaux, do have developed river-valley cropping, although the steep banks imply a rather different cropping pattern.

Rainfed upland farming is more common, and is associated with shifting agriculture and savannah ecologies. Powell (1984) describes the operation of these systems in Kurmin Biri and Abet. The principal crops are the cereals, tubers, pulses and the more traditional vegetables such as roselle (Hibiscus sabdariffa), okra (Hibiscus esculenta) and garden eggs (Solanum spp.), with ginger grown as a cash crop. Powell (1984:6) found in Abet that 23 crops were grown in 64 cropping enterprises. Manure from cattle brought in to eat the cereal residues, and burning brushwood are common methods of restoring the fertility of the soil. Intercropping is practiced in upland regions to improve yields. Although fallowing is a traditional method of regenerating fertility in the soil, the recent availability of chemical fertilisers has lead farmers to adopt them as an additional strategy.

1.2.5.4 Cash-crops and subsistence

Nowhere in the SHZ do arable farmers depend entirely on cash-crops; the fluctuating prices for such produce would make this a problematic undertaking. However, the significance of an income from cash-crops varies with access to roads and markets and in relation to centres of innovation, such as ADPs and mission stations. The distinction between the minor cash-crops, such as ginger and fruit, and the market in staples, is important on a regional basis; for example, Southern Zaria produces very little in the way of surplus staples, whereas Niger State and the Federal Capital Territory produce staples, such as sorghum and yams, but little or no minor crops.

Subsistence agriculture remains the dominant mode of production in many regions of the SHZ, particularly the more inaccessible parts. It is also dominant in the extremely densely populated regions of Igboland, where pressure on land is so extreme and the land is worked so hard that there is no place for surplus production. Nadel (1941), Smith (1975) and Netting (1968) provide detailed descriptions of the type of agricultural economy north of the Niger-Benue, and Bohannan & Bohannan (1968) covers the earlier type of Tiv agriculture south of the Benue.

1.2.5.5 Shifting agriculture and intensive production

The distribution of these types of production is related to the pressure on land. In the past, this pressure resulted from the confinement of many peoples to restricted montane habitats (cf. Netting, 1968). However, today it reflects urban and rural population expansion, especially south of the Benue. In a study of three villages in the northern SHZ, Norman (1978) found that farm size was inversely related to population density. In the past, it was created by the confinement of many peoples to restricted montane habitats (cf. Netting, op. cit.). In certain regions there is a current transition between the extensive agriculture of the past and the intensive methods used today. For example, the Tiv people in the southeast used to be classic shifting cultivators (Bohannan, 1968). However, in the

1960's they began to adopt both irrigation techniques and a form of crop rotation (Edwards, pers. comm.).

However, in the sparsely populated regions both east and west of the central zone fallow systems remain the most common form of land-use. Tiv farmers in southern Gongola State still farm in this way (RIM, 1984c), as do the Busa and other peoples in the extreme west.

1.2.5.6 Tuber and cereal based agriculture

The SHZ is a region where the rainfall allows for the combination of two very different types of crop; tubers and cereals. Apart from maize, which is found everywhere except in extremely semi-arid regions, the principal cereals grown in Nigeria, such as sorghum, bulrush millet and fonio, are associated with the semi-arid regions. Tuber-based agriculture, depending on yams, cocoyams, cassava and sweet potato, is characteristic of the humid zone.

However, with care, both types of crop can be grown in many parts of the SHZ, thus making possible the diverse cultigen repertoires that characterise many parts of the region. Powell (1984) gives a comprehensive picture of the cropping systems in the ILCA case study areas in Southern Zaria. The expansion of the yam trade, serving both the cities and southerners living in the north, has stimulated traditional yam-growers such as the Gbari, Tiv and Mumuywe peoples, to extend the regions under cultivation, and a town such as Lafia, where yams were insignificant in the market economy in the 1960's, is now a major focus of the trade.

1.3 Livestock and its Production Systems

This section describes the present state of knowledge about livestock production in the SHZ, based on available literature, and recent work by both RIM and ILCA. The principal types of domestic livestock in the SHZ are cattle, goats, sheep, pigs, horses, donkeys, chicken, guinea-fowl and ducks. Poultry are excluded from this discussion.

1.3.1 Cattle

1.3.1.1 Breeds

There are two principal types of cattle in the SHZ, the savannah West African shorthorn, or muturu , and the zebu. Crosses between these two types exist, both in Borgu - the 'Keteku' breed and among the Mumuye (RIM, 1984b,2:47). In addition, there are some 15,000 Ndama humpless longhorns, imported from Senegambia, although these are presently confined to government ranches.

Historical evidence suggests that until recently the muturu cattle were considerably more widespread than they are today (Morrison, 1976). They have a degree of trypanotolerance that previously favoured their extension throughout most of the forest zone as well as the SHZ. However, because of their small size, muturu have recently been preferentially discarded in favour of zebu in many regions. As a result, they tend to be found in 'refuge' areas such as the Atlantika mountains and the southern escarpment of the Jos Plateau. It is likely that the expanding settlement of the SHZ and the related decline in tsetse challenge has made it possible for the zebu to colonise areas that would previously have been closed to them (Bourn, 1983). The extent of humpless shorthorns south of the Niger-Benue remains unknown, although a recent survey by NLPU (1984) suggests that they are widely distributed, but not found in large concentrations. ILCA (1979a) estimates 150-180,000 Keteku and 100-120,000 muturu in addition to the Ndama.

The zebu cattle have been brought into the SHZ by the FulBe, both as a consequence of drought in the arid zone and under pressure from arable expansion in the semi-arid zone. There are numerous zebu breeds, but the four most economically important in Nigeria are; the reddish Rahaji or Bodeeji, the white Daneeji or Bunaji, the Bokolooji or Sokoto gudali, white but with very reduced horns, and the white Adamawa gudali. Of these, the 'white' breeds are generally considered to be most readily able to withstand hardship, both famine and disease, and are therefore preferred in the SHZ. Indeed, there is some evidence for herd-owners switching to 'white' breeds, as pressure on resources increases, or stock moves into marginal areas.

Crossbreeding trypanotolerant and zebu stock would amalgamate the qualities of both breeds and might produce a more appropriate subspecies for the SHZ. However, apart from Borgu region of western Nigeria where the Keteku are widespread, crossbreeds seem rarely to have been important. This may reflect only the relatively short period for which the two breeds have been in contact, and the consequent delay in emergence of a stable cross-breed.

1.3.1.2 Cattle production systems

It must be emphasized at the outset that there is an exteme paucity of literature on traditional cattle production in the SHZ in Nigeria. This partly reflects the relatively recent movement of Zebu cattle into the zone; at present there are only the studies by ILCA staff in Kurmin Biri and Abet (summarized in Kaufmann et al. 1986) and by RIM in Gongola State. The production systems of indigenous breeds such as the Keteku and the savannah shorthorn are also unknown.

1.3.1.2.1 The savannah shorthorn production system

In general, the method of keeping muturu is reported as labour-intensive (e.g. Netting, 1968:62; or Bohannan & Bohannan, 1968). Animals are either stall-fed or else taken out to the fields and staked out every day. The most notable feature of their production is their important role in ceremonial life. In parts of Igboland, the sacrifice of cattle is central to the process of title-taking. In Sabongida-Ora, dwarf shorthorns are sacrificed as part of the process of divination. According to ILCA (1979a,2:215) the Keteku cattle are sometimes taken on seasonal transhumance. A particular feature of shorthorn production is the small size of herds - these rarely exceed twenty animals, and there may be only two or three animals in a given household. The manure from muturu in the Nigerian SHZ is often not systematically collected, and the cattle are not milked, in contrast to elsewhere in West Africa (ILCA, 1979b,1:41).

1.3.1.2.2 Zebu

Animal production studies on traditionally managed zebu cattle, such as Pullan (1979), Synge (1981), Otchere et al. (1982) and Otchere (1984) have generally been carried out on the Bunaji breed. RIM, (1984c:99 ff.) reviews this literature and contrasts it with data on Adamawa gudali collected in the Toungo Block, and with comparable figures drawn from studies in other parts of West Africa. Results were broadly similar, with high calf mortalities of around 30% in both the Toungo Block and Southern Zaria, but the average calving interval of 17 months was lower in the former, as opposed to 25 months in the latter.

'White' breeds of zebu cattle are the principal livestock type used by pastoralists for their expansion into the SHZ. ILCA (1979b) and Agboola, (1979) argue that the empty northern SHZ is increasingly exploited by herds from the semi-arid and arid zones.

1.3.1.2.2.1 Nomadic pastoral production

The social organization of nomads has been described many times; cf. for example, Dupire (1970), Stenning (1958), Hopen (1959) and Swift (1984). However, these descriptions all apply to the semi-arid zone, and the transformations that FulBe society may have undergone in adapting to the SHZ have nowhere been systematically investigated. RIM (1984c), Blench (1984b and 1985) suggests that in the Toungo Block at least, the following changes have occurred:

a). The pattern of pre-inheritance, whereby herds are distributed to kin before the death of their owner is being abrogated. Older FulBe now retain their own livestock until death, the better to control the labour of their offspring. Blench (1985) provides a more extended discussion of this topic.

b). The fragmentation of geographically coherent clan organization. In the semi-arid zone, FulBe tend to form geographically coherent clan areas (Dupire, 1970; Swift, 1984). Interview locations in the Toungo Block (RIM, Vol. III, Appendix V) showed that as many as twenty clans may all be living in one restricted geographical region. The explanation for this may be that the abundance of resources, although constrained by disease, has encouraged a type of economic individualism.

c). The lack of a basis of exchange of cereals for dairy products, and manure for cereal residues, coupled with a low price for milk, has compelled pastoralists to sell an increasing number of their cattle every year in order to supply their family. If dairy products cease to form a basis for subsistence, then proximity to markets becomes a less important factor in decisions relating to production, because cattle-buyers seek out herdsmen in the bush rather than attending formally constituted markets. The price of dairy products is low in terms of their exchange value against cereal staples and this situation has presumably been exacerbated by the influx of cheap powdered and canned milk over the last decade. (A study of the processing and marketing of dairy products in Southern Zaria has been prepared by Anne Waters-Bayer (1985)).

There is no doubt that nomadism was common in the past; RIM (1984c: Map 6) charts the gradual movement of the herds of nomadic FulBe (FulBe na'i) into southeastern Gongola State, in a region of forest and derived savannah. In the study areas of Kurmin Biri and Abet, the principal cattle-owners are FulBe whose immediate ancestors were FulBe na'i who settled in the region, and whose failure to obtain land rights comparable to those of the indigenous arable farmers reflects their recent immigration.

1.3.1.2.2.2 Settled FulBe pastoralists

Stenning (1959) and Hopen (1958) provide summary descriptions of the household structures of partly sedentary FulBe in the semi-arid zone of Nigeria; work by ILCA staff-members in Southern Zaria e.g. Waters-Bayer (1983); Bayer (1984b); Waters-Bayer and Taylor-Powell (1984); provide detailed studies of domestic production.

Most of the FulBe settled in the SHZ came originally as nomads; their settlement may be due to a number of causes (adapted from ILCA, 1979b:28):

a) Favourable conditions for all-year round herding.

b) Epizootics or other disasters leading to unviable herds.

c) Political events.

d) Desire for consumer goods.

e) Pressure on grazing land.

The types of production are correlated with the sizes of herds owned and the existing pressure on pasture. For example, in Bauchi, where land is scarce and average herd size is said to be low, the cattle are used as draught animals. However, in Southern Zaria, agropastoral FulBe herds are larger (an average size of herd owned of 46 animals (Otchere, 1984). On the Mambila Plateau, where sedentarization and arable farming is a consequence of the lack of a market for dairy products, average sizes of herds owned may be as high as 248 (RIM, 1984c: Table 14). However, these animals play no part in the farming system, either for manure, or for traction.

Settled FulBe are the principal purveyors of dairy products in many parts of the SHZ, around Kaduna and Jos, for example. South of Yola, however, competition from the nomadic FulBe has caused the decline of this practice. FulBe pastoralists almost inevitably grow cereals, especially sorghum and millet. If their herds are large enough to practice transhumance, they will usually take the surplus stock away for several months in the dry season, leaving the milk-herd together with their families and old people. However, this is by no means always the case, as in zones of high population density, such as west of Zaria, the labour costs of controlling the cattle and finding food for them during the cultivation season has lead to the practice of moving them away in the wet season.

1.3.2 Sheep and Goats

Small ruminant production in the humid tropics has been reviewed by ILCA (1979c) and Bayer (1984a) has studied aspects of small ruminant production in the SHZ.

1.3.2.1 Breeds

The principal breed of sheep in the SHZ, as in most of the semi-arid zone is the hairy, thin-tailed sheep (Epstein, 1971,2:41). These are divided into two major breeds, the Balani, or Bornu sheep; and the Uda or pied sheep. These breeds tend to be confined to the region north of the Benue except in the dry season, because they are liable to footrot. The Uda sheep, although larger and alleged to be more productive than the Balani, is less tolerant of wet conditions and tends to be further north. Both these breeds tend to be associated with towns in the SHZ, in view of the greater concentrations of Muslims in urban environments. Further south, on the edge of the humid zone, there are Yankasa or 'Djallonke' or dwarf forest sheep (ILCA, 1979a). These are well adapted to the wetter conditions and are presumably also trypanotolerant. Little is known about their exact geographical distribution, for unlike the sheep associated with pastoral herds, they cannot be easily counted from the air.

There are two important breeds of goat in the SHZ, the black, dwarf forest goat, and the larger 'Red Sokoto' savannah goat (Epstein, 1971,2:240). The first of these is an anciently established trypanotolerent breed whose small stature is related to adaptations its original forest environment. Although common in the forest zone, arable farmers in the Toungo Block asserted that it is gradually being replaced by the larger savannah species in the SHZ. The savannah species are of a number of different regional types, distinguished by colour. The expansion of the savannah goat is also associated with the spread of Islam in this region.

1.3.2.2 Sheep and goat production systems

Bayer (1984a) estimates that there are approximately 7 million goats and 1 million sheep in the Nigerian SHZ. Sheep are kept by both settled people and pastoralists, although they are preferred by pastoralists to goats as they are easier to herd with cattle. A survey of FulBe households near Kachia (Bayer, 1984a:4) concluded that there was a ratio of 4 to 1 between cattle and sheep. In the ILCA Case-Study areas, the average number of goats per compound was 5 and 90% of all households kept goats.

Specialised FulBe sheep-herds, known as Uda'en, bring large flocks of Uda sheep down from the semi-arid zone every dry season. As with savannah goats, there is a strong correlation between Islam and the extension of sheep into the northern SHZ as sheep are sacrificed for ceremonial purposes, such as Sallah. Hay & Smith (1970) testify to an expanding trade in sheep from the semi-arid zone to the markets of the South, presumably in response to a demand from resident Muslim communities.

Goats are kept principally by arable farmers and do not have significant ceremonial uses outside the regions where they are bred. As a result there is less inter-regional trade in goats, although they are of greater economic significance. They are kept by cattle pastoralists, particuarly settled ones, in some parts of the SHZ, although in the Toungo Block they are not reared at all.

The omnivorous and potentially destructive eating habits of goats have led to the evolution of elaborate control systems in some parts of the SHZ. Among the Nupe, where the principal crops are tall-stemmed cereals such as sorghum, goats are controlled by village decree during the growing season. In Southern Zaria, where the higher population density and broader variety of domesticated herds means that the threat from loose goats in the growing season is greater, they are either tethered or cactus hedges of Euphorbia spp. are used to control access.

Goat manure is occasionally used in the same way as cattle manure in parts of the SHZ. The people of the Srubu hills, for example, stake goats sequentially in fields where they are growing cocoyams. In the Kachia area (Bayer, 1984a) goat manure is mixed with wood ash and applied to millet nurseries.

1.3.3 Pigs

Despite their present widespread occurence throughout the northern SHZ, less is known about the breeds and distribution of pigs than almost any other types of livestock. It is uncertain whether the pigs in West Africa were introduced by the Portuguese, or are of greater antiquity (Epstein, 1971,2:340). Most of the pigs in the northern SHZ (i.e. north of the Niger-Benue) were introduced by missionaries and are therefore of 'improved' European types. However, further south, domestic pigs are black, hairy types (J. Eboreime pers. comm.). Their descent and breeding qualities are unknown, although it has been argued that they represent the 'unimproved' Iberian pig.

Pigs do not play a significant role in the ceremonial life of peoples in the northern SHZ, and they are therefore generally sold to the markets of the South. The numbers of pigs kept by individual households is constrained by the labour abd the availability of spent grains to feed them. Development agencies have usually tended to downplay pigs as it is argued that they compete with human beings for food. In the South, where pigs are often fed on specially grown cassava, this is certainly true. However, pigs have ready-made food throughout the northern SHZ in the form of spent grains, the residue of beer-production.

Other authors have commented upon the important role of beer in the ceremonial and social life of northern SHZ peoples (e.g. Netting, 1964), and among such peoples as the Mumuye, the recent expansion of pig-keeping is entirely premised on the availability of beer residues. Pigs are very often kept by women to supplement their income, and they are appropriate as they are often fed on household wastes.

South of the Niger-Benue, the black pigs play a more important role in community life, as they are sacrificed for ceremonial purposes in some areas. They are kept around the compound, and are rarely sold except for sacrifices. Along the Benue, a number of specialised fishing-peoples such as the Junkun fishermen and the Bacama have also begun commercial pig-raising on a large scale (RIM, 184c,2:50). Pigs are raised by women using household refuse and maize husks, and sent down the river to the large market at Ibi, several times a year.

Pigs must either be confined throughout the year, or allowed to graze freely only when there are no crops that they can uproot. The provision of fences can aid in the control of pig movements, but these are not yet common in the SHZ and it is more common to confine the pigs in sties. In communities with a Muslim sector, this may also be done to avoid friction within the community.

1.3.4 Horses and Donkeys

Horses and donkeys are not common in the SHZ today; the only donkeys are those owned by FulBe pastoralists and Hausa traders. Horses in the SHZ are of two types: small suposedly trypanotolerant ponies of considerable antiquity (Blench, n.d. reviews the distribution and present status of this breed) and larger horses of Arab descent. Neither of these are widespread today, although the decline of the tsetse challenge in the SHZ makes it an increasingly suitable environment.

Donkeys are bred by FulBe pastoralists for use as pack-animals; although common further north they are susceptible to trypanosomiases and are rarely used today. They have not been brought to the grasslands, such as the Mambila and Shebshi plateaux, where motor-bikes effectively fulfil their traditional function. Donkeys are rarely brought to market and when they are sold it is usually by private treaty.

Horses are bred on the Mambila Plateau for sale and riding, especially along the southern border with Cameroun. A small number are sold to Igbo traders who will transport them to the market of Enugu where they are sold for ceremonial purposes and eaten.

SECTION 2: THE IDENTIFICATION OF NATIONAL TRENDS

2.1 General Trends in Livestock Production and Land Use

Jahnke (1982) gives an overall view of livestock production systems in tropical Africa, and Fricke (1979) provides a synthesis of the Nigerian situation. Bourn & Milligan (1984:20 & Fig. 15) have already presented schematically some speculations about future trends in livestock production in the SHZ. They suggested that the central corridor or 'bridging band' of the SHZ will be increasingly colonized by arable communities, and that the association of pastoralism with crop farming will increase, with nomad production gradually squeezed out. Settled FulBe will tend to evolve farming systems that integrate crops and livestock and the long-distance transhumance that characterises the present situation will gradually disappear. Aspects of these processes are discussed in ILCA (1979b) and FAO (1983).

The new information available from the ground surveys of southern Gongola State and the ILCA Case Study areas has brought to light other changes that are in progress. These studies were undertaken over the period 1979-84 and it is important to take into account the impact of drought and rinderpest on the results. The drought in the arid zone since 1983 has had the effect of pushing cattle populations in the semi-arid zone further south. In addition, rinderpest has affected parts of the SHZ since December 1982. The effects of the epizootic have been patchy, but work in Gongola State suggests that the most immediate result was for herders to take their cattle into remoter areas as a form of temporary quarantine. The correlations with roads, towns, rivers and cultivation may therefore not always be as good as they normally would be.

2.1.1 Arable and Pastoral Expansion in the SHZ

Since the begining of the colonial era the part of the SHZ north of the Niger-Benue system has been subject to the expansion of arable farmers from both the humid and arid zones. The exact speed and pattern of such 'pioneer colonization' is unknown, and it undoubtedly varies from one region to another. In many areas, it may well be that the expansion of the population in rural areas has been balanced by net migration of young people to the towns. Another factor that must be taken into account, for example in the lowland regions of the Toungo Block, is the rapid settlement of the roadsides by commercial yam farmers (RIM, 1984c,III: Map 2). At the same time, however, the Samba area south of Sugu was becoming depopulated.

This suggests that not all agricultural colonization is a result of population expansion; in many cases populations relocate to have improved access to road and rail communications. However, certain peoples such as the Gbari, Mumuye and Pongu tend to move into remote areas, to be nearer fertile farmland. The drought in the arid zones

of the north that tends to move cattle popluations further south also causes relocation of arable farming communities. Gongola State proved (RIM, 1984c) to have numerous small communities that had recently immigrated from further north.

The future settlement of the SHZ depends in part on the economic strategy of Nigeria as a whole. The expressed policy of the FLD (David-West, 1981) is for general relocation of the national herd further south, in the SHZ. However, if urban populations continue to grow or even maintain their present levels, then rural enterprise providing both cereals and meat for the towns must also continue to expand.

Fricke (1979:218 ff.) and Putt et al. (1980) in independent analyses of Jangali cattle-tax returns have both demonstrated that there has been a marked tendency for a southwards expansion of the Nigerian cattle population since the 1950's. Jangali returns fell in the semi-arid north and increased further south. This correlates with a substantial body of anecdotal evidence. The impact of the drought in the early 1970's would further act to encourage this trend.

The ground survey found that in a wide variety of locations in the SHZ that transhumance movements within the SHZ are increasingly taking place within the zone rather than as movements from the semi-arid zone. This reflects either year-round settlement by pastoralists, or else migration between the northern and southern regions of the zone by FulBe na'i.

There is only a partial correlation between the degree of cultivation and the presence of cattle, although the relationship between cattle and densities of arable farmers is more consistent. This correlation is better in cereal-growing areas, where residues provide fodder through a good part of the dry season, and alleviate some of the labour problems associated with long-distance transhumance (Okali & Milligan, 1981). However, the SHZ must be regarded as a dynamic system, with constant exploration of new regions by arable and pastoral groups and the types of stable relationships between these two groups that obtain further north have not yet had time to evolve.

A trend well demonstrated by the aerial survey is the preferential colonization of grassy uplands. Such uplands, because of the cool temperatures are less likely to harbour cattle infections and the pasture, in the initial stages is better. Moreover, when pastoralists originally moved into these grasslands their arable farming populations were very sparse. This is likely to be true for the Jos Plateau (Morrison, 1976) and was certainly true for Mambila, Shebshi and the other grasslands of Nigerian Adamawa. However, the presence of cattle seems to attract farmers, or else populations expanded because of the preference given to grasslands by the colonial authorities, and so the cattle tend to be pushed off again. On Mambila, Jos and Shebshi, pastoralists graze their cattle partly on and partly off the Plateau.

It is unknown to what extent FulBe pastoralists, or herders of muturu have colonised the smaller grasslands southwest of the Niger-Benue confluence. However, they have certainly begun to explore this region

and on the basis of other areas will rapidly fill them to carrying capacity.

The availability of fodder for cattle and access to farms and markets is therefore a major force in attracting pastoralists to the zone. Pastoral colonization from the arid zone is therefore likely to continue, as long as there is land available for the herds. However, there is good evidence to suggest that pastoralists may preferentially avoid tuber-producing areas, such as the region south of the Benue, because of the lack of a basis for exchange with the farmers and the potential for conflict (Blench, 1984b).

2.1.2 Pastoral Production

2.1.2.1 Factors determining livestock species raised

The high market price of cattle and the prestige associated with them in the past ensure that they were the inevitable choice for farmers intending to invest surplus labour or capital in livestock. The figures quoted by Jahnke (1982:35) for increases in tropical livestock numbers in Africa during the 1970's suggest that this force is acting throughout the continent. However, in Nigeria this situation has changed since 1970 for three reasons;

a). The high incidence of disease and unreliable supplies of veterinary medicines.

b). The relatively long term required for a turnaround of capital.

c). The high labour costs of controlling cattle in densely settled zones.

An alternative, at least in those parts of the northern SHZ where Islam is not widespread is pigs. Indigenous breeds are reportedly less susceptible and may also be less exposed to disease, they can be kept confined and fed on household refuse, and full-grown pigs were being sold for as much as 200 Naira in 1982. The Sholyo people in Coori (Section 3.3.1.5) provide an example of a community that was previously investing in cattle, but is increasingly transferring to pigs.

2.1.2.2 The sedentarization of pastoralists

The expanding settlement of the SHZ by indigenous farmers cannot fail to impress upon pastoralists that the only way to claim land is to settle on it. Since FulBe are denied full land rights in many areas of the northern SHZ, they are likely to preferentially settle in areas where they can obtain such rights. Although it has been suggested above that the marketing of dairy products is increasingly less important in such decisions, pastoralists still insist on access to

arable communities; a preference determined by the availability of crop residues and also reflecting decreased tsetse challenge around such settlements. In addition, if pastoralists decide to cultivate a small area to supplement their household income, then they prefer to crop fallow land rather than clearing a fresh area of bush.

Settlement of areas set aside by government, such as Grazing Reserves, is therefore only likely if arable farming communities are adjacent. Since only those FulBe with reduced herds farm over and above minum subsistence requirements, it is likely that FulBe na'i will settle in grazing reserves and create their own farming community. However, the allocation of land for fodder banks in Kurmin Biri as a result of the ILCA programme may set to change these attitudes.

Sedentarization of pastoralists is therefore likely to be outpaced by the expansion of cultivators, and pastoralism runs the risk of being squeezed out in the decades to come. The experience of Lafia ADP (LADP) in establishing grazing reserves, where only four FulBe family-groups were induced to use the Grazing Reserve over five years of the project, suggests the slow pace of this process. While parts of the northern SHZ, such as the Tegina/Mariga area, continues to offer attractive grazing even for large herds, extensive settlement of nomads is unlikely.

2.1.2.3 Nomadic migration patterns

Migration patterns are usually presented in standard texts (e.g. Fricke, 1979 or Stenning, 1959) as between wet and dry season pastures. However, ground surveys conducted recently have shown that a more usual pattern is a tripartite movement. The cattle are usually kept around the compound during the growing season, except where cultivation densities are so high that they are troublesome to control. At the end of the dry season, they may be kept for two or three months to eat the cereal residues, or they may be taken elsewhere to exploit the residues. When these are finished, the cattle will be taken to the dry season pastures proper, usually along the banks of a river. However, towards the end of the dry season, with the first specks of rain, they will be moved rapidly to a southern location where the newly flushing grass is available. They then move back to the compound again.

Apart from the evolution of this pattern, since the 1960's migrations within the SHZ have undergone other changes, in both volume and spatial arrangement. They can be summarized as follows;

a). FulBe na'i have pushed the frontier of migration increasingly further south. Many groups now regularly migrate to regions south of the Niger-Benue system. The montane grasslands in these areas are thought to have exceeded their carrying capacity and are in danger of irreversible degradation. For example, FulBe now exploit rain forest in the dry season in southern Gongola State, despite the apparent risk from tsetse fly infestation.

b). Pastoralists with larger herds have been pushed to the east or west of the central corridor in the SHZ. In the Benue lowlands and south of Mariga, around Funafuna, large herds were recorded, far exceeding those in Southern Zaria, for example. Since the labour costs of managing large herds are reduced in regions of low population density, it is reasonable to speculate that individuals with large herds are likely to preferentially migrate to these regions.

c). Transhumant or nomadic pastoralists moving through the SHZ are increasingly confined to 'corridors' that pass through regions where there are no farms. In many regions this has been formalized by agreement with local village and District Heads. However, the attraction of such land because of its fertility has already encouraged some farmers to cultivate it and this is likely to be a potent source of friction in the future.

2.1.2.4 The development of integrated livestock and arable farming

Arable farmers in the Azare and Gombe regions of Bauchi State demonstrate a considerable degree of integration, both circulating cattle for ploughing within the community, drawing carts, using manure and fattening surplus males for sale. However, Azare and Gombe are at the very northernmost limit of the SHZ and this pattern is by no means typical; this integration may well reflect only low numbers of cattle held by individual households and the need to use them efficiently.

More commonly, livestock and arable cropping, even when combined, are regarded as distinct economic enterprises and are managed for the economic bebefit of individuals. Cattle, for example, were commonly given to FulBe na'i to look after, if no competent member of a family was available to herd them. Samba men in the Toungo block take cattle on transhumance themselves in the dry season, thus withdrawing their labour on farms. Ploughs have generally had strikingly little impact in the SHZ, and even highly subsidized attempts to introduce them, as in the LADP, have failed. Without intervention, it is unlikely that integrated farming systems will evolve rapidly of their own accord, although 'combined enterprises', herding and cultivation, are already widespread.

2.1.2.5 The transfer of cattle to the arable farmers

One of the most important trends in livestock production in the northern SHZ has been the transfer of cattle to arable farming communities. This is most noticeable in parts of southern Gongola State, but is common in many regions (cf. Section 3). In some cases, this transfer dates back to the 1920's but it became substantially more common after the influx of oil wealth after 1967. In the past the arable farmers could only obtain cattle by working for the FulBe pastoralists; more commonly today they simply buy them on the open market.

The key to this process is the availability of surplus wealth to invest; the rising prices obtained by farmers for cereal staples since 1970 have generated considerable wealth in rural areas, and tin roofs, bicycles, motor-bikes and radios are a reflection of this. For various reasons, farmers are unwilling to invest this in farm mechanization, and unless they live near an urban centre, alternative investment possibilities, such as transport, are difficult to monitor. As a result, cattle or other livestock become an attractive investment, as elsewhere in West Africa (Delgado, 1979).

As was pointed out above, the purchase and maintenance of livestock does not mean the evolution of traction farming. Cattle may be either kept and fattened for immediate resale, as among the Gurmana and at Kauru, or they may be intended to form the nucleus of a breeding herd. In both cases, the intention is to store wealth in a form that appreciates. However, in terms of intervention strategy, such livestock producers clearly form a significant 'target' group, amenable to suggestions concerning improved production methods.

2.1.2.6 Herds and grazing units

In previous ILCA/RIM reports the terms 'herd' and 'grazing unit' (GU) as observed from the air were treated as synonymous. However, ground surveys in Gongola State showed that is convenient to analyse the observed grazing units as management units and contrast them with 'herds', that is the numbers of animals owned by individuals. On the Mambila Plateau, some FulBe own several thousand cattle and these are subdivided into GUs each in the control of a single herdsman. By contrast, Mambila herds may number as little as 5-10 animals, and often the herds of several individuals are joined together to form a single GU.

Various factors, both ecological and social, control GU size; for example,

a) The availability of labour. This affects the management of herds when watering at wells or borehole; and is particularly important for the prevention of trampling and consumption of crops growing in unfenced fileds.

b) The needs of the family unit; for example, when sedentary FulBe take their herds on transhumance, they usually divide the herd into a group of lactating females, calves and weak animals and leave these at the compound to be cared for by the family, and take other stock on transhumance.

c) The skills of the herders. In southern Gongola State the FulBe, because of their long experience of livestock, were reputed to be able manage larger herds than other ethnic groups. On Mambila, for example, the maximum an individual FulBe was said to be able to manage was 150 animals, whilst for a Mambila herdsman it was only 60 animals.

Aerial survey is well suited to the estimation of grazing unit size, and its potential for correlating GU size with cartographic and

environmental parameters makes it possible to establish the constraints on GU size that operate within particular geographical regions.

2.2 National Trends as Derived from Aerial Surveys

2.2.1 The Areas Surveyed from the Air

The surveys were conducted over a range of geographical scales such as (though not necessarily in chronological order); the SHZ as a whole; selected states; particular areas that are being intensively studied by multidisciplinary ILCA ground teams; and the potential and actual regions gazetted as grazing reserves. These are shown on Map I.

Time, manpower and financial constraints limited high sampling intensity aerial surveys to specific study areas, but nevertheless low intensity surveys over some 356,510 square kilometers of the Sub-Humid Zone were carried out during March and July 1983 (dry and wet seasons, respectively).

It should perhaps be emphasized that the objectives of this very low intensity, low level aerial survey of the Sub-Humid Zone were primarily, to put the ILCA case study areas into zonal perspective; to assess overall cattle distribution gradients; and to determine seasonal changes in cattle density and GU size. With such low intensity sampling, estimation of total cattle numbers was thought to be of secondary importance, but nevertheless the results are of considerable general interest, as they provide an objective measure of the size of the Nigerian Sub-Humid Zone cattle population.

RIM, in association with Nigerian agricultural development agencies, has carried out intensive large scale surveys in two States - in Bauchi and southern Gongola. The former was concerned largely with cultivation and human habitation, and will only be referred to in passing in this report, while the latter covered livestock, land use and human population indicators, from both the air and the ground.

Within the central corridor of Nigeria, nine distinct ILCA case study areas were flown in the wet season of 1984. They can be divided into four geographical groups: Giwa, west of Zaria and to the north of Kaduna, for NAPRI; Pambeguwa, Kurmin Biri, Abet and Ganawuri to the south and east of Kaduna and reaching as far as the Jos Plateau escarpment; Tegina, Mariga and Funa Funa to the South and west of Kaduna; and a site to the north east of Lafia, for BICOT. Three of these sites were also flown in 1979 or 1980 - Kurmin Biri, Abet, and Mariga, as was a site to the south east of Lafia, on the northern bank of the Benue River, east of Makurdi. The first three of these areas have been the focus of considerable ground based ILCA research during the past six years.

Finally, in conjunction with the southern Gongola survey, three grazing reserves were surveyed, in northern Gongola and Bauchi States. These sites lie just to the north of the SHZ, and fall within Semi-Arid Zone .

2.2.2 The Methods used in Aerial Survey

The aerial survey technique followed standard procedures for livestock and land use assessment, which was adapted from existing techniques of wildlife population assessments (Norton Griffiths, 1978), and are described in RIM 1984c. The survey zones are each divided into a regular 5 x 5 or 5 x 10 kilometer sampling grid, using the UTM projection, which forms the basis for a systematic pattern of low level aerial sampling by a team of experienced observers, flying in a light aircraft along the centre line of each cell.

This systematic and unstratified sampling strategy is considered more valuable than a random stratified design for two major reasons. Firstly, each part of the survey areas is covered uniformly, so that the data collected is immediately mappable and relatively easy to interpret. Secondly, after the surveys have been completed, the information can be analysed in relation to a range of strata such as vegetation density, administrative area, ethnic distribution, and so on, which may be defined long after the survey was flown. Such flexibility of analysis and interpretation would be greatly reduced if the sample design was locked into a specific and predetermined type of stratification. Thirdly, surveys using this sampling strategy can easily be repeated or replicated, which allows for their use in monitoring and evaluation programmes. A further advantage of this sampling pattern is that it permits the calculation of indeces based on the combination of several of the parameters measured for each grid square.

Full details of the operating survey methodology can be found in Appendix 1, while the parameters that have been estimated from the air are shown in Table 1. Sample intensities vary according to the particular requirements of each project, but commonly vary between 5 and 15%. The reliability of the population estimates is impossible to assess without replicated surveys which, to date, financial constraints have precluded. However, considerable efforts are made to minimise inaccuracies due to observer error, variation in flying altitude, and thick vegetation cover. These are also detailed in Appendix 1.

2.2.2.1 The Development of Aerial Survey Methodology 1979-1984

During the last six years, ILCA and RIM personnel have adapted and expanded the basic aerial survey methodology, as initially developed for wildlife counts in East Africa, in a variety of directions. The major avenues have been: an expansion of the parameters recorded; the extension of the aerial survey methodology to include the measurement of cropping patterns, and potentially, selected aspects of forestry; the visual presentation of the results; the evaluation and statistical analysis of the information collected; the planned integration of ground and air survey; the scale of the areas surveyed; the uses to which the data are put; the use of aerial survey to identify sites for potential development options for interventions identified on the ground; the quantification of the target populations of the

TABLE 1. PARAMETERS ESTIMATED FROM THE AIR.

WITHIN THE SAMPLE BAND	
NUMBERS	
Animals	Red Cattle, White cattle, Pastoralist Sheep, Horses and Donkeys, Wild animals
Habitations and Settlements	Arable, Agropastoral, Settled/Transhumant Pastoralist, Settled/transhumant Pastoralist with associated crops, Nomadic Pastoralist, Fishermen's Tin and Grass roofs
Other	Deserted Corrals, Tar Roads, All Weather Roads, Tracks Deserted settlements and Habitations, Rivers and Open Water
WITHIN EACH GRID	
	Presence/absence of open water, % Cultivation, % Burned Ground, Gully and Sheet Erosion (each 0-5) % Closed Canopy Forest, % Open Canopy Woodland, % Savanna Woodland, % Grassland, Flying altitude, Grass cover (0-5)

Not all of these data are presented in the text.

development options identified; and the use of ground and air data to estimate populations otherwise inimical to air survey methods.

The actual parameters recorded initially consisted of those strictly describing the levels of livestock populations, arable and pastoral habitation, as well as land use and environmental conditions. The livestock counts made have changed little since 1979, bar an increased emphasis being placed on the types of cattle seen, should it have proven necessary as in southern Gongola.

Since 1983, the arable farmer populations have been estimated using roof tops rather than compound numbers, and for a short period, the wealth of the agricultural population was assessed by recording the ratios of tin to grass roofed dwellings. This last measure has been subsequently abandoned because the number of tin roofs is likely to reflect the rainfall levels, and the local availability of corrugated iron sheeting, as well as the amount of surplus cash available. Another recent development in this area is the division of pastoralist habitation into purely pastoralist and agropastoralist categories, based on the presence of adjacent cultivation and cattle corrals. Further division of the arable and agropastoralist farmer dwellings into ethnic groups is now under consideration, as each group is likely to practise specific husbandry techniques, and information about the distribution of differing husbandry practices would prove an invaluable aid to assessing the local applicability of individual development interventions. Such a fine resolution of agricultural dwellings presupposes a close link, at the start of an aerial survey, between exploratory photographic ground teams and the aerial observers and photointerpreters.

In terms of the environmental and land use parameters, the more recent aerial surveys have recorded degree of topographic dissection, various categories of access, erosion scores, amount of burning, and cattle trails and their direction, in addition to the basic estimates of grass cover, vegetation category, water availability and cultivation levels.

The use of aerial survey to assess cultivation patterns in West Africa has been extended considerably in recent years, using small format (35mm) vertical photography. A experimental RIM survey in conjunction with APMEPU has demonstrated that, by dint of taking both wide angle and telephoto photographs of the sample strips within each grid, it is possible to estimate not only the overall percentage cultivation, but also the proportions of many of the most widely grown crops and crop mixtures.

However, several factors affect the accuracy of this procedure. The exact timing of the flights in relation to the maturity of millet, sorghum and maize determines the degree to which these crops can be distinguished apart; also the flights should avoid early morning and late evening so as to minimise the amount of shadows which, if excessive, may make crop identification difficult. Finally, the use of telephoto photography while necessary for identifying crop types, severely limits the sample intensity, so that a compromise may be desirable between photographic resolution and sample coverage.

This photographic technique has the potential for being used to estimate tree cover and even standing timber volumes, if a degree of ground truthing is available to first link crown measurements with timber volume. This possibility has been treated in detail by Keppel Palmer, Speight and Wint (forthcoming).

A major area of recent development has been the visual presentation of the survey results. The recent reports have contained computer generated distribution maps, in which relative population densities are represented by proportional symbols, calculated directly from a rectangular summary of the survey data set. ILCA and RIM have collaborated in the production of a software package for the entry, analysis and mapping of survey data, using the HP150 computer (ILCA-RIM, 1986). Data entry is by means of a suite of menu-driven dBaseII programmes, with options for determining observer bias, data validation and checking for errors. The information is then summarized on a grid by grid basis for use by the analysis and mapping component, which is derived from MAPICS.

Statistical analyses of these data are performed primarily using the Minitab packages, and currently consist of fairly simple treatments. A review of statistical procedures used in the analysis of ILCA/RIM aerial survey data has recently been completed by Marriott and Wint (1985).

As the West African Aerial Survey Programme has progressed, it has become increasingly evident that a considerable amount of the potential value of air surveys has remained unexploited because of the lack of adequate complementary and integrated information from the ground. Such information, if collected at the same time as the aerial estimates, has proved invaluable, not only to explain specific or apparently anomalous local distribution patterns, but also to validate any interpretations of the aerial surveys. For example, is a fall in cattle numbers within a particular locality the result of mortality, seasonal or longer term emigration, or merely the departure of temporary immigrants?

The potential value of ground investigations that are fully integrated with preceding aerial surveys has been demonstrated by the southern Gongola Livestock and Land Use survey (RIM, 1984). In this study, the primary locations for ground studies were first identified by an aerial survey, thus reducing the amount of time and manpower needed to adequately cover the major sites of cattle concentration. Once targetted, the ground team then collected a wide range of information covering husbandry techniques; herd structures, large and small livestock ownership patterns, offtake and mortality figures; details of the constraints acting upon local livestock production, as perceived by the pastoralists themselves; and the stock-owners opinions of the acceptability of the available development interventions. From these it was possible to formulate a range of possible development options specific both to the study area as a whole, and to sub-sections of it, that were designed to promote livestock production.

The data collected on the ground were then re-integrated with the numerical estimates and distribution patterns obtained from the aerial

survey to provide a wide variety of information that was not available from either survey alone. Some examples are: the size of the target livestock populations potentially susceptible to each development options; the possible locations for specific development interventions based on the environmental, sociological and demographic characteristics of each sample grid cell; the overall size and distribution of livestock populations that could not be counted from the air, such as goats; macro-economic descriptions of the livestock sector within the survey area, based on stock prices and numbers.

The integration of air and ground surveys thus allows for the much wider use of the otherwise purely numerical information collected from the air, particularly in relation to the identification, targetting and evaluation of possible development options over a large geographical area. Such information provides an invaluable basis for the process of project identification and appraisal, and can also be used as baseline data for subsequent monitoring and evaluation.

2.3 Results

Detailed information for each of the survey sites has already been published and so, rather than reiterating these, the following section summarizes the available information and describes some of the large scale (as opposed to local) trends that can be identified on a nationwide, regional and intraregional basis. The presentation is not necessarily in chronological order.

A summary of the data collected is given in Tables 3a, b & c. The figures have been abstracted from the published reports, and augmented by additional unpublished data. The evolution of survey techniques since 1979 means that fully comparable data are not available from all the sites. For example, in 1979, the arable farmer population was measured in terms of the number of compounds, rather than the number of dwellings that was used from 1983 onwards. Thus, there effectively are gaps in the data, and so an equivalent level of analysis and interpretation has not been possible for all the areas.

The survey results have been examined using the site means for selected parameters, in order to investigate overall relationships between them. Two forms of analyses have been used: univariate regression, in which the association between a dependent variable and the other parameters are examined one at a time; and multivariate stepwise regression, in which the relationship between a dependent variable and a range of intercorrelated parameters is examined in a single analysis. The multivariate analysis allows for the isolation of the strongest relationship, and then having taken into account the correlation between the primary predictor and the other independent parameters, progressively examines the relationships between the dependent variable and the remaining variables.

Because of the acknowledged gaps in the data, the multiple regressions have been performed on a subset of the data, including only sites for which all the necessary figures are available - predominantly those surveyed in 1983 and 1984. Also southern Gongola has been divided

TABLE 2. CATTLE AND HERD ESTIMATES FOR THE NIGERIAN SUBHUMID ZONE, DERIVED FROM LOW INTENSITY, LOW LEVEL AERIAL SURVEYS AND HIGH INTENSITY LOW LEVEL AERIAL SURVEYS.

	LOW INTENSITY *		HIGH INTENSITY**		HIGH INTENSITY *	
	Dry season.	Wet Season.	Dry	Wet	Dry	Wet
Area of Subhumid Zone km^{-2}.	455,500					
Area Surveyed km^{-2}.	356,510		80,350		66,575	
Sample Intensity %.	1.4	1.3	5 - 14.2			
Date of Survey.	March 1982	July 1982	1980 - 1984		1982 - 1984	
Mean Cattle Density km^{-2}.	10.25	9.44	14.56	20.23	12.86	13.7
(% Standard Error)	(11%)	(16%)				
Estimated Number of Cattle.						
In Area Surveyed.	3,654,200	3,365,500	1,169,900	1,625,500	856,200	913,300
In Subhumid Zone.	4,668,900	4,299,900	6,632,000	9,214,900	5,858,000	6,249,000
Mean Herd Size.	55	68	41	48	43.1	45.7

* Excluding the Jos and Mambila Plateaux
** Including the Jos and Mambila Plateaux

TABLE 3a. SUMMARY OF LIVESTOCK, LAND USE AND HUMAN POPULATIONS, 1979 - 84.

SURVEY			LIVESTOCK			HUMAN HABITATION					ENVIRONMENT			
SITE	YR	SN	PER SQ KM CAT	PER SQ KM GU	GU SIZE	PER SQ KM PAST	PER SQ KM ARAB	% SET	% AP	% NOM	% CU	% DR	VEG DEN	AREA
Kurmin Biri	79	D	17.7	0.34	51.4	0.4					15	35		2500
		W	4.2	0.07	58.0									
	84	D	7.9	0.20	37.0	0.3	7.6	64	17	19	11	73	145.7	
		W	9.9	0.17	58.0	0.8		100	0	0	14		145.7	
Abet	79	D	37.4	0.78	47.8	2.5					24	57		2475
		W	22.7	0.36	61.0									
	84	D	33	0.69	48	1.1	26.2	82	10	8	20	44	86.0	
		W	31.8	0.61	52.1	2.2		97	3	0	25		86.0	
Gana-wuri	84	D	24.3	0.71	34	1.7	32.1	73	25	2	33	33	48.5	800
		W	29.1	0.81	36	1.0		100	0	0	26		48.5	
Pambe-guwa	84	D	18.2	0.43	42	1.7	14.2	52	0	48	25	81	87.0	3000
		W	16.6	0.43	38	2.2		100	0	0	18		87.0	
Giwa-NAPRI	84	D	24.4	0.76	32	1.2		50	0	50	23	88		3350
		W	31.4	0.62	50	1.3		99	1	0	20			

YR = Year. SN = Season. CAT = Cattle. GU = Grazing Unit. PAST = Pastoralist ARAB = Arable. SET = Settled. AP = Agropastoral. NOM = Nomadic. CU = Cultivation. DR = Dry season grids without water. VEG DEN = Vegetation density index.

TABLE 3b. SUMMARY OF LIVESTOCK, LAND USE AND HUMAN POPULATIONS, 1979 - 84.

SURVEY			LIVESTOCK			HUMAN HABITATION					ENVIRONMENT			
			PER SQ KM		GU	PER SQ KM		%	%	%	%	%	VEG	
SITE	YR	SN	CAT	GU	SIZE	PAST	ARAB	SET	AP	NOM	CU	DR	DEN	AREA
Mariga	79	D	6.6	0.27	24.6	1.4					13	70		2750
		W	23.5	0.44	53									
	84	D	9.4	0.34	27	1.0	8.7	59	17	24	10	61	125.9	
		W	22.0	0.47	46	1.6		76	22	2	12		125.9	
Tegina	84	D	19.4	0.41	47	2.3	9.9	46	45	9	8	60	122.5	3250
		W	20	0.54	37	1.1		75	19	6	12		122.5	
Funa-Funa	84	D	2.9	0.09	31	0.2	9.6	29	71	0	8	80	127.4	750
		W	3.8	0.12	31	0.2		100	0	0	10		127.4	
Lafia SE	79	D	12.7	0.21	59	1.0					12			2325
		W	37.7	0.43	86									
Lafia NE	82	D	16.4	0.21	75	1.0	16.8				30			
	84	W	22.9	0.33	70	1.1	14.6	95	3	2	24		144.0	2300
Jos	80	D	16.4	0.34	48.7									
		W	46.7	0.66	70.4									
Sorau	84	D	5.7	0.19	29.7	0.6	20.0	54	26	10	7	90	170.1	1325
	83	W	11.2	0.35	32.3	0.8		28	26	46			170.1	
Garkida	84	D	5.4	0.16	35.9	0.4	10.1	88	0	12	6	86	170.4	1600
	83	W	12.0	0.37	32.1	0.6		89	0	11			170.4	
Wawa	84	D	7.2	0.32	22.3	1.4	11.8	82	12	6	10	95	167.0	3750
Zangi	84	W	10.6	0.31	35.0	2.0		55	21	24			167.0	3750

YR = Year. SN = Season. CAT = Cattle. GU = Grazing Unit. PAST = Pastoralist ARAB = Arable. SET = Settled. AP = Agropastoral. NOM = Nomadic. CU = Cultivation. DR = Dry season grids without water. VEG DEN = Vegetation density index.

TABLE 3c. SUMMARY OF LIVESTOCK, LAND USE AND HUMAN POPULATIONS, 1979 - 84.

SURVEY			LIVESTOCK			HUMAN HABITATION					ENVIRONMENT			
			PER SQ KM		GU	PER SQ KM		%	%	%	%	%	VEG	
SITE	YR	SN	CAT	GU	SIZE	PAST	ARAB	SET	AP	NOM	CU	DR	DEN	AREA
All sites are 30 km radii centred on Livestock Development Foci* within southern Gongola State														
Ganye	84	D	9.5	0.28	33	1.1	37.1	3	96	1	10	52	168.6	2850
	83	W	21.0	0.62	33.7	0.8		23	60	17			168.6	
Bali i	84	D	8.5	0.28	19.7	0.4	10.2	89	0	11	3	65	207.9	2850
	83	W	5.5	0.09	92.4	0.4		98	0	2			207.9	
Sabon Gida	84	D	27.4	0.40	68.4	0.8	10.9	87	0	13	6	73	161.4	2850
	83	W	24.8	0.25	100.6	0.6		31	0	69			161.4	
Mara-raba	84	D	9.3	0.14	68.1	0.3	13.5	71	3	26	4	57	213.8	2850
	83	W	19.4	0.22	86.1	0.8		43	2	55			213.8	
Nguroje	84	D	38.0	1.17	32.6	3.2	29.8	46	64	0	10	6	97.8	2850
	83	W	64.7	1.66	39.1	1.9		49	51	0			97.8	
Mbamnga	84	D	48.4	1.68	28.7	3.7	25.7	31	69	0	13	10	16.1	2850
	83	W	79.5	1.91	41.5	2.0		45	55	0			16.1	

YR = Year. SN = Season. CAT = Cattle. GU = Grazing Unit. PAST = Pastoralist ARAB = Arable. SET = Settled. AP = Agropastoral. NOM = Nomadic. CU = Cultivation. DR = Dry season grids without water. VEG DEN = Vegetation density index.

* Livestock Development Foci as described in text.

into a series of 30 kilometer diameter circles (Livestock Development Foci as defined in Section 3.8 below), the areas of which are more nearly equivalent to those of the case study areas in the central corridor. Despite this, the sample size remains sufficient to produce meaningful indicators of zonal trends, and covers the whole geographical and ecological range of the full data set.

2.3.1 Environmental Variables

Three environmental parameters were consistently recorded, in all but the earliest surveys - percentage cultivation, vegetation density and dry season water availability.

Water

It is a truism to state that water availability varies with geographical region within Nigeria. However, the available data allow some more meaningful statements to be made, particularly with respect to the availability of dry season water. In Table 3 this has been expressed as the percentage of grid cells that did not contain substantial sources of surface water during the dry season.

In total, during the 1984 dry season, while just over half of the grid cells (52%) were waterless in southern Gongola, 63 to 71% of those in the central corridor survey zones contained no visible open water, and 92% were dry in the grazing reserve areas in northern Gongola and neighbouring parts of Bauchi State (Table 3 and Map III). Only in this last group of surveyed areas was any point further than 20 kilometers - equivalent to a days' trek - from open water during the dry season.

Within these regions, however, there proved to be considerable variability. In southern Gongola, most of the lowland sites considered contained 62-75% dry grid squares, whilst on the southern uplands, 80 - 90% of the grids held some open water throughout the year. In the survey sites in the central corridor, the proportion of dry grids ranged from 33 - 88%, Ganawuri and Abet being conspicuously well watered, and the two most northern study areas (Giwa and Pambeguwa) being the driest. In the other sites, between 60 and 80% of the grids contained no surface water during the dry season.

Perhaps surprisingly, given the recent drought in northern Kaduna, the mean percentage of waterless grids during the dry season differed little between 1979 and 1984, at 55 and 59% respectively. Examined separately, Abet and Mariga were slightly wetter in 1984, but Kurmin Biri was considerably drier.

Cultivation

Mean total cultivation levels, that is the percentage of land within the current cropping cycle, appear to vary in a fairly predictable fashion, given the general hypothesis that the central portion of Nigerian SHZ is more heavily utilised by arable farmers than its eastern quadrant (Tables 3 & 4 and Map IV). In the first of these,

high intensity aerial survey estimates a mean cultivation intensity of 17.5%, as compared to 7.6% in the second. This reflects the fact that much of the cultivation in eastern Nigeria is of relatively limited extent, often occuring as concentrated pockets around towns and larger villages, or as narrow ribons along major roads, with large tracts of land contain no cultivation whatsoever. The low intensity survey reveals a very similar pattern. On an east to west axis, cultivation intensity is at its lowest in the margins of the country, and reaches a peak to the east of a line from Kaduna to Makurdi. With respect to a north/south axis, the northern and southern boundaries of the SHZ are substantially more cultivated than is its core.

Average cultivation levels in the eastern survey zones of Gongola and the nearby grazing reserves ranged from 2-14%, while in the central region of the country, equivalent values ranged from 8-33% (Table 4).

The most heavily cultivated survey zones were Ganawuri and Lafia NE, though Pambeguwa and Abet were also comparatively densely cropped. In the remaining sites, mean cultivation levels were estimated at between 8 and 13%. The study areas to the north, east and south east of Kaduna supported 20 to 25% cultivation, but those to the south west only 8.8%. A comparison of the 1979 and 1984 cultivation estimates indicate that the relative cropping levels in each of the case study areas has remained consistent, and do not appear to have changed significantly.

Vegetation density

The overall patterns in vegetation within Nigeria have in the past been relatively well mapped (e.g Federal Department of Forestry, 1976). However, vegetation types frequently have a very patchy distribution, and are subject to considerable modification over time. It has been found useful, therefore, to establish a current measure of vegetation density, which can be related to livestock and human population levels. The index used is based on the proportion of grassland, light and heavily wooded savannah, and closed canopy forest estimated to be present within each aerial survey grid cell.

The information from which the vegetation density index is calculated is available only for those surveys completed after 1982, i.e the ILCA case study areas, the grazing reserves in Gongola and Bauchi, and southern Gongola State. The index ranges from 0 to 500. The higher the value, the denser the vegetation cover. A value of 0 represents open grassland, while 500 depicts closed canopy forest.

As might be expected, the calculated vegetation density index varied widely between sites (Table 3 and Map III). Much of southern Gongola, particularly the south, was densely forested, and the majority of the remainder was wooded to a greater or lesser extent. Only the upland plateaux in the extreme south, and in the lowlands, the flood plains alongside the major rivers were prominently open grassland. In Ganawuri, Abet and Pambeguwa, the vegetation cover was light, being largely grassland or lightly wooded savannah. Heavily wooded savannah was the most widespread vegetation category in Kurmin Biri and Lafia, and in the three sites to the south and west of Kaduna - Tegina,

Mariga and Funa Funa - lightly wooded savanna was the predominant vegetation type. All three grazing reserve areas in the Semi-Arid zone were largely covered by moderately, and at times, heavily wooded savannah.

2.3.2 Cattle Densities and Distributions

2.3.2.1 Large scale - Zonal

The size and distribution of Nigeria's cattle population has long been a subject of debate and informed guesswork. Various population estimates have been derived on the basis of cattle tax (Jangali) returns; off-take rates; hide and skin exports; trade cattle passing from the north to southern markets; and vaccination returns. The accuracy of the estimates obtained of course depends on the validity of the underlying assumptions: the degree of tax evasion; the measure of herd productivity; the proportion of animals imported into, or exported from the country; and the efficiency of the vaccination programmes. Nevertheless, despite the inherent uncertainty, it is generally believed that Nigeria's present cattle population is 9 - 15 million, the vast majority of which are of the humped Zebu type and owned by the FulBe people.

Estimates of the cattle population supported by the Nigerian SHZ have been particularly uncertain. Until the low intensity survey of the SHZ was completed in 1983, answers to the fundamental questions: 'How many cattle are there?' and 'Where are they to be found?' remained largely a matter of conjecture and speculation.

No significant difference was found between overall seasonal cattle populations estimated by the low intensity survey (Table 2). For the area surveyed they ranged from 3.4 million head in the wet season to 3.7 million head in the dry season, equivalent to a total of between 4.3 and 4.7 million head for the Nigerian Subhumid Zone as a whole. The dry season estimate of 10.3 animals per square kilometer was only 8% higher than the wet season value of 9.4 animals per square kilometer. Thus, no major dry season influx of cattle was detected, and net seasonal cattle movement into and out of the zone appeared to be approximately in balance. This would indicate either, that seasonal immigration is more or less equal to emigration; or, as seems more likely, that, most seasonal cattle movements are on relatively modest scale and take place largely within the Subhumid Zone. This is supported by the evidence collected in southern Gongola, as well as in the ILCA case study areas of the central corridor, where many of the livestock were moved relatively short distances, rather than on long range transhumance.

The results gleaned from this low intensity survey can be compared with the amalgamated figures from all the regional surveys completed between 1982 and 1984, which covered a total of 80,350 square kilometers, or approximately 17.5% of the Subhumid zone, at a sample intensity of ranging from 5-14%. These regional estimates also suggest that there is a substantial permanent cattle population within the SHZ, but that the dry season density is rather lower, at 14.6 animals

per square kilometer, than that of the wet season, at 20.4 per square kilometer. In contrast to those of the low intensity survey, these figures indicate that there is a considerable seasonal influx of cattle into part or all of the SHZ during the wet season, and that the overall densities are somewhat higher than those suggested by the low intensity survey alone.

However this discrepancy between the two sets of figures should be interpreted with caution. Firstly, it should be remembered that substantial numbers of cattle were lost to rinderpest between the 1983 wet season and following dry season. Further, many of the stock owners, at least in southern Gongola, stated that they remained in the region during the wet season, despite the increased risk of trypanosomiasis, in order to avoid the rinderpest epidemic further to the north. If these were zone-wide phenomena, then the wet season cattle populations were likely to have been abnormally high, and the dry season one abnormally low.

Also, and perhaps most importantly, the regional amalgamations are based on a non-random sample and include the Mambila and Jos Plateaux. Both these areas support higher than average livestock populations, especially during the wet season, when average densities may exceed 70 head per square kilometer. If these upland grasslands are excluded, then the seasonal differences shown by the regional amalgamation figures are minimal, (some 6%), though the overall density remains some 30% higher than that suggested by the low intensity survey.

Thus, there is an indication that the total cattle population of the SHZ in 1984 may have be somewhat higher than initially put forward by Bourn and Milligan (1984) for the previous year, with perhaps as many as 6.25 million in the dry season, and 7.0 million in the wet season. This amounts to a half of the estimated national cattle herd, if the total figure of 10 - 15 million is accepted.

This apparent increase, in the face of the rinderpest epidemic, is unlikely to be a result of a natural reproduction in the resident cattle population, but may represent a particularly large influx of cattle from the overpopulated and drought stricken zones to the north during 1984. Such an hypothesis would certainly explain the anomalous presence of Sokoto Gudali in the heavily forested regions of southern Gongola.

Even these larger figures only represent densities of 13.7 to 15.4 cattle per square kilometer, which, at 6.5 - 7.5 hectares per head, is well below the potential year round carrying capacity of the SHZ. At first sight, this argues that there is considerable room for expansion in the cattle herd of the Nigerian SHZ. However, as stated in RIM (1984c) much of the land is unavailable to livestock because of competing pressures of arable farming, urban expansion, forestry and so on. Also, taking southern Gongola State as a perhaps somewhat extreme example, as much as 32% of the available land area is unsuitable for cattle because the land is too steep, or the vegetation density is too dense.

While other parts of the SHZ may not contain as much dissected or forested land as does southern Gongola, they are more heavily populated by both rural and urban people, cultivation levels are generally higher, and, unlike southern Gongola, substantial areas may lack sufficient water to support year round cattle populations. Thus, it is arguable that perhaps an equally large proportion of the land area may be unsuited to cattle, even if it is assumed that the areas which are suited to cattle change to some extent with season.

If so then the effective zonal cattle densities are some 30% higher than the initial figures suggest, i.e 18 to 20 head per square kilometer. If the year round carrying capacity of the SHZ is taken as 2 - 3 hectares per head, as can be inferred from de Leeuw's estimates in Putt et al (1980), then this figure would still allow for a rise of 50 - 100% in the present cattle population within the Subhumid Zone as a whole. Any increase would, of course, have to be accommodated in those areas which are presently understocked, rather than those which are already showing signs of overgrazing.

Whilst such a potential may not be as great as frequently assumed heretofor, it undoubtedly represents a substantial increase on existing levels. Nevertheless it is important to bear in mind that there are finite limits to population growth, and that in the long term greater meat production must ultimately depend on improving the productivity of livestock populations, rather than increasing their number.

2.3.2.2 Regional

The contrasting patterns of wet and dry season cattle distribution over the Subhumid Zone, as estimated by the low intensity survey, are represented by the three dimensional surfaces shown in Figure 1, in which cattle density is indicated by apparent height.

Caution should be exercised when interpreting these surfaces, as the coordinates of the Subhumid Zone have been transformed in order to make the information amenable to three dimensional computer analysis. Effectively the east-west dimension has been foreshortened, and the north-south dimension has been equilibrated, so that the whole of the Nigerian Subhumid Zone is represented by a square. However, as an aid to orientation and better understanding, the course of the Benue and Niger rivers, and the location of major towns have been indicated.

These illustrations clearly show the dynamic nature of seasonal cattle distribution within the SHZ. Although cattle are found throughout the zone, their overall distribution is far from uniform, and shows a generally clumped pattern, especially during the wet season. In the dry season (upper surface, Figure 1) cattle distribution is more widespread, with higher densities found to the east and north-east, and lower densities to the south-east and along the southern, western and most of the northern boundaries.

In contrast, wet season cattle distribution (lower surface, Figure 1) appears to be generally more restricted and concentrated within a broad central region to the north of the the Niger and Benue rivers.

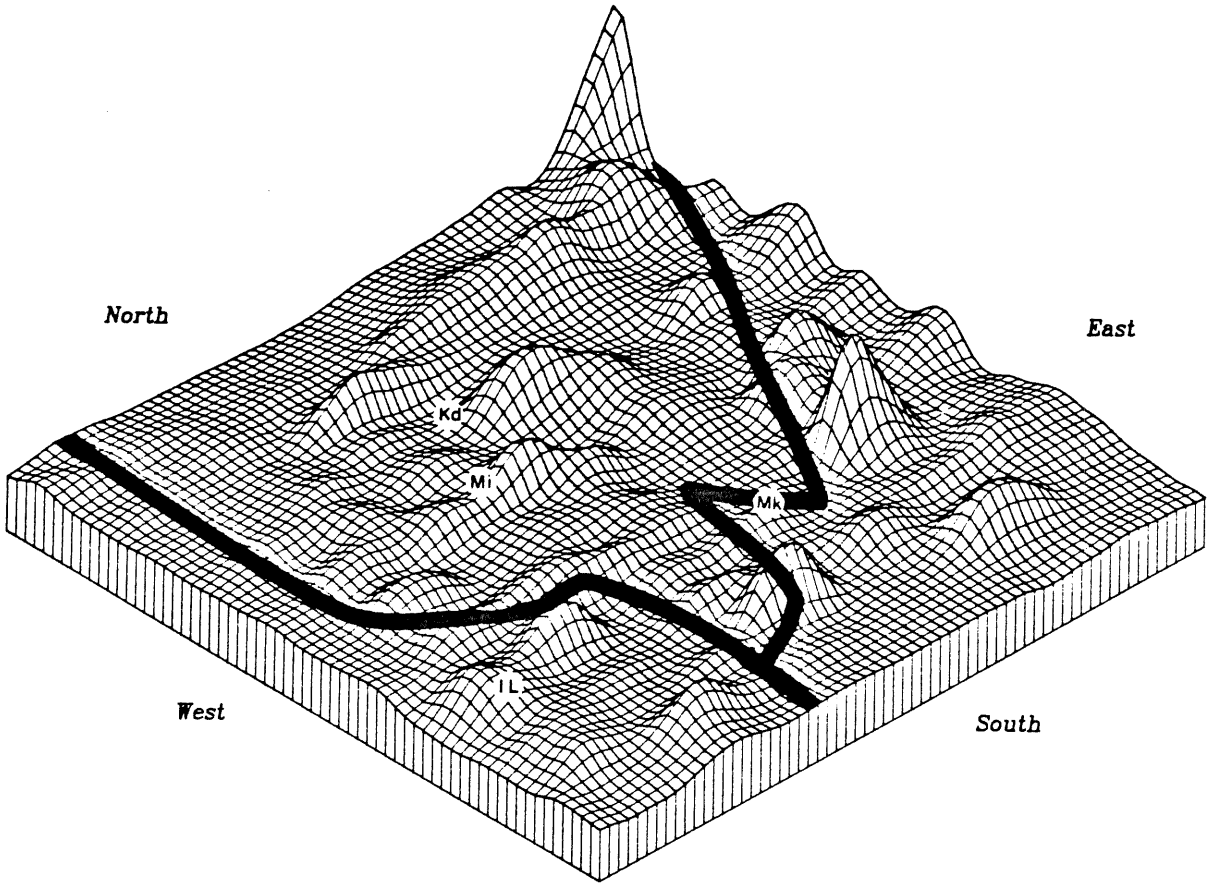
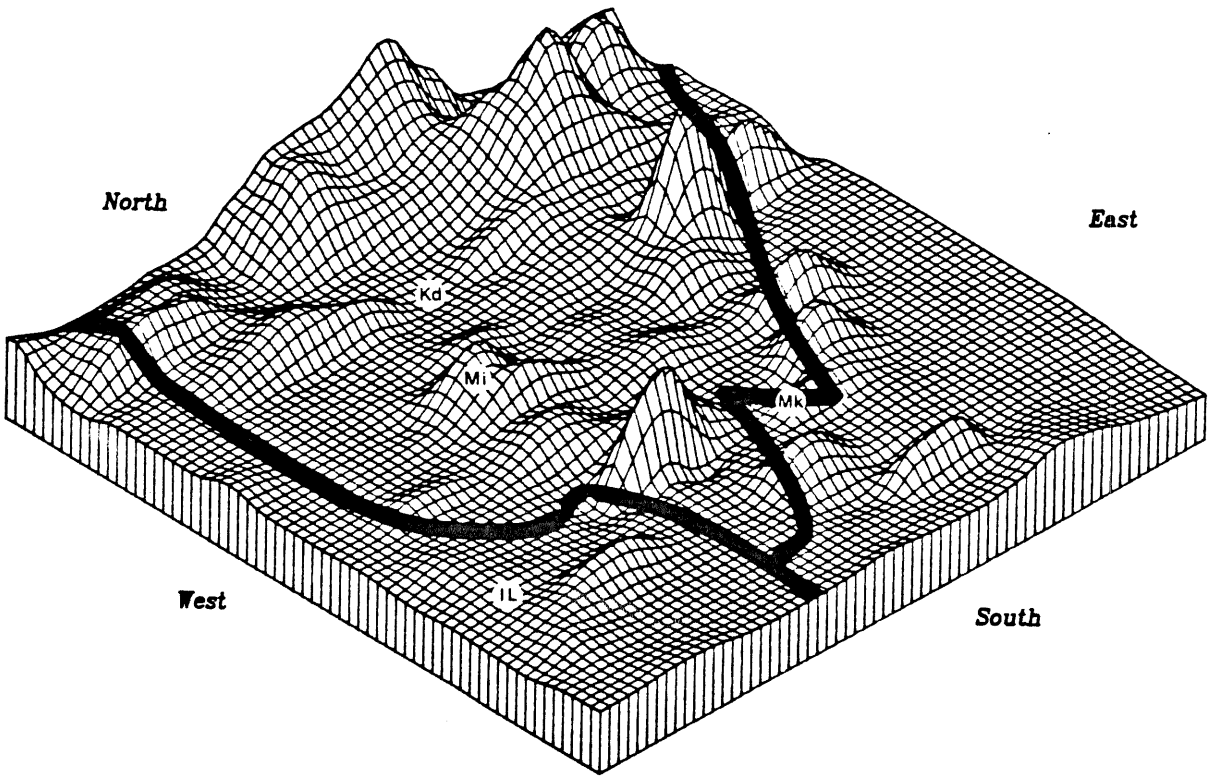


FIGURE 1: WET AND DRY SEASON SUB-HUMID ZONE CATTLE DISTRIBUTION.



The highest densities occur on the northern boundary of the Subhumid Zone, with a progressive decrease in density further south, particularly to the south west and the south-east. In more southerly latitude dry season cattle density exceeds that found in the wet season, whilst in more northerly parts of the zone the reverse is the case. Only in the extreme east of the Subhumid Zone is there any indication of substantial cattle immigration during the dry season.

The regional summaries (Table 4 and Map V) also allow for further direct comparison of cattle densities in the different parts of the SHZ. As indicated above, the highlands of Jos and Mambila consistently support high densities of cattle throughout the year, totalling between about 25% and 40% of the entire population recorded, depending on season, in just 22% of the area surveyed. The wet season populations are between 1.81 (Mambila) and 2.85 (Jos) times those found in the dry season.

Similarly, the survey zones in the "central corridor" of the SHZ - i.e the area defined by Bourn and Milligan (1984) as being associated with the major north/south commercial and historical axis of Nigeria - supports cattle densities some 1.5 times that of the eastern lowlands as represented by southern Gongola State. However, the estimated seasonal variation in livestock populations between these two sections of the country are closely comparable - in both, the wet season densities are 15 to 20 % higher than the dry season ones.

Thus any major increase in the current cattle populations of the Subhumid zone would have to be accommodated in areas other than the central corridor and the heavily stocked uplands of Jos and Mambila, as suggested by Bourn and Milligan (1984) and Milligan et al (1984) in their model for the dynamics of cattle distribution in the Sub Humid Zone.

Another contrast between the central and eastern sites that is evident from the high intensity survey concerns the types of cattle that were recorded. Two major types were differentiated: red or Rahaji Zebu; and white Zebu. It was very noticeable that the red cattle were largely limited to those areas that are likely to be most favourable for cattle production, i.e the Mambila uplands or the lowland floodplains in the well watered regions to the east of the country, where dry season condition are likely to impose the least stress on cattle condition, and where pasture is relatively abundant. This finding is in full accordance with the results gathered by RIM's ground survey team, and with the qualities accorded to the two breeds by the FulBe pastoralists, which suggest that the white Zebu are more suited to marginal conditions than are their red counterparts.

2.3.2.3 Intra Regional

The central corridor 1982-4

Within the central corridor, the highest cattle densities were found in Abet, neighbouring Ganawuri, and in Giwa. This was the case in both wet and dry seasons. The lowest cattle densities were recorded in

TABLE 4. SUMMARY OF REGIONAL CATTLE AND HUMAN POPULATION, AND SELECTED ENVIRONMENTAL PARAMETERS

SITES**	SN	CATT/ SQ.KM	GU SIZE	PAST/ SQ.KM	ARAB/ SQ:KM	CATT/ PAST	CATT/ ARAB	PAST/ ARAB	% CULT	% DRY
1982 - 1984 SURVEYS										
CENTRAL CORRIDOR										
GROUP 1	DRY	19.95	43	1.14	17.35	17.48	1.14	0.065	20.33	64
	WET	20.11	45	1.70		11.82	1.16	0.098		
GROUP 1 + LAFIA										
	DRY	19.21	46.5	1.11	16.75	17.28	1.15	0.066	21.1	N/A
	WET	20.64	49.3	1.58		13.05	1.23	0.094		
GROUP 1 + Giwa-NAPRI										
	DRY	21.17	38.7	1.15	N/A	18.37	N/A	N/A	21.1	71
	WET	23.23	47.2	1.59		14.66				
GROUP 2	DRY	13.89	39.1	1.57	9.36	8.84	1.48	0.168	8.8	63
	WET	19.07	40.7	1.2		15.91	2.04	0.128		
GROUPS 1+2 + LAFIA										
	DRY	17.19	44	1.28	13.95	13.38	1.23	0.092	16.4	
	WET	20.04	46	1.44		13.96	1.44	0.103		
THE EASTERN REGIONS										
GROUP 3	DRY	6.47	25.3	0.94	13.01	6.85	0.50	0.073	8.4	92
	WET	11.04	33.7	1.42		7.74	0.85	0.109		
GROUP 4	DRY	13.6	41	0.69	12.1	19.12	1.13	0.059	7.5	52
	WET	15.7	43	0.88		17.84	1.3	0.073		
GROUP 3 +4										
	DRY	12.65	39.5	0.74	12.15	17.06	1.04	0.61	7.6	57
	WET	15.04	42.3	0.95		15.84	1.24	0.078		

** Sites grouped as follows: GROUP 1 = Kurmin Biri, Abet, Ganawuri, Pambeguwa.
GROUP 2 = Mariga, Tegina, Funa Funa.
GROUP 3 = Sorau, Garkida, Wawa Zangi.
GROUP 4 = southern Gongola State.

Sn = Season CATT = Cattle GU = Grazing Unit PAST = Pastoralist Dwelling ARAB = Arable Dwelling CULT = Cultivation DRY = Gridcells without open water during the dry season

Kurmin Biri and Funa Funa, irrespective of season, and in Mariga during the dry season only.

It is therefore possible to differentiate these survey areas into two broad groups: those to the north and south east of Kaduna, which constitute the majority of the sites; and those to the south and west of Kaduna, near Minna. The former are characterised by relatively high cattle densities, in the region of 16 - 24 per square kilometer (range 7.9 - 33) which, with the exception of Lafia, vary little between the wet and dry seasons. The latter group support rather fewer cattle, a mean of 14 - 19 (range 2.9 - 22) per square kilometer, and support an average of 40% more cattle in the wet season than in the dry season.

Seasonal changes in overall cattle densities were evident in only some of the sites surveyed during 1984 - Lafia North East, Giwa and Mariga (i.e one site in each of the geographical groupings defined above) - and in all of these, the wet season densities were substantially higher than the dry season ones. This probably reflects a general northward movement of pastoralists and their cattle as they return to their family homes from the dry season pastures along the Benue and Niger rivers to the south.

This suggests that Abet, Kurmin Biri, Ganawuri, Pambeguwa and Tegina hold a stable, and often large cattle population throughout the year, whilst Lafia, Giwa, and Mariga, are pre-eminently wet season pastures, though only Mariga does not support a significant dry season cattle presence.

The seasonal changes in cattle distributions (as distinct from densities) within these central corridor sites can be divided into two categories. In Kurmin Biri and Ganawuri, little difference was evident, and even in Giwa and Mariga, where the wet season density was rather higher than the dry season figure, the overall pattern of cattle distribution changed little between seasons. In Abet, Funa Funa and Pambeguwa, on the other hand, the the centres of cattle concentration varied between wet and dry seasons. In Abet, a general move to the east was evident after the dry season, while in Funa Funa and Pambeguwa, the wet season cattle concentrations were further to the north than in the preceding dry season.

The eastern regions

In southern Gongola State as a whole, overall cattle densities were also comparatively stable through the year, as in the first mentioned group of sites in the central corridor, and the stocking rates were relatively low. These overall figures, however, belie a considerable amount of variation, both in terms of density and distribution. This is compounded by the fact that ground investigations demonstrated that much of the cattle owners' seasonal transhumance in this region are internal to it, rather than involving immigration or emigration per se. These short distance seasonal movements make it possible to define a series of cattle systems within the southern Gongola region, each of which support characteristic and more or less self contained livestock production systems (Map VI). The livestock populations of these areas is shown in Table 5, as a simple example of the integration of the results gathered from complimentary ground and air surveys.

TABLE 5. ABUNDANCE AND DENSITIES OF LIVESTOCK IN SOUTHERN GONGOLA, BY CATTLE SYSTEM**.

Cattle System		Cattle No.	Cattle /sq km	Cattle % White	Goats* No.	Goats* /sq km	Sheep No.	Sheep /sq km
Ganye I	Wet	34800	16.4	83			1300	0.6
	Dry	33100	15.6	82	237200	111.6	2200	1.0
Shebshi III	Wet	37700	8.6	85			1000	0.2
	Dry	9700	2.2	83	40700	9.3	1100	0.2
Mambila II	Wet	301800	67.4	15			7700	1.7
	Dry	167200	37.4	12	99400	22.2	21000	4.7
Fali IV	Wet	11100	9.0	100			300	0.3
	Dry	5600	4.6	92	700	0.6	700	0.6
Falinga V	Wet	8600	4.5	54			300	0.2
	Dry	7100	3.7	40	0	0	1600	0.8
Kam/Serti	Wet	5500	2.1	85			200	0.5
VIII/XII	Dry	11400	4.3	77	45000	17.1	500	0.2
Wase-Jalingo	Wet	79600	11.3	85			1100	0.2
VI	Dry	185800	26.3	94	97700	13.8	22800	3.2
Suntai VII	Wet	125200	21.6	81			1700	0.3
	Dry	106300	18.3	97	203100	35.0	10500	1.8
Takum IX	Wet	29200	32.5	91			400	0.4
	Dry	18800	20.9	96	64200	71.3	2000	2.2
Wukari X	Wet	3200	27.1	100			40	0.3
	Dry	20800	166.3	99+	26400	210.9	2300	18.1
Development Region***								
Ganye	Wet	72500	11.1	79			2300	0.4
Lowlands	Dry	42900	6.6	82	278000	42.6	3200	0.5
Southern	Wet	325200	34.0	20			8300	0.8
Uplands	Dry	184300	19.3	17	107300	11.2	23400	2.4
Benue	Wet	239000	16.4	84			3300	0.2
Lowlands	Dry	338700	23.2	95	429300	29.4	37900	2.6

* Goats densities assumed to be aseasonal (see text).
** Cattle system as described in text.
*** Development Region:- geographical grouping of cattle systems as described fully in RIM (1984c).

Broadly speaking, the cattle in southern Gongola are concentrated in three geographical blocks, regardless of season; the Mambila plateau and its associated uplands in the south; the Ganye lowlands to the north east, and the extensive savanna woodlands of the Benue lowlands to the north west. In the dry season, many of the cattle native to the Mambila are moved into the lowlands to the north, and those that are already in the lowlands are moved closer to the river flood plains to the north or west. There is also an influx to the Benue floodplains from the north, but this is probably matched, at least in 1984, by the number of cattle leaving the survey zone for the Cameroun grasslands, and the large scale, rinderpest-induced sales to the markets of Igboland.

2.3.2.4 Grazing Unit Size

Although only minor seasonal differences were found in the estimated size and density of the Subhumid Zone cattle population during the low intensity survey, a substantial 25% difference in mean GU size was detected (Table 2). Mean GU size in the dry season was 55, whilst in the wet season it increased to 68 animals per GU. This resulted in a marked fall in the estimated number of GUs in the surveyed area from 66,000 in the dry season to 49,000 in the wet season, or 85,000 and 63,000 respectively, for the Subhumid Zone as a whole. In terms of overall GU density this amounted to a decline from 18 to 14 GUs per hundred square kilometers. Such seasonal changes in mean GU size have been detected in other aerial surveys within the Subhumid Zone (Milligan et al., 1979). They are largely due to the FulBe management practice of herd splitting during the dry season period (Okali and Milligan, 1980), so as to minimise the trampling of crops, and which reflects the fact that some of the cattle are not taken on transhumance.

The amalgamated results of the high intensity surveys suggest a rather different picture which, as with cattle densities, may reflect a sampling bias rather than conflicting evidence. Overall results indicate that the mean grazing unit size in the SHZ is only slightly higher in the wet season than in the dry season, and falls in the range of 40 - 45.

On a regional basis (Table 4), the estimated mean grazing unit sizes are more or less uniform, at 40 - 46, in all the sites except the more southerly central survey zones of Jos and Lafia, where they reach 70 the wet season and range from 49 (Jos) to 75 (Lafia) in the dry season.

It should be remembered that the mean values for grazing unit size may conceal considerable variation. This is well illustrated by the figures for different areas within southern Gongola State, where the mean GU in the wet season is 43, but varies from 25 near Jalingo in the north to 101 around nearby Sabon Gida, and 39 at Nguroje on the Mambila Plateau (Table 3). In all the separate localities within southern Gongola, the wet season grazing units were equal to or considerably larger than the dry season ones, which strongly supports

Moreover, it was evident from the studies in southern Gongola that GU size was related to the production system in which they were kept. In general, the nomadic FulBe both own larger herds, and manage them in bigger groups than do the sedentary pastoral peoples.

A comparison of the 1979 and 1984 surveys of Abet, Kurmin Biri and Mariga reveals that little significant change in grazing unit size has occurred in these areas during the past six years. Wet season grazing units have remained 25 - 30% larger than their dry season counterparts, and overall sizes have declined by some 5-6%. This constancy is to be expected, given that the major determinants (see section 2.1.2.6) of GU size are unlikely to change from one year to the next.

2.3.2.5 Grazing Reserves

In a number of instances, aerial surveys have been either commissioned specifically to evaluate the potential and current utilisation of grazing reserves, or the results collected during larger scale surveys have been examined in relation to proposed reserve areas.

These results fall into two categories: those in areas of high cattle concentration and those in areas of low cattle population. Of the former, on the Jos Plateau, cattle densities differ little between potentially reserved sites and non reserved areas during the dry season, but during the wet season, when the overall Plateau cattle population is very high, the potential reserves attract significantly more cattle than the unreserved grazing land. This is presumably because the reserved areas were less populated by the arable farmers, and so were acting as refuges in which the pastoralists faced reduced competition, and were thus more open to exploitation as pasture.

Kurmin Biri, Abet and Mariga each contain areas designated as Grazing Reserves, and it is of some interest to examine the degree to which they have been used by the arable and pastoral farmer communities. The Reserves in Kurmin Biri and Mariga have consistently held comparatively low wet and dry season cattle densities and sparse populations of arable habitations. This was not the case in the Abet Reserve however, which generally contained substantial numbers of both cattle and arable farmer dwellings, though it has not been a site where they are particularly concentrated.

Three established grazing reserves, in regions of low density cattle populations were also surveyed - two in northern Gongola State and one in Bauchi State. In all three, the cattle densities inside the reserves was found to be lower than those in the surrounding areas, an effect which was particularly evident during the dry season. The most likely reason for this state of affairs was the availability of more suitable pasture to the south during the wet season, and that during the ensuing dry season, the fact that water was in poor supply, despite the provision of dams. The situation in the dry season may have been further exacerbated by the scarcity of arable farmers who the assertion of dry season herd splitting made by Bourn and Milligan (1984).

could provide sufficient dry season fodder to sustain the cattle populations. Thus, these reserves at least, proved incapable of attracting and permanently sustaining significant numbers of cattle.

In southern Gongola State, the aerial survey results were used, not to estimate the degree to which known grazing reserves were utilised, but to identify possible locations for new reserves. Two types of reserve were considered: one without additional infrastructural support included (the so-called grazing refuges) and one adhering more closely to the conventional concept of a Grazing Reserve which would incorporate dams, improved access, grazing rights and the like. The aerial survey results alone identified a relatively large number of potential sites, which were then examined in the light of the ground survey investigations, so that areas with, for example, potentially high farmer-grazier conflict were discarded. Conversely, areas perceived by the FulBe to be suitable for reserves were examined in relation to the additional information available from the air. As the resulting recommendations have yet to be implemented, this application of an integrated use of aerial and ground survey results cannot yet be evaluated.

2.3.3 Human Populations

A distinction is drawn between arable habitation - dwellings without associated cattle corrals; and pastoral habitation - dwellings with associated corrals. Pastoral dwellings are further subdivided on the basis of structure and apparent degree of permanence. Permanent rectangular structures, or typical semi-permanent, round, beehive rugas are classified as 'settled' pastoral; temporary shelters, either made from cut branches or crop stalks, are classified as 'nomadic' pastoral. In the most recent surveys, the 'settled' pastoralist dwellings are further divided into agropastoral - those having both cattle corrals and crops associated with them.

The term 'nomadic' is used here to signify probable short term occupancy indicated by the temporary nature of the structures, and to distinguish them from the more permanent beehive rugas of the 'settled' FulBe. It does not necessarily reflect any fundamental difference in life-style or husbandry technique.

Somewhat contrary to expectation, the average densities of arable dwellings within the SHZ appear to be remarkably uniform if large scale patterns alone are considered (Map IV). The central corridor survey zones hold some 14 per square kilometer as opposed to the eastern survey areas' 12 per square kilometer (Table 4). These figures naturally conceal considerable ranges, and do not reflect even distributions with the regions surveyed. Certainly in southern Gongola, and most probably in the central regions as well, the arable farmers are not evenly dispersed within specific sites, but are frequently clustered alongside major roads, railways and other such infrastructural features.

The numbers and densities of arable farmer dwellings in the case study areas generally reflect the overall cattle densities (Table 3). Thus relatively high densities were recorded in Abet and Ganawuri, and low

ones in Kurmin Biri, Mariga and Funa Funa. Tegina proved the exception to the rule, however, as it supported intermediate numbers of cattle but comparatively few arable habitations. This is to be expected given the finding of the ground survey that the arable farmers in this area themselves keep zebu cattle.

The numbers and densities of the pastoralist dwellings are more variable, both in terms of relative distribution, and seasonal change (Table 3 and Map VII). Average densities of all the pastoralist dwellings in the central parts of the country fall between 1.3 and 1.45 per square kilometer, according to season, the dry season figures being the lower. In eastern Nigeria, the equivalent densities are estimated to be considerably lower, at 0.75 and 0.95 per square kilometer.

In relation to the number of arable farmers' dwellings, there are rather more pastoralist habitations in the centre of the country (1:10) than in the more remote regions (1:12-14). Thus the pastoralists are likely to be a smaller fraction of the human population in the more remote regions, where they have only recently arrived, than they are in the middle of the country, where they have been relatively long established. Similar data from other regions, particularly the supposedly overpopulated Arid and Semi-Arid zones, that pastoralists use would allow us to attach more significance to these ratios, perhaps in terms of the degree to which the two agricultural sectors have become established in each locality.

As intimated above, the differentiation between the types of pastoralist dwellings from the air should be viewed with caution, because, for example, many nomadic FulBe will build rugas typical of "settled", transhumant FulBe if they intend to stay in a particular area for some months. It is, however, possible to ask at least two questions of the aerial data: what is the proportion of permanently settled agropastoralists?; and what is the proportion of the more temporally resident stock owners - i.e those categorised as nomads from the air. The answers to both these questions have a direct bearing on the degree to which the pastoralist population within a specific area have become "sedentary".

The results gathered during 1983 and 1984 show that the proportions of these two pastoralist groups is extremely variable between sites, and that no definite pattern can be easily extracted (Table 3). In very broad terms, it seems that both agropastoralists and nomads are more frequent in eastern than central Nigeria, and that within the central band, the areas to the south west of Kaduna, contain a higher proportion of either agropastoralist or nomad dwellings than do the remaining sites. In other words the areas remote from the Zaria - Lafia axis, as well as supporting the lower cattle densities, also hold a lower proportion of more permanently settled pastoralists, a result that is amply supported by evidence from ground investigations.

The proportion of short term residents in an area varies markedly with season in most of the areas covered from the air. In the majority of the sites in the central part of the country, these more "nomadic" cattle owners are found in greater numbers in the dry season, whereas in southern Gongola, and the nearby grazing reserves to the north, the

reverse is generally the case. This apparent contrast reflects the flexibility of the nomads' response to local conditions.

It is tempting, though not fully justified, to infer from this disparity that these pastoralists move to the wetter zones during the wet season, and the drier ones during the dry season. This is not the direction which intuition would predict. A more likely interpretation is that the nomad densities in Gongola were abnormally high during the wet season, because of the rinderpest epidemic, and that the dry season occupants of the central zones originated from further north and moved back there during the wet season.

In relation to the number of cattle, the numbers of both arable and pastoralist dwellings also differs between the central and more remote parts of Nigeria (Table 3). In the former, there are approximately 1.2 - 1.44 cattle per arable dwelling, and 13.4 - 14.0 per pastoral dwelling, according to season. In the latter, the corresponding figures are 1.0 - 1.2, and 15.8 - 17.1 respectively, the dry season figures being the first quoted. This again supports the hypothesis that cattle husbandry is more firmly established and integrated with the arable sector in the central corridor than in the east of the country. These figures also indicate that individual pastoralists in the central corridor own fewer cattle than do their counterparts to the east. This is well supported by the evidence collected on the ground in southern Gongola which suggests that individual ownership in that region averages some 200 head, and that herds of over 1000 are not unheard of.

2.3.4 Longer Term Changes in Livestock and Land Use Patterns within the Subhumid Zone

It has been hypothesised that the presence of a significant year round cattle population within the SHZ reflects a southward expansion of the Nigerian cattle herd in response to increasing pressure acting upon traditional grazing grounds in the Arid and Semi-Arid zones to the north, due to human (particularly arable farmer) population expansion; increasing degradation of pasture quality as the pastoralists are forced onto ever more marginal areas; immigration from further north in response to the Sahel drought; and the reduction in trypanosomiasis challenge within the SHZ itself that is consequent upon the rapid and continuing bush clearance, and the extensive removal of natural hosts and habitats of the tsetse fly (Bourn, 1983; Milligan et al, 1984)

If true, this process should be reflected in a long term increase in cattle numbers within the SHZ, particularly in the less populated regions to the east and west of the "central corridor", and possibly, but not necessarily, within the central corridor itself, as that part of the country is already well stocked.

The ILCA/RIM surveys of the last six years can only provide information on the longer term changes in the ILCA case study areas within the central corridor, covering a relatively small area (7725 square kilometers).

In 1979, the total number of cattle in these three areas fell by some 15% in the wet season, from about 154,000 to 131,000. In 1984, this seasonal trend was almost exactly reversed, changing from approximately 127,000 in the dry to 28% higher, at 164,000, in the wet season. The figures suggest that dry season populations have fallen between 1979 and 1984, by 18%, but that wet season densities have increased by 25% over the same interval.

The marked difference between the two data sets reflects the fact that in Kurmin Biri and Abet, during 1979, wet season cattle densities were substantially lower than were the dry season ones, whereas in 1984, there was little inter-seasonal variation. These areas are reputed to attract transhumant pastoralists from the drier zone to the north during the dry season. The drought of 1984 is likely to have made these two areas, and in particular Kurmin Biri, less attractive to these migrant stock-owners so that they moved further to the south, and consequently escaped the attentions of the aerial survey team. It may be that the wet season figures should therefore be considered as the more representative of any long term changes that are taking place.

If so, cattle densities within these areas are indeed showing a long term increase, which would support the hypothesised southward shift in cattle distribution. It must be readily appreciated however, that such an interpretation of the trends within such limited areas is at best conjectural, and that while they may be of value to ground studies within them, their extrapolation to a zonal wide scale would be unjustified. The interpretation of such figures is further confounded by the presumed effects of both the widespread rinderpest epidemic of 1983-4, and the 1984 drought. Reliable figures of this sort can only be obtained from large scale surveys, conducted on a regular basis, over large, and representative (or randomly selected) areas.

The long term changes in cattle distribution and land use patterns are examined for each site separately in Section 3 below. The overall impression is one of remarkable constancy between 1979 and 1984. This vouches both for the accuracy of the methods used to assess the distributions of livestock and land use parameters, and for the conservatism of a relatively long established agricultural community.

2.3.5 Interrelationships Between Cattle Population evels and the Human and Environmental Variables

Throughout the ILCA and RIM aerial surveys, considerable emphasis has been placed on the use of the livestock distribution data in relation to various stratifications of the survey zones that can be gleaned from published maps. Hence the choice of a systematic unstratified sampling pattern. These stratifications have included: ecological and geological land systems, drainage basins, vegetation types and density of cover, topographic dissection, altitude, administrative area, cultivation levels, distance to towns, rivers and roads, and human habitation. Space permits only some of these parameters to be treated here.

The densities of livestock have been consistently related to several of these possibilities, namely cultivation; water availability; vegetation density; distance to towns and roads; and densities of arable and pastoral habitation. Figures 2, 3 & 4 show examples of some ofthese relationships as found in southern Gongola.

2.3.5.1 Univariate analysis

2.3.5.1.1 Cattle density in relation to:

Cultivation and arable habitation

In both wet and dry seasons, there are broadly speaking more cattle where there is more cultivation. This relationship holds in all the parts of the country for which aerial survey data is available, whether the cultivation levels are assessed from published maps (based on classes of cultivation intensity) or estimated as a continuous variable from the air.

It should be remembered that, at very high cultivation levels, in excess of 60%, the cattle densities are found to decline rapidly, presumably because of a dearth of open pasture. There is not, therefore, a simple linear relationship between cattle density and cultivation level. Thus, a regression analysis, incorporating all the Subhumid Zone sites for which data are available, does not indicate a significant correlation between the levels of cropping and cattle populations (Table 6).

A separate analysis of the case study areas, using the 1982-4 data also suggests that mean cattle densities are only weakly correlated with average cropping levels, and only significantly so in the wet season. This is despite the fact that the 1979 data consistently shows a significant relationship between these two parameters, a discrepancy which probably reflects the use of individual grid cell values, as opposed to site means, in the analysis of the earlier data.

This suggests that the association between cattle densities and cultivation levels is not a straightforward one. For example, cattle may indeed be closely associated with cultivated areas, but are kept close to rather than actually in heavily cropped localities. Furthermore, because cattle tend to migrate in the tri-partite pattern described above, they are only dependent on dry season crop residues for a limited period after the harvest and before the first appearance of newly flushing grass (i.e before dry season flying becomes practicable). This effect would tend to obscure a simple correlation in the aerial survey data.

In addition, cultivation itself may be related to some other parameter that more closely determines cattle distributions. Perhaps more importantly, the blanket measure of total cultivation used in these surveys does not reflect the inherent variety of arable systems. More especially, some crop species, such as cereals and legumes, are utilised by cattle, whereas others, in particular the root crops, provide little useful residue.

FIGURE 2A. CATTLE DENSITY IN RELATION TO DISTANCE FROM RIVERS

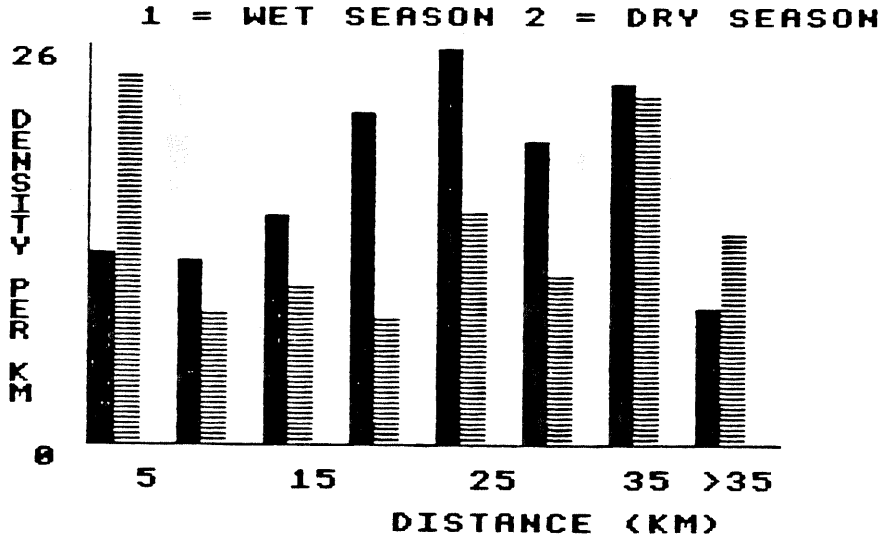


FIGURE 2B. LIVESTOCK DENSITY IN RELATION TO VEGETATION DENSITY INDEX

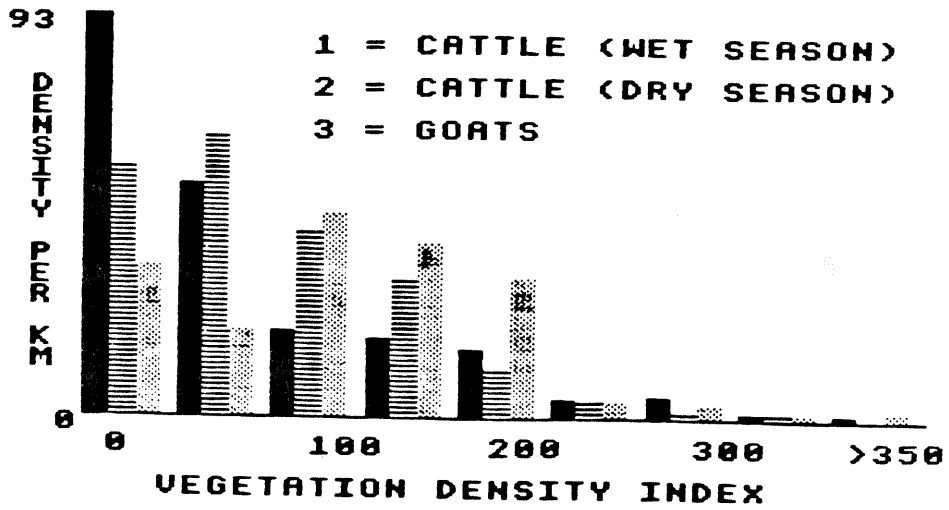


FIGURE 3A . CATTLE DENSITY IN RELATION TO % CULTIVATION

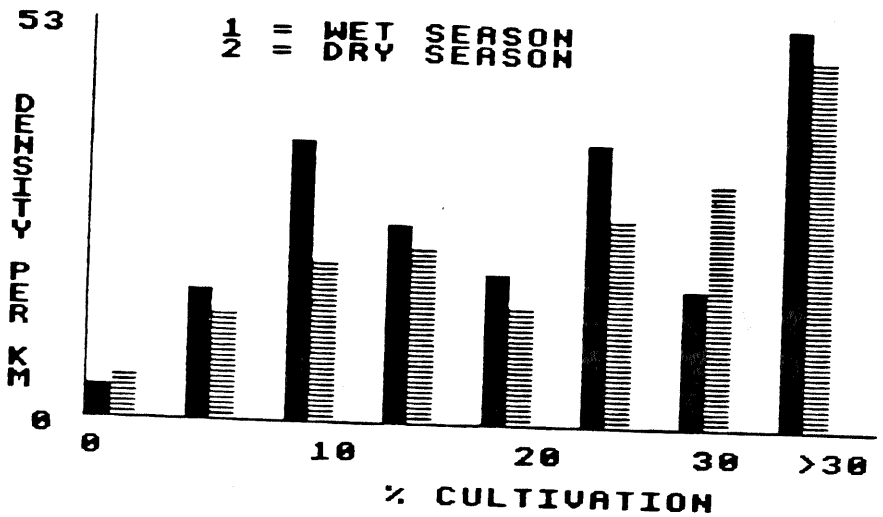


FIGURE 3B . CATTLE DENSITY IN RELATION TO DISTANCE FROM TOWNS

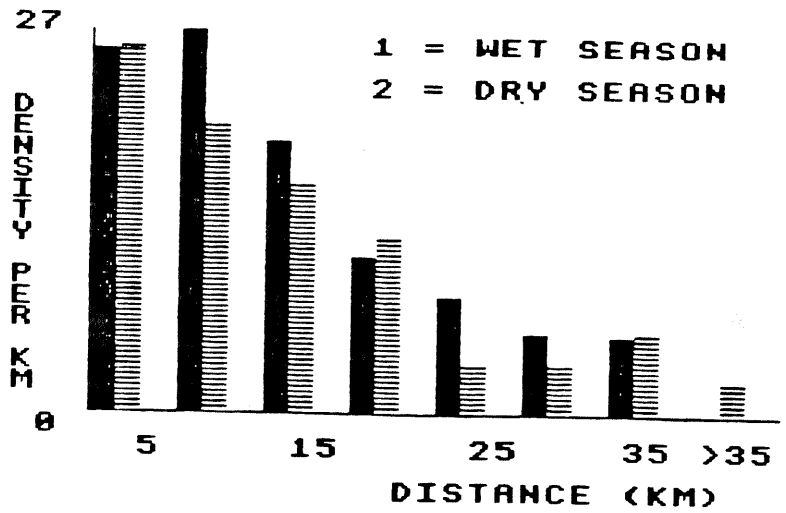


FIGURE 4A . CATTLE DENSITY IN RELATION TO DISTANCE FROM ROADS

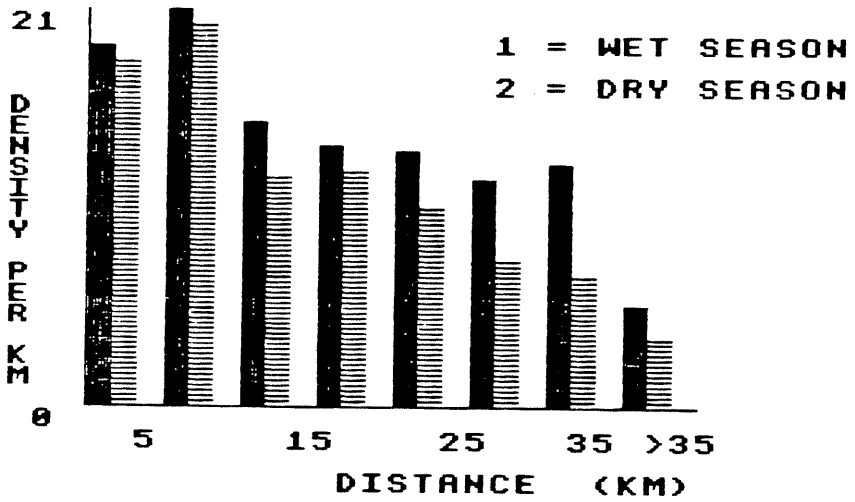


FIGURE 4B . GOAT DENSITY IN RELATION TO DISTANCE FROM ROADS, TOWNS AND RIVERS

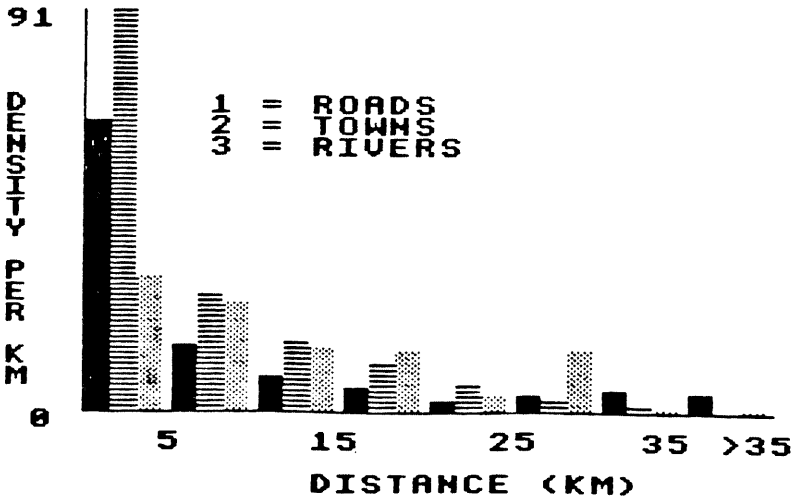


TABLE 6. PERCENTAGE OF VARIANCE EXPLAINED; UNIVARIATE CORRELATIONS

Parameter	Correlate									
	% Cultivation		Vegetation Density		%Grids dry in dry season		Habitation density Arable		Habitation density Pastoral	
ALL SITES										
Cattle density per sq.km.										
Dry Season	14	(NS)	54	***	55	***	31	*	67	***
Wet Season	5	(NS)	47	**	68	***	35	*	29	*
Arable Habitation density per sq.km.										
Dry Season	23	(")	22	(")	44	**				
Pastoral Habitation density per sq.km.										
Dry Season	11	(NS)	61	***	51	**	24	(NS)		
Wet Season	31	*	34	*	11	(NS)	7	(NS)		
CASE STUDY AREAS										
Cattle density per sq.km.										
Dry Season	33	(NS)	53	(")	23	(NS)	63	*		
Wet Season	48	*	33	(NS)	23	(NS)	58	*		
Arable Habitation density per sq.km.										
	73	**	75	**	68	**				
Pastoral Habitation density per sq.km.										
Dry Season	14	(NS)	26	(NS)	12	(NS)	11	(NS)		
Wet Season	15	(NS)	15	(NS)	3	(NS)	9	(NS)		

Significance levels: * = 5%, ** = 1%, *** = 0.1%, " = 5-10%, NS = not significant.

Another factor that may obscure a statistical link between cattle numbers and cultivation levels is that some sections of the pastoralist community may actively avoid cultivated areas. For example, in the Lafia South East zone, which was surveyed in 1979, the majority of the cattle were owned by nomadic FulBe, and were concentrated in the upland areas away from the lowland farmlands and floodplains.

Yet another consideration is the degree of farmer grazier conflict that exists. On the Mambila plateau, such conflict is intense and so the two communities tend to segregate. This state of affairs can be contrasted with that found in the Giwa study site, where there are good relations between the Hausa arable farmers and the FulBe pastoralists, and so the two populations are closely interdigitated.

Some light may be shed on this problem by the fact that cattle densities are consistently related to the densities of arable farmer habitation, whether the case study areas alone, or the SHZ as a whole are considered (Table 6). Concentrations of arable farmers represent both abundant cultivation (and so dry season crop residues) and markets for pastoralist produce, both of which are likely to attract cattle owners. That proximity to markets enhances cattle densities is supported by the evidence gathered in southern Gongola where the distribution of cattle is linked to various infrastructural parameters such as distance to roads and towns. In general, the cattle of this region are more concentrated close to towns of significant size, as well as near to the major roads. This pattern holds for both wet and dry seasons, particularly in relation to the major towns.

To summarize, it seems that the numerical link between cattle densities and cultivation levels is likely to be weak, and that much of the assumed statistical association between these two parameters reflects the conjunction of cropping and proximity to markets.

Vegetation density

Where there is a substantial proportion of dense vegetation, such as in southern Gongola, few cattle are found in it, particularly in the wet season, when the perceived risk of trypanosomiasis is at its height. In the dry season, fewer livestock are found in open grassland, and rather more (25 - 30 per square kilometer) in the equivalent of moderately wooded savannah (Figure 3). Some breeds, however, such as the browsing Sokoto Gudali, may be found in heavily wooded savannah, or even closed canopy forest at this time.

Within the central corridor, a similar trend is evident, both in 1979 and 1984, though in 1984, the relationship is not formally statistically significant (Table 6), probably because the range of calculated vegetation indices is comparatively small. The association is considerably stronger in the dry season than in the wet, which may reflect the probably increased dispersal of cattle at this time, when pasture availability is less of a constraint upon their distribution.

This broad pattern can also be seen when the SHZ is taken as a whole, where mean cattle densities are highest in "aquatic grassland" and lowest in "woodland" (Bourn and Milligan, 1984), though the increased dry season utilisation of wooded savannah is not as evident as in southern Gongola. Univariate regression analysis also shows that vegetation density is strongly and negatively correlated with cattle densities in both wet and dry seasons ($r = -0.687$ and -0.744 respectively, p 0.001).

Availability of water

The association between cattle densities and water availability has been evaluated within the ILCA/RIM surveys using three distinct measures: annual rainfall gradients; distance to rivers; and the availability of dry season water, as represented by the percentage of grid cells that have no open water during the dry season.

In East Africa, where rainfall rarely exceeds 700 mm/annum, cattle biomass per square kilometer increases rapidly with rainfall (Coe et al., 1976). In Nigeria, however, where annual precipitation increases from base level of some 600 mm, both cattle densities and cattle biomass per square kilometer drop according to a steep negative power curve with increasing rainfall (Bourn and Milligan, 1984). These two relationships are, at first sight, mutually antagonistic, until it is realised that rising rainfall in East Africa frequently with a bimodal distribution, probably enhances both the quality, quantity and relative permanence of the available grass, whereas in Nigeria, more rain leads to more dense woodlands, and so a smaller area of open grassland on which the cattle can feed.

The availability to cattle of drinking water, particularly during the dry season does not necessarily reflect annual rainfall, because runoff and evapotranspiration rates vary with soil, vegetation and the type of topography. This is illustrated by the fact that, even in a well watered area such as southern Gongola, the highest dry season cattle densities are found within 5 kilometers of rivers.

This point is further emphasised by the fact that few cattle are found in those areas with sparse dry season water sources, such as the Grazing Reserve areas in northern Gongola and Bauchi. Using the site means for all the surveyed areas, the relationship between frequency of dry season water (expressed as the % of grids that are without water) and dry and wet season cattle densities alike, is very strong. Univariate correlation analyses show that variation in the proportion of dry grid cells during the dry season explains 55% of the variance in dry season cattle densities, and 68% of that of the wet season cattle densities (Table 6). In other words, dry season water availability is a better predictor of wet season cattle densities than of dry season ones. One possible explanation for this is that those areas with more extensive dry season water have a longer growing season, and also start to produce grass earlier than the drier sites. Thus the pasture availability in the wetter areas, even during the wet season, is greater than that of the drier areas, and so attracts more cattle.

Though the general relationship is strong, the data indicate that cattle density and the availability of dry season water are not always closely related on a local level. For example, in the case study areas of the central corridor, during 1983-4, the relationship is, perhaps counterintuitively, significant only if the most northerly (and driest) of the study areas - Giwa and Pambeguwa - are excluded. This could be because aerial survey is likely to overlook more limited water sources, such as boreholes, and so underestimate the actual presence of water in these northern areas where wells provide a substantial part of the water resource.

2.3.5.1.2 Grazing unit size

In contrast to cattle density values, with which a wealth of variables are significantly related, the size of grazing units within the SHZ is correlated to none of the environmental parameters, nor indeed to any of the densities of habitation types. It is, however, positively related to the proportion of "nomadic" habitations, at least during the wet season, (R = 0.57, p 0.02), which reflects the fact that these pastoralists often own more cattle and manage them in larger groups than do their more sedentary counterparts.

2.3.5.2 Multivariate analysis

The plethora of relationships that can be demonstrated between cattle density and environmental, geographical and human parameters in the Nigerian Sub Humid zone are of considerable predictive value, but may not help so unequivocally to isolate the factors that actually cause the observed variation, because so many of the variables are strongly intercorrelated. Arable habitation levels may be closely associated to cattle densities, for example, but they are also linked to vegetation density, which may in turn be related to dry season water availability.

One way to minimise these problems is to combine many of the variables into a single index, as was done with the data from southern Gongola (RIM, 1984c) by calculating a "suitability index". This incorporated water availability (as represented by distance to dry season water), cultivation level, arable population density, land dissection, and vegetation density into a single value for each grid cell, such that 0 represented highly suitable land, and 500 unsuitable pasture. The variation in this index explained 71% of the variance in cattle density, in both wet and dry seasons, (df = 21, p 0.0001, where lny = 3.86 - 0.003x, y being the cattle density, and x the index value).

Another way to investigate these interrelationships is to use multivariate analysis techniques. In the following section this has been attempted using the survey site means of each included parameter in a multiple stepwise regression programme (BMDP P2R) with a PDP-11 computer.

In both wet and dry seasons, the most important single environmental predictor of cattle density, in the Subhumid zone as a whole, is the proportion of grids that are without water in the dry season. This explains 65 to 77% of the cattle density variance, according to season (Table 7). In a stepwise regression of the dry season figures, vegetation density is identified as the second step variable that explains cattle densities (R = -0.52). In a corresponding analysis of the wet season figures, none of the other variables, be they environmental or descriptive of human populations, contribute further to the explanation of cattle density.

If the dry season water availability is forced out of the analysis, then it is vegetation density that is the most significant predictor of the dry and wet season cattle densities (Table 7) - decreasing vegetation density leads to a rise in cattle populations. As might be expected from the complexity of the relationship between cattle and cultivation discussed in the preceeding section, neither arable farmer habitation density nor percentage cultivation can be used as significant predictors of livestock density within the Sub Humid Zone as a whole, even if both vegetation density and dry season water availability are first excluded. Indeed, the stepwise regression analyses suggest that, if anything, once the relationships between cattle and the primary predictors have been taken into account, the remaining correlation between cattle and percentage cultivation is actually negative.

Within the case study areas alone, a different story emerges because there is no correlation between cattle density and dry season water availability. As a result, the primary predictor of wet and dry season cattle densities is that of arable farmer habitations.

The technique of stepwise regression analysis also allows for the identification of those variables which are significant predictors of the densities of arable habitations, as well as the proportions of agropastoralists and "nomadic" pastoralists. The density of arable farmers, in the SHZ as a whole, is predicted only by the dry season water availability to which it is positively correlated (R = -0.66), whereas within the case study areas, it is rather vegetation density which is its primary predictor. This environmental parameter is also the best predictor of the density of pastoralist habitation density within the SHZ, as it is of the proportion of nomadic pastoralist dwellings during the wet season. Increasing vegetation density is likely to reduce the potential for both cultivation by arable farmers and grazing by the pastoralists' cattle, and also represents an increased risk of trypanosomiasis.

Finally, the proportion of agropastoralist dwellings may be expressed as y = 26.89 + 1.883 (ln arable habitation density) - 3.39 (percentage cultivation) + 13.665 (total pastoralist habitation density) - 0.172 (vegetation density), R = 0.907, p 0.0001. In more straightforward terms, the primary determinant of the proportion of pastoralists who also grow crops is the density of arable farmer dwellings, with which it increases. It is further increased by reduced cultivation levels, a rising number of pastoralist dwellings in total, and a fall in vegetation density. This suggests that agropastoralists fare best where there is less competition from high intensity cultivation, and where conditions are suitable for the pure pastoralist.

TABLE 7. PRIMARY PREDICTORS, WITH PERCENTAGE VARIANCE EXPLAINED; STEPWISE REGRESSIONS

Parameter	Wet Season	Dry Season
ALL SURVEY ZONES @		
Cattle Density per sq km.	dry season water 77% ***	dry season water 65% ***
Cattle Density Water removed from analysis	vegetation density 47% **	vegetation density 55% **
Arable Habitation Density/sq km.	dry season water 41% **	
Pastoral Habitation Density/sq.km.	vegetation density 61% ***	vegetation density 34% *
% Agropastoralists	Arable dwelling density 32% *	
% "Nomadic" pastoralists	vegetation density 33% **	None
CASE STUDY AREAS @		
Cattle density per sq km.	arable dwelling density 58% *	arable dwelling density 63% *
Arable Habitation density/sq.km.	vegetation density 75% **	

@ Only those sites for which data on all variables were available included in analysis.

Significance levels: * = 5%, ** = 1%, *** = 0.1%.

It is unwise to extrapolate definatively from correlations and regressions in order to identify causal relationships. Nevertheless, the analyses described in the preceeding pages indicate some tentative conclusions concerning the major determinants of cattle distribution patterns within the Subhumid Zone of Nigeria.

The major predictors of large scale variations in wet and dry season cattle density have been shown to be the availability of dry season surface water, and vegetation density. More cattle are found throughout the year where there is more surface water in the dry season, and where there is less vegetation cover. It is unlikely that water availability per se is the major causal factor underlying patterns of cattle distribution because much of the Nigerian SHZ is well watered, particularly in the wet season. Similarly vegetation density itself may not be strictly relevant, but reflect other conditions, such as reduced tsetse challenge and more widespread open grassland. It seems probable therefore that available water and open vegetation represent a third parameter that favours the presence of cattle. Where these conditions obtain, it is likely that the available grazing is widespread, of relatively high quality, and is present for a comparatively large part of the year.

Cattle densities are also linked, though less strongly, to the densities of arable dwellings, which represent both markets for the pastoralists' produce and a source of the crop residues that the cattle need to supplement their dry season forage.

Taking these two associations together, it seems reasonable to conclude that the large scale variation in cattle distribution observed within the SHZ is primarily determined by the availability of grazing, and thereafter by the proximity to concentrations of arable farmers. The latter of course produce crop residues, create areas of cleared fallow land suitable for grazing, and represent potential markets for the sale of livestock products.

SECTION 3: ILCA AND RIM CASE-STUDY AREAS

3.1 ILCA Case Study Areas

3.1.1 Introduction

A number of general hypotheses have been presented about long-term changes occurring in the Nigerian SHZ, both generally and on the basis of the case-study areas. Bourn and Milligan, (1984); Milligan et al. (1984) and Bourn & Wint (1985) should be consulted for graphic representations of the distributions of livestock and land-use patterns. In order to explore the specific context of such trends a number of ILCA case-study areas were surveyed on the ground in June, 1984. These were the interconnected regions of Tegina, Mariga and Funafuna, the large region west of Zaria adjacent to Giwa, Ganawuri and Pambeguwa. The function of the groundwork was to assess the comparability of these locations to the intensively studied Kurmin Biri and Abet, in terms of the mode of livestock production. In addition, a visit to officials at the Lafia Agricultural Development Project (LADP) allowed for brief discussion of its livestock operations. Data from the RIM (1984c) report on southern Gongola State is also included for comparative purposes. Since groundwork has not been conducted in the Jos and Bauchi areas, nothing can be added to the aerial survey data.

These regions are shown in their national context on Map I. Maps VIII-XIII show the roads and towns, as these were recorded by the ground survey; changes and construction of roads, the resiting of towns and inaccurate toponyms made earlier maps unreliable. In lieu of accurate surveying, these maps should be treated as no more than sketches.

This section describes aspects of domestic livestock production across the SHZ. A number of parameters were isolated as of particular relevance to understanding the social context of production, and these are systematically compared from region to region.

3.1.2 Kurmin Biri and Abet

Pastoral and arable communities have been studied by ILCA staff in locations within the aerial survey zones of Kurmin Biri and Abet. In each case the communities represent an area of some sixty square kilometers. Both have a single pastoral group, the Kacecceere'en, a section of the FulBe, resident in the area. FulBe na'i pass through the larger zones but their production has not been studied in detail. Although the Kacecceere'en have been present since before 1900, they have only begun to farm in the last few decades as elsewhere in the SHZ.

Work by ILCA staff is reviewed by Kaufmann (1984) and the particular areas of concentration for present and future research are outlined.

TABLE 8

Topic	Kurmin Biri	Abet
1. Stock-rearers	FulBe (Kacecceere'en)	FulBe (Kacecceere'en)
2. Other ethnic groups	Kulu (Ikulu)	Jju (Kaje), Kamanton
3. Years stock-rearers present	from before 1900	from before 1900
4. Years since they began stock-rearing	very long	very long
5. Stated purpose of stock-rearing	Subsistence through sales of stock and dairy produce. Prestige	
6. Land rights of pastoral groups	Land is loaned from the indigenous farming peoples. No secure tenure until the gazetting of the Grazing Reserve established in 1974	Bush land may be cleared by arrangement with the chief, fallow land by arrangement with individuals. No security of tenure.
7. Land sales	None	None
8. Sizes of herds owned by pastoral group	Range 4-86 Average 40-60	Range 10-182 Average 40-50
9. Principal breeds of cattle	Zebu: Bunaaji	Zebu: Bunaaji
10. Other livestock owned by pastoral group	Sheep (ratio of 1 sheep to 4 cattle) Donkeys, chickens	
11. Livestock owned by arable groups	Goats (Average flock size 5), pigs, dogs, chickens, ducks	
12. Movements of herds	No regular pattern. Larger herds are divided in the dry season, with the milk-herd left near the compound and the remainder sent to nearby fadamas.	
13. Non-resident pastoralists	FulBe na'i Yaabaaji Katsinanko'en	Gorkanko'en, Yaabaaji Tubanko'en, Bokolooji Katsinanko'en

14. Seasonal movement of non-resident pastoralists	Herds graze in this area between December and April before returning further north.	Some groups stay between January and April but the majority pass through in November/December going south and return north again in April
15. Place of dairy products in household economy	All income from the sale and manufacture of dairy products is accrued to women. Only a small proportion of this income is now spent on satisfying subsistence needs.	
16. Conflict between farmers and pastoralists	Medium level of conflict - no long-term relations between pastoralists and farmers	Low level of conflict long-term relationships formed.
17. Exchanges between pastoralists and farmers.	FulBe have free access to crop residues at present, although farmers have begun to try and charge them since 1982. Previously farmers would pay FulBe small sums to graze on their fields, to obtain manure for the ginger, a major cash-crop.	
18. Extent of fencing of fields	Pastoralists rarely fence their fields, relying on human labour to control stock access. Local farmers frequently use Euphorbia sp., especially in areas of high cultivation.	
19. Ploughs	Ploughs are not used in either area, although a single successful plough-user in Zonkwa shows that there is no inherent problem.	
20. Dry-season fodder	None traditionally, although some fodder banks as a result of ILCA intervention.	
21. Houseforms	The length of time FulBe have been settled is reflected in the type of house built. For the initial five years, a 'beehive' ruga is made, and following that a square mud-brick house with thatch or tin roof. After ten years a cement-block house can be put up.	

Bayer (1984a and b) has studied small ruminant production and agropastoral herding practices in some detail. Cropping systems are described in a paper by Powell (1984) and crop-forage interactions by Saleem (1984). Waters-Bayer (1983) and Waters-Bayer & Taylor-Powell (1984) studied the settlement and land-use patterns of FulBe. Otchere (1984) provides a resume of cattle production parameters.

In Kurmin Biri the distributions of cultivation, vegetation density, arable habitation and wet season cattle populations are very similar. Cultivation is lightest in the northeastern quadrant, the density of natural vegetation is lightest in the northwest. Arable dwellings are sparse both in the northeast and southwest of the survey zone. The distribution of dry season water sources is also broadly similar in both years with a conspicuous absence along the northwest/southeast diagonal. 1984, however, was substantially drier in the centre of the zone, near the grazing reserve.

The distribution of human settlement and environmental and land use parameters changed very little over the period 1979-84, although wet season cultivation was more extensive in the second survey, as would be expected from the general expansion of cropping in the central corridor. The heaviest vegetation was along the northern and southern borders of the survey zone.

Table 8 contrasts selected features of pastoral society and environment in Kurmin Biri abd Abet. This material was derived from discussions with ILCA staff at Kurmin Biri and Abet and may be considered more reliable and deeply researched than the brief surveys in this report.

3.1.3 Giwa

Map VIII shows the roads and towns of the Giwa case-study area being jointly studied by ILCA and NAPRI, and should be compared with Table 3, showing the abundance of livestock. Map 9 in Milligan et al. (1984) shows a high degree of cultivation associated with high cattle densities concentrated in the northern, more arid parts, although they show no strong association with either roads or rivers. The principal lightly cultivated region is south of the main Sokoto-Kaduna road. As this is an area where pastoral FulBe are in the process of sedentarization, the distribution of pastoral habitation should be interpreted as the transition between initial immigration, construction of 'permanent' grass ruga, and eventual movement into a mud-brick house.

Unlike the other case-study areas, the population of the Giwa zone is extremely homogenous, as it consists almost exclusively of Hausa and settled FulBe. Both groups raise cattle, although the Hausa have only recently adopted them, both fattening them for sale and using them to draw ploughs. Sheep and goats constitute the principal small-stock of the Giwa region. The sheep are Uda and Balani and the goats are the larger red savannah breed. Sheep have a high prestige for Islamic sacrifices and prices are consequently higher than goats as a result

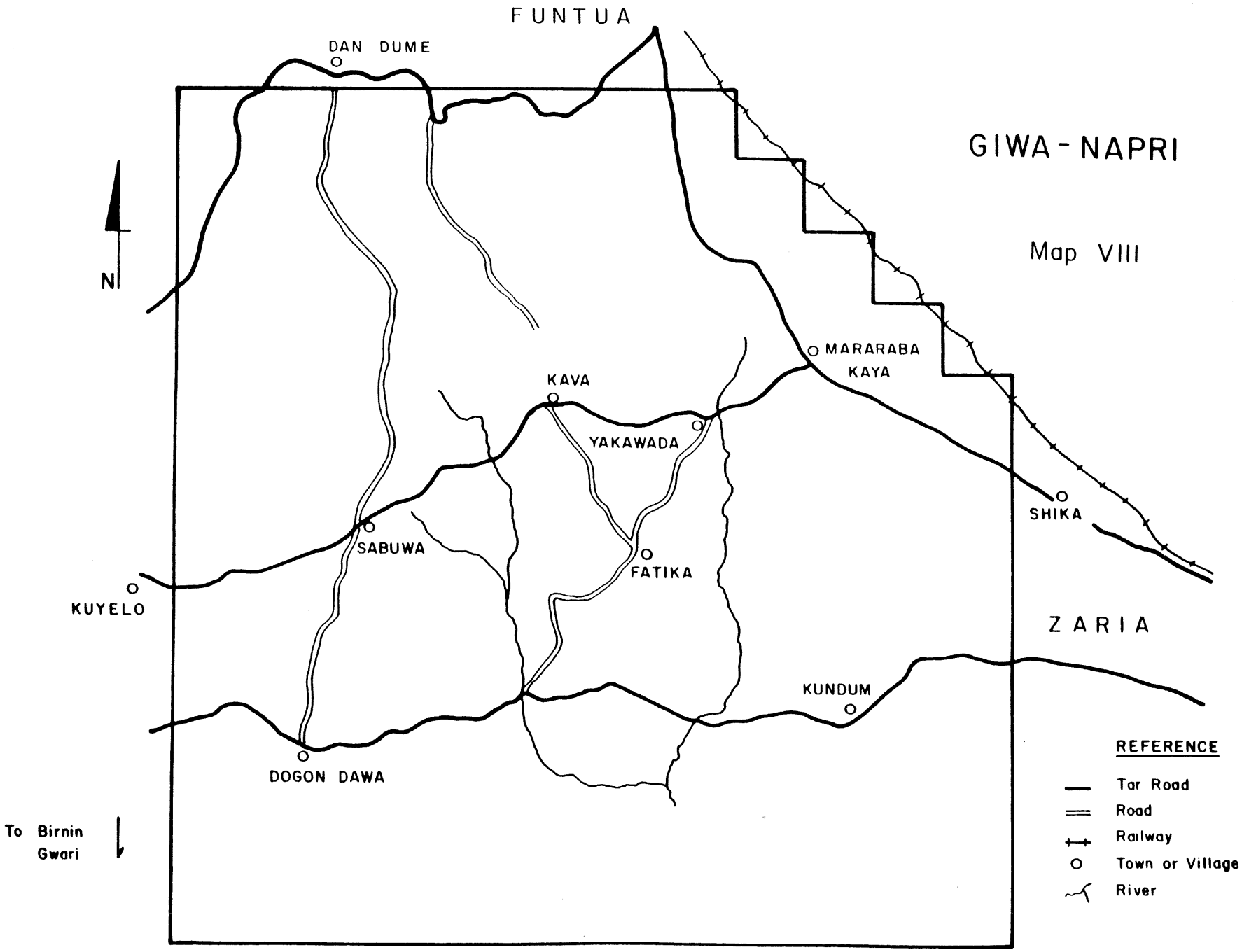

GIWA - NAPRI
Map VIII
FUNTUA
DAN DUME
N
MARARABA
KAYA
KAVA
YAKAWADA
SHIKA
SABUWA
FATIKA
KUYELO
ZARIA
KUNDUM
DOGON DAWA
To Birnin
Gwari
REFERENCE
Tar Road
Road
Railway
Town or Village
River

TABLE 9

Topic	Maji Dawa	Kaya
1. Cattle-rearers	Hausa	Hausa
2. Other farming groups.	None	None
3. Period which this group present.	Indigenous	Indigenous
4. Number of years since cattle first obtained.	ca. 20	ca. 15
5. Stated purpose of stock-rearing	Ploughing Fattening for sale	Ploughing Fattening for sale
6. Land rights of stock-rearers	Land may be bought and sold freely. Uncleared bush land may be allot-ed to settlers from any ethnic group sold after a certain time.	Land is traditionally owned by lineages but it rarely sold due to its free availability. Any bush land cleared by a farmer may be ceded to another for a token pay-ment.
7. Land sales.	Yes	Only within the town
8. Herd sizes of stock-rearers	Range:2-5	Range:2-5
9. Principal breeds of cattle.	Zebu: Bunaaji, Gudali	Zebu: Bunaji, Gudali
10. Other livestock owned by stock-rearers	Goats Sheep Donkeys, chickens	Goats (10-20 p.c.) Sheep Donkeys, chickens
11. -	-	-
12. Movements of cattle.	Resident all year. Cattle are either stall-fed or taken out to graze on crop residues or at nearby rivers in the dry season by small boys.	

13. Non-resident pastoral groups	Galeeji, Daneeji Rahaaji	FulBe na'i ceased to pass through when the settled groups arrived 25 years ago
14. Seasonal movement	FulBe na'i pass from north to south in October and return in January to eat crop residues.	-
15. Place of dairy products in household.	Not relevant as Hausa farmers only buy male animals Dairy products are purchased from settled FulBe.	
16. Conflict with farmers.	None	None
17. Exchange relations between farmers and graziers	Previousy FulBe were allowed to graze on crop residues in exchange for helping with harvesting. This has been commuted to a fee of 10-20 Naira.	-
18. Extent of fencing /control of crop damage.	Only cassava plots are fenced. Small boys control animals when they are not confined.	
19. Ploughs	Ploughs adopted from further north 20 years ago. Almost all farmers now own or hire them.	Ploughs adopted 5 years ago from Katsina immigrants No government extension. Widespread but not universal.
20. Dry-season fodder.	No external feedstuffs used. Bean and groundnut leaves saved for stall-fed animals.	
21. Houseforms	Rectangular mud-brick houses with thatch or tin roofs.	Rectangular mud-brick houses with thatch or tin roofs. Round thatched mud houses vertical ribbing set in the external wall.

TABLE 10

Topic	Maji Dawa	Kaya
1. Cattle-rearers	FulBe (Kacecceere'en)	FulBe (Katsinanko'en, Sulebawa=Bokoloji Kananko'en)
2. Indigenous groups farming	Hausa	Hausa
3. Period this groups has been settled.	at least since 1900	since 1960
4. Years since cattle obtained	Indigenous	Indigenous
5. Stated purpose of stock-rearing	Subsistence: the sale of stock to meet cereal needs in provision of dairy produce. Cattle also provide manure and are used for ploughing. Prestige.	
6. Land rights of of stock-rearers	Land may be bought on the market to gain rights in perpetuo. Fallow land can be loaned from individuals rights in bush alloted by the chief. Complete security of tenure in bush land.	Unclaimed bush land allotted to FulBe may be transferred on payment of compensation for bush-clearing. Immigrant FulBe have security of tenure.
7. Land sales	Yes, although non-indigenous residents must have permission from the chief.	No
8. Sizes of cattle-herds	Range:5-100. Average:40-50.	Range:5-200. Average:40-50
9. Principal breeds of cattle.	Zebu: Bunaji, Gudali	Zebu: Bunaji, Gudali
10. Other livestock owned by stock-owners	Sheeps, Goats (N.B. FulBe often manage small ruminants for Hausa farmers) Donkeys, chickens	Sheep, goats. Donkeys, chickens

11. -	-	-
12. Movements of cattle	The entire herd is sent south to Lafia, Minna and Abuja areas during the growing season from April/May to December. They return to eat crop residues. Farming is in the hands of older people resident all year round.	In the case of larger herds a small milk-herd is left at the compound and the majority are sent south to the rivers Gazare, Tubo and occasionally the Kaduna, leaving between October and December and returning in March. They do not eat locally generated crop residues.
13. See Table 9	-	-
14. See Table 9	-	-
15. Place of dairy products in household economy.	The processing, distribution and resultant income from all dairy products is in the hands of women. Only a small proportion is spent on subsistence needs.	
16. Relations between farmers and graziers	Good	Excellent
17. Exchanges between farmers and graziers	Exchange of crop residues for manure now on a cash basis. Few crop damage suits.	Free exchange of crop residues for manure. Excellent relations and few court cases.
18. Extent of fields fenced.	Only cassava plots are fenced with cereal stalks.	
19. Ploughs	See Table 9	
20. Dry season fodder /Crop residues.	No	No
21. Houseforms	Identical with those of the Hausa (see Table 9)	Large rugas and circular mud houses with vertical ribbing on exterior wall.

of the entirely Muslim population. Donkeys are widely bred as pack-animals by both FulBe and Hausa. Pigs are unknown because of the religious prohibition on them.

Table 9 summarizes aspects of the mode of subsistence of Hausa farmers in two settlements sampled;

The FulBe divide into two types; settled FulBe, FulBe wuro, crop farmers whose mode of production is indistinguishable from their Hausa neighbours, and who live in square mud-brick houses in villages, and recent migrant FulBe who live in grass rugas or individual mud houses in open areas. These migrants have gradually been filtering down from Katsina and adjacent areas of the arid zone. They have been moving into the SHZ as pressure on them from the arable communities increases.

Map 9 (Milligan et al., 1984) shows the distribution of pastoral habitation in the dry season in the Giwa zone. The two types of pastoral dwellings are associated with different types of livestock producer; the 'rough shelter' beehive rugas are used by the transhumant groups that pass through this area moving north to Katsina in the dry season. The larger rugas belong to the Katsinanko'en FulBe who are in the process of sedentarization throughout the zone (cf. Norman, 1982). The correlation between cattle and settlement reflects the good relations between the pastoralists and the arable farmers and the practice of systematically exploiting cereal residues available on the farms.

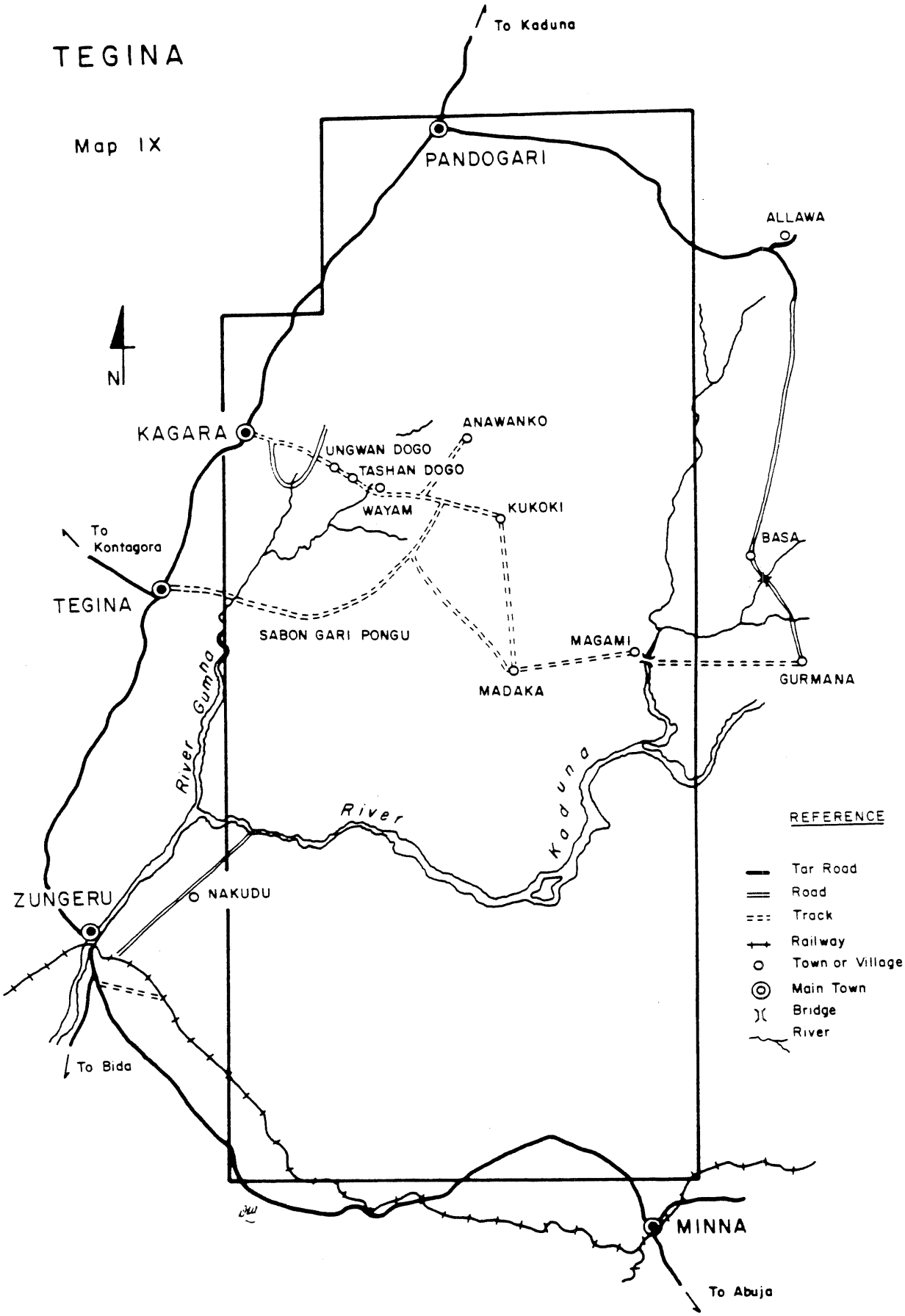
In neither season were there great numbers of 'nomad' shelters, those interpreted as belonging to FulBe na'i on the move. Between the dry and wet season surveys their numbers fell, suggesting that there were few large herds in transit at this period. Cattle-owners emphasized that the high density of cultivation made it difficult to manage cattle without extensive crop damage. Therefore FulBe na'i migrating further north probably only rarely pass through the Giwa zone. Interviews in the Mariga area, suggested that many of the FulBe coming up from the Niger-Benue system would pass further west of Kaduna, beyond the Kamuku game reserve.

The overall increase in cattle numbers in the wet season reflects the return of cattle from dry-season transhumance, and the passage of FulBe na'i from north to south. Possibly many of the FulBe na'i en route stay with friends in villages, and this may account for the low number of temporary shelters observed.

Table 10 represents the mode of production of two FulBe groups investigated in Maji Dawa and Kaya, and should be compared with Table 9, showing Hausa in the same area.

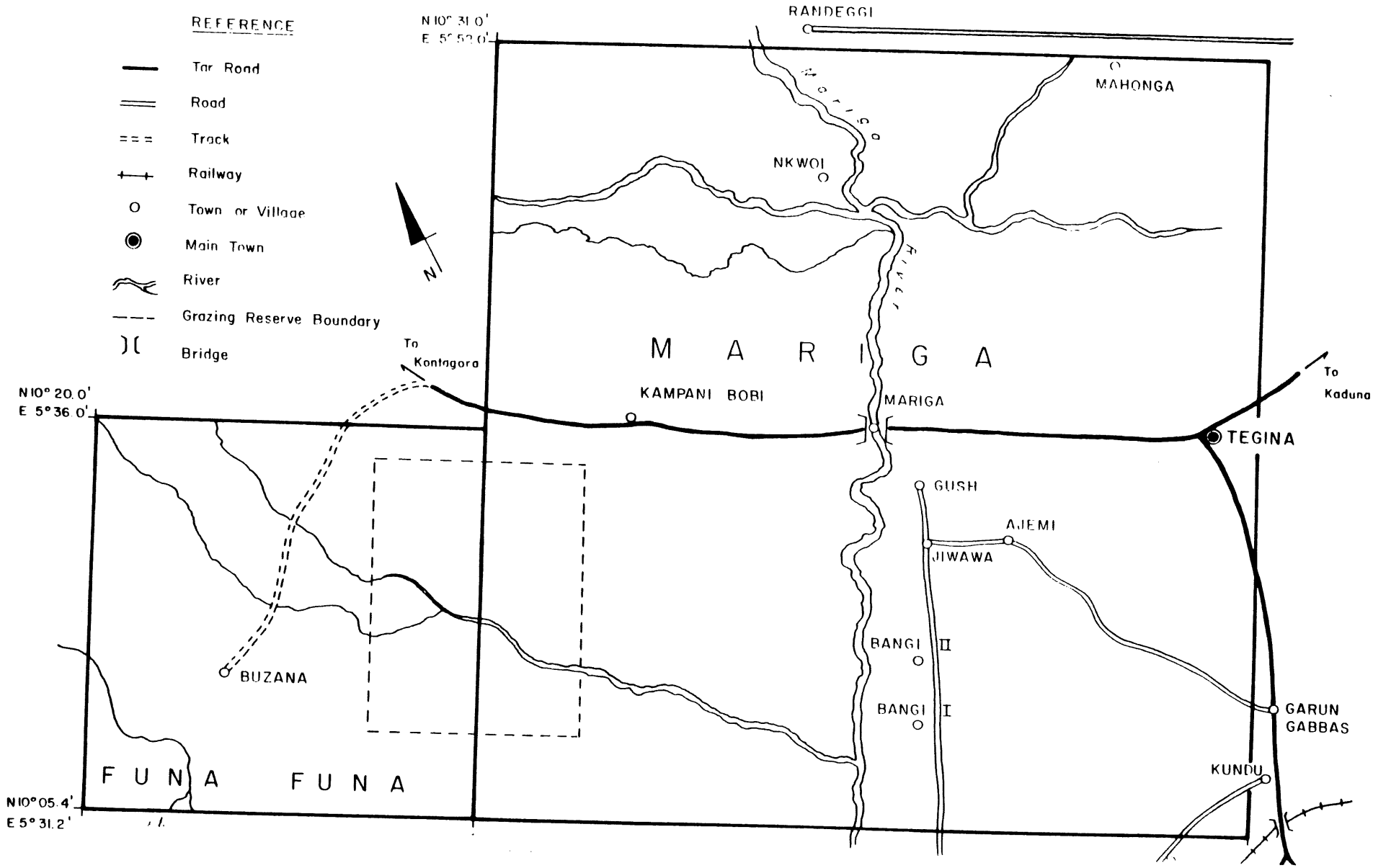
3.1.4 Tegina-Mariga-Funafuna

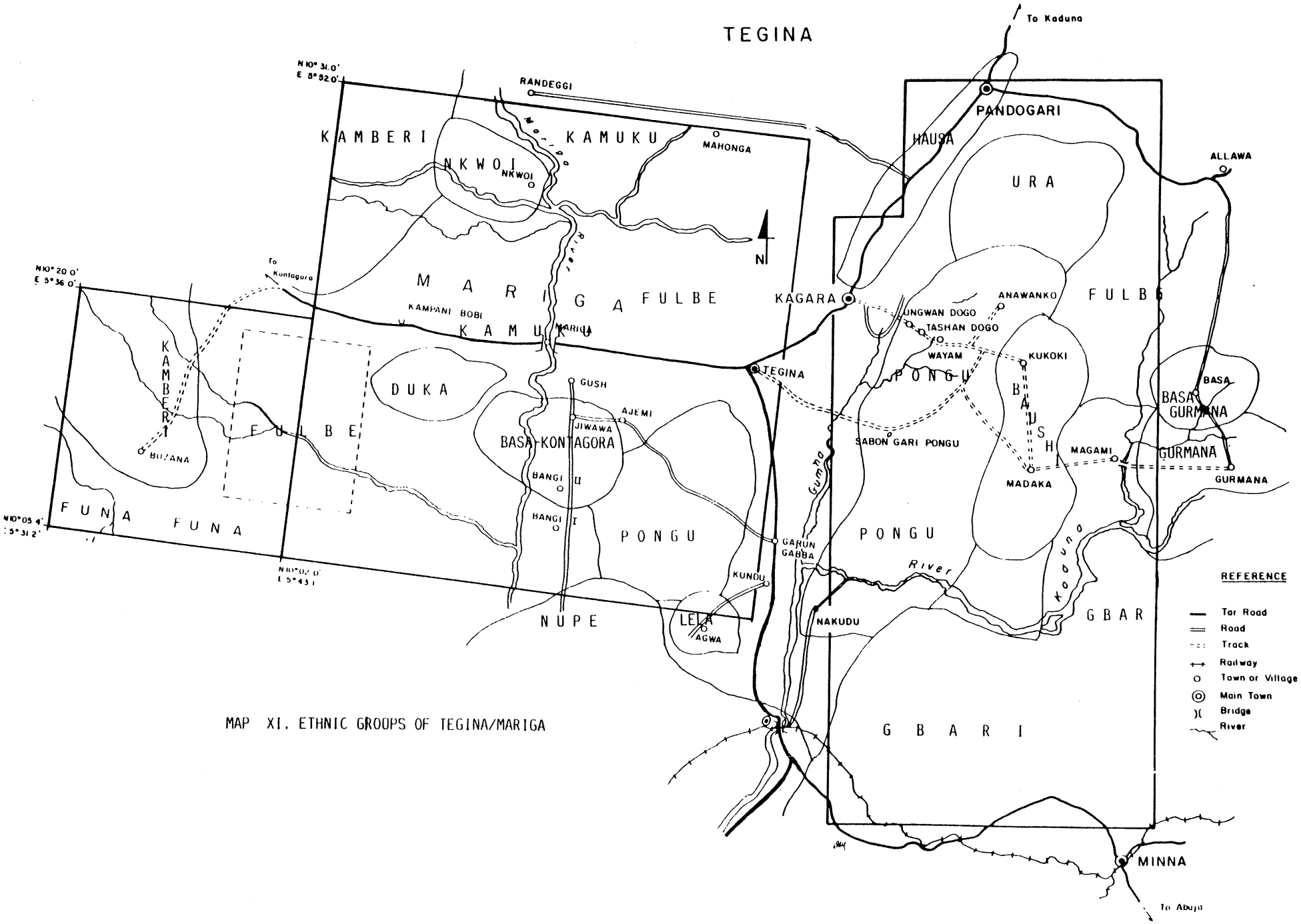
Maps IX and X show the Tegina/Mariga area and Map XI presents an outline of the distribution of ethnic groups in this area. It is


TEGINA
Map IX
To Kaduna
PANDOGARI
ALLAWA
N
KAGARA
ANAWANKO
UNGWAN DOGO
TASHAN DOGO
WAYAM
KUKOKI
To Kontagora
TEGINA
BASA
SABON GARI PONGU
MAGAMI
GURMANA
MADAKA
River Gumna
River Kaduna
ZUNGERU
NAKUDU
To Bida
MINNA
To Abuja
REFERENCE
Tar Road
Road
Track
Railway
Town or Village
Main Town
Bridge
River

MARIGA and FUNA FUNA

Map X





MAP XI. ETHNIC GROUPS OF TEGINA/MARIGA

immediately apparent that this region is the most complex of those studied in this report with a minimum of fourteen languages spoken. The region has been subject to agricultural migration from both north and south; recent settlements of Lela and Duka from Zuru in Sokoto state are found west of Zungeru, while Nupe and Gbari expansion is increasing along the southern edges of the Block.

Despite this, these three regions are the least populated of all the study areas; aerial survey figures show a range of 8.7 to 9.9 arable dwellings per square kilometre in the three zones. In Mariga, cultivation tends to cluster around the Kontagora-Tegina road, and the Mariga river that crosses it at right angles. The low human population densities are almost certainly associated with the notorious depopulation of this region by the Emir of Kontagora in the late nineteenth century (Gunn & Conant, 1960). A consequence is that the region is favourable for pastoralists who own large herds; sizes of herds owned were among the largest recorded outside the Toungo Block. Indeed, the overall cattle densities, generally 20+ per square kilometre were extremely high.

Apart from the FulBe, the most significant cattle-owning populations were the peoples of the Kamuku-Basa group (Hansford et al. 1976). These consist of the Basa-Kontagora, Baushi, Gurmana, Kamuku, Nkwoi, Pongu and Ura. Of these, the Nkwoi and Ura, both numerically small groups, could not be interviewed due to difficulties of access to their villages. Gunn (1960) has reviewed the exiguous documentary sources on this region, but he includes very little that relates to livestock, and most of that is contradicted by the findings of the groundwork.

The Tegina area shows hardly any seasonal change in cattle numbers overall, although they have undergone a distinctive relocation. This is likely to reflect the fact that many of the cattle are owned by non-FulBe agropastoral groups such as the Pongu, who send their cattle to the Kaduna and other smaller rivers during the dry season. Those FulBe who are settled in the region, mostly along the Tegina-Kaduna road, also do not send their cattle long distances.

This contrasts with the Mariga region where in both the 1979 and 1984 aerial surveys the cattle populations nearly tripled in the wet season. This is the result of the large herds owned by FulBe resident along the Kontagora-Tegina road returning after dry-season transhumance to the Niger-Benue system. This accounts for the relatively poor correlation between cattle densities and cultivation recorded in the wet season. The adjacent Funafuna area shows patterns resembling those of Tegina, although because FulBe seem to be excluded from the grazing area within it, it is difficult to interpret this as a 'normal' pattern.

All the peoples in this group seem to have owned savannah shorthorn type cattle until recently. Small populations are still found dispersed throughout the area. However, when they were encountered, they proved to be dissimilar to the conventional muturu described by Epstein (1971:xx) and to be dwarfed white shorthorns with a reduced hump. Since such animals do not seem to have been reported from this area, speculation on their origin and potential must await further

research. They may prove to be a stabilised zebu-muturu cross, similar to the 'Keteku' cattle of Borgu.

The mode of production that formerly prevailed when farmers had small herds of muturu is clearly quite different from today. Muturu were previously kept in small numbers for prestige and to fulfil ceremonial obligations and were either stall-fed, or kept in small herds close to the compound. They were rarely milked and never used as draught-animals.

The gradual replacement of muturu with zebu began as long ago as 1930 with some groups, such as the Baushi, but in Mariga, for example, it only began in 1972. The reasons for the change are always given as prestige; zebu cattle are said to be larger and more attractive. However, they are recognized as being locally more susceptible to trypanosomiases; so their gradual establishment in the region may reflect a decline in the trypanosome challenge.

This is also matched by an expansion of the FulBe population in the Mariga area; part of a trend towards relocation in more southerly latitudes. Many of the FulBe in this region are originally from the Sokoto area; and they now go on transhumance to the south of the Niger in some cases. Often they begin their movement from Mariga at the end of the harvest, exploiting the cereal residues from one community after another as they move south.

The Kamuku say that it is difficult to keep zebu cattle close to the compound throughout the year because of tsetse flies. Only FulBe herdsmen, who are on the move and can keep their herds away from infested areas can protect them effectively. For the Kamuku, cattle-rearing has decreased as a prestige activity and increased in commercial significance as a result of the switch from muturu to zebu, despite the difficulties of raising these latter.

The Pongu, who constitute the other substantial non-FulBe cattle-owning group in this area, have a quite different approach. They began to herd zebu in the 1930's and none of those interviewed were willing to speculate on the original motives for taking up cattle-herding. However, far from trying to gain access to roads and markets, the Pongu seem to move actively away from them, seeking out the best agricultural land. Few Pongu have passed through secondary schools and they retain a remarkable attachment to traditional religion in an area that has been subject to intense proselytization from Christianity and Islam. Cattle-traders in the region remarked on how unwilling they were to sell cattle, and the conventional correlation between size of herds and other signs of wealth, such as tin roofs, radios and motor-cycles was significantly lacking.

The Kamuku, Pongu, Baushi and Basa all have as their stated objective the establishment of breeding herds, and maximising their herd size as far as is compatible with the labour requirements of their agriculture. In this sense, the FulBe pastoralists form an important pool of flexible labour for them; since there will almost inevitably be a herdsman willing to take on the responsibility of a few extra cattle in return for payment. This allows the mixed farmers to allocate their resources most effectively. Delagado (1979) discusses a similar situation in Burkina Fasso.

TABLE 11

	Topic	Nakudu	Madaka
1.	Cattle-rearers	Pongu	Baushi
2.	Indigenous groups farming locally	Baushi, Gbari, Lela	Pongu, Ura, Gurmana
3.	Period since group settled in area	Indigenous	Indigenous
4.	Years since cattle first kept.	Muturu: indigenous Zebu: 50 years	Muturu: indigenous Zebu: 50 years.
5.	Stated purpose of stock-rearing	Prestige/ceremonial obligations. Cash reserve. Manure.	Investment to provide cash needs. Manure
6.	Land rights of stock-owners	Complete control in traditional areas. Pongu are constantly expanding into fresh areas of unclaimed bush.	Complete control by individual compounds.
7.	Land sales	Low population density makes these unnecessary	
8.	Sizes of cattle-herds	Range ca. 0-50 Average 25	Range 0-134 Average 25
9.	Principal breeds of cattle	Muturu: Keteku? Zebu: Bunaji, Gudali	
10.	Other livestock owned by stock-owners.	Goats (10 p.c.) Sheep ('very few') Chickens, ducks	Goats Sheep (10 p.c.) Chickens, ducks,
11.	-	-	-
12.	Movements of cattle	Kept around the compound or in the immediate area throughout the year. Taken by younger sons to nearby rivers in the dry season.	
13.	Non-resident pastoral groups	Keranko'en Hausaje=Bokolooji	Settled FulBe from Kagara Hausaje

14. Seasonal movement of non-resident pastoral groups	Keranko'en move south of the Kaduna to eat crop residues and move north in April. Hausaje come in June and return at the end of the wet season.	Hausaje from Sokoto come in November, eat crop residues and return north in May. Transhumant groups of FulBe from Kagara spend the dry season at Madaka. Until 15 years ago they spent the entire year there but were forced north by lack of pasture [!]
15. Place of dairy products in the household	Cattle not milked	Men milk cattle and the milk is drunk in the compound or sold to friends
16. Relations between stock-rearers and non-resident pastoralists.	FulBe impotent to prevent bush-burning and this is a source of friction. Incoming 'nomad' herds are thought to bring disease into the area. Low population density results in few damage suits.	
17. Exchanges between stock-rearers and non-resident pastoralists.	Pastoralists of all ethnic groups are allowed access to crop residues, assuming the needs of the indigenous owner has first been satisfied.	
18. Extent of fields fenced.	Only cassava plots are fenced. Livestock in either tied up or herded in the growing season.	
19. Ploughs	None	
10. Dry season fodder /crop residues	Muturu seem to have been stall-fed in the past, but are presently herded with Zebu.	
21. Houseforms.	Pongu villages consist of small circular houses joined by a high exterior mud wall with only a single entrance house	Separate rectangular or circular houses with thatch or zinc roofs and occasional cornstalk fences forming a living space

TABLE 12

	Topic	Gurmana	Mariga
1.	Stock-rearers	Gurmana	Kamuku: Ucinda
2.	Indigenous groups farming in the area	Basa-Kuta, Gbari Baushi	Basa-Kontagora, Kamberi Nkwoi, Hausa, FulBe wuro
3.	Years stock-rearers present	Indigenous to the area	
4.	Period when cattle keeping adopted.	Zebu cattle present for 50+ years	Muturu: indigenous Zebu: adopted ca. 1972.
5.	Stated purpose of cattle-keeping	Cattle are a means to invest capital and also provide manure.	Muturu were originally kept to fulfill ceremonial obligations but both races are a means to provide cash on demand.
6.	Land rights of stock-rearers	Complete control	
7.	Land sales	Low densities make these unnecessary	
8.	Sizes of herds owned by pastoral	Range:2-5	Muturu:rarely more than 10 Zebu:range 0-100 Average ca. 20.
9.	Principal breeds of cattle	Zebu: Bunaaji, Gudali	Muturu:Keteku? Zebu: Bunaaji, Gudali
10.	Other livestock owned by stock-owners.	Sheep, goats, chickens	Sheep, goats, chickens.
11.	-	-	-
12.	Cattle movements	Cattle kept around the compound all year. Tied to stakes to manure the fallow land in the early rainy season, otherwise grazed by the river	Muturu were always grazed arround the compound or stall-fed. Zebu are kept in the area only if they are in very small herds. Other-sent south with transhumant FulBe to avoid the high tsetse challenge

13. Non-resident pastoral groups	As for Madaka (see Table 11)	Oroji, Hausaji, Daneeji Borganko'en, Katsinanko'en Japanko'en [!], Rahaaji, Dauranko'en, Gensanko'en, Zegizegi'en
14. Seasonal movement of pastoral groups.	As for Madaka (Table 11)	The FulBe na'i have mud houses in the towns where they leave their possessions and old people. The younger families move South as far as the S. bank of the Niger in the dry season and return to farm for 3 months in the wet.
15. Place of dairying in the household	None	Both muturu and zebu were said to be milked by anyone and the milk drunk or sold informall
16. Interactions with farmers	No conflict	No conflict
17. Exchange relations between stock-raisers and non-resident pastoralists	FulBe are allowed to use crop residues freely and many form special relationships with Gurmana to stake cattle at regular intervals on freshly-sprouted fallow land.	Fulani used to help with the harvest in exchange for primary access to residues. This is now commuted to a token money payment.
18. Extent of fencing	All domestic animal are staked in the growing season.	Only cassava is fenced. All domestic animals are tied or herded in the wet season.
19. Ploughs	None	None
20. Dry-season fodder	No external feedstuffs used.	
	Grass may be cut when cattle for fattening are confined.	Grass cut for muturu cattle when stall-fed, also bean and groundnut leaves are conserved.
21. House types	Rectangular mud houses	Rectangular mud houses in road towns, but circular mud houses surrounded by cornstalks in rural areas.

TABLE 13

Topic	Mariga	Buzana
1. Stock-rearers.	FulBe wuro: Oroji, Hausaji	FulBe na'i: Salanko'en, Jalanko'en Dauranko'en
2. Indigenous groups farming	Kamuku, Nkwoi, Basa	Kamberi, Kamuku
3. Period this group has been in the area.	since 1900	since 1900
4. Years since cattle first obtained.	Indigenous	Indigenous
5. Stated purpose of stock-owning	To provide subsistence to act as a source of wealth, provide milk and manure and to draw the ploughs.	To provide subsistence through sales of animals and dairy products. Prestige.
6. Land-rights of stock-owners	Identical to those of the Kamuku.	None, although this is not a problem because these groups do not farm.
7. Land sales	Only in the town.	None
8. Sizes of herds	Range:30-200 Average ca. 100	Range:100-400 (?) Average ca. 150
9. Principal breeds of cattle	Zebu: Bunaji, Gudali	
10. Other livestock owned by stock-owners.	Goats, sheep, chickens	Sheep, chickens Donkeys
11. Livestock owned by indigenous farmers.	As above	Goats, sheep
12. Movements of cattle	The majority of the herds are sent south to the Niger valley between the end of the crop February and the end of the wet season in November. A milk-herd is left with old people in Mariga	The entire herds go south to the Niger valley from the end of the crop residues to May, when they pass through on their way further north.

13.	Non-resident pastoral groups	See under Kamuku of Mariga	-
14.	Movements of non-resident pastoral groups.	See under Kamuku of Mariga (Table 11)	-
15.	Place of dairy products in the household economy.	Dairy products entirely controlled by women both in processing and marketing. Their contribution to subsistence has been increasingly less significant since 1970 and is now reckoned to be negligible.	
16.	Interactions with farmers	Very good. Kamuku cattle are entrusted to FulBe herders in the wet season.	Very good.
17.	Exchange relations with farmers	Farmers' crop residues are freely available to graziers	Crop residues are free to herders with 'special' relations otherwise a token payment is made.
18.	Extent of fencing. /control of crop damage.	Only cassava fenced. Control of animals dependent on human labour	
19.	Ploughs	Ploughs have been common 'for a long time'.	-
20.	Dry-season fodder	None	None
21.	House types	Rectangular mud houses in villages, except for recent migrants who build large rugas.	Small rugas covered in plastic when in transit. large rugas or mud houses at 'home' further north.

The Gurmana people form a contrast, in that they do not attempt to create breeding herds, but buy young male animals to fatten for sale. This may be because unlike these other groups, they did not have muturu cattle previously. Whatever the reason, their strategy for raising livestock closely parallels that of the Hausa of Western Zaria and Kauru.

The Kamberi in the extreme west of the Tegina zone are a small section of this otherwise numerous group described in more detail in Gunn (1960). The central Kamberi of the Salka area do not keep cattle and this practice is only found in the groups between Rijau and Kakihum.

Kamberi pastoral production differs from the other groups who have taken up the management of Zebu because dairy products are systematically exploited. Because muturu were not milked, dairying has little cultural significance for other settled cattle-raisers, who may indeed be lactase intolerant. (Although this would not prevent them from drinking soured milk.) Cattle are occasionally milked by men and fresh milk is drunk within the compound or sold to friends and visitors. However, among the Kamberi, as the FulBe, women are responsible for processing and marketing dairy products and these are sold to provide money for personal expenses. This is bound up with considerable FulBe influence in many other araes of their society, particularly in dress and ceremonies.

Kamberi explain this by saying that their original means of gaining cattle was by working for the FulBe and receiving stock in payment. However, to contrast this state of affairs with the Samba in Gongola State (RIM, 1984c) little assimilation has occured, despite an initially similar means of obtaining cattle.

The isolated Kamberi community in Buzana in the Funafuna survey zone shows yet a third contrast for it is specialised in arable farming, with only goats and sheep, despite regular acquaintance with FulBe na'i who pass through their farms every year.

Small stock in the Tegina/Mariga area are confined to sheep and goats; despite the importance of pigs in other regions of the SHZ, they have signally failed to spread to this area. Although the Kamuku have been heavily influenced by Islam, this is not true for other groups and the lack of interest in pigs probably reflects only their unfamiliarity. The introduction of pigs is often linked with missions, and missions in this region are few and far between.

Tables 11, 12 and 13 compare the modes of production of livestock-rearers in the Tegina/Mariga zones.

3.1.5 Ganawuri

The Aten people have been selected by ILCA for further work as they represent an agricultural people who have taken up cattle-rearing.

GANAWURI

Map XII

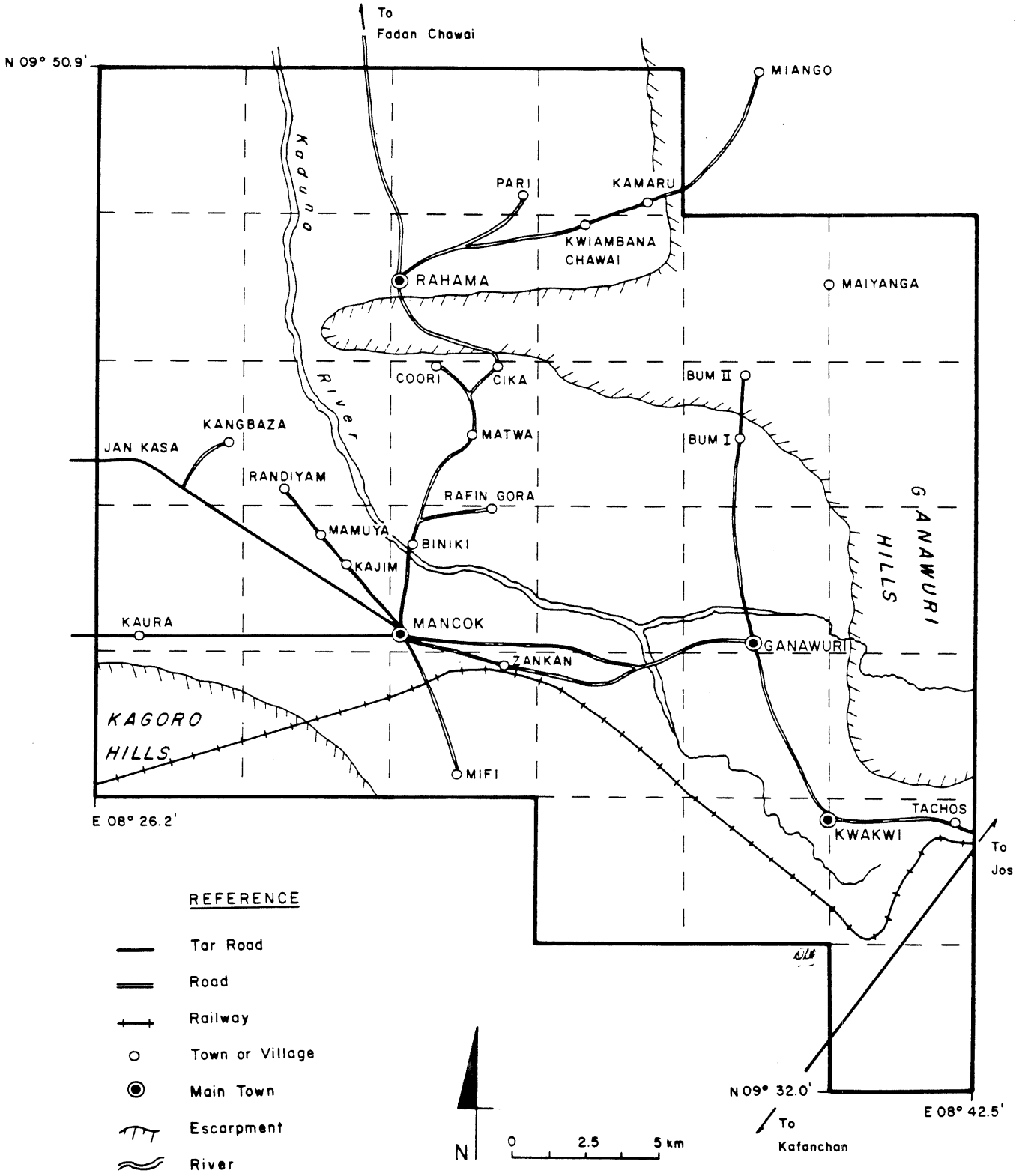


TABLE 14

Topic	Pari, Kamaru	Coori, Mancok
1. Stock-owners	Atsam (=Chawai)	Sholyo (=Moroa, Morowa)
2. Other ethnic groups	Hausa, Tyap, Sholyo Irigwe, FulBe	Ataka, Tyap, Atsam, Aten FulBe, Kagoro
3. Number of years stockowners settled in area	Indigenous	Indigenous
4. Date when cattle-owning began.	Since the early years of this century	
5. Stated purpose of cattle-rearing.	Investment of profits from farm surpluses.	
6. Land rights of stockowners	Land is held by the community and cannot be alienated for any purpose. (Mancok town constitutes an exception to this rule). Indigenes have complete security of tenure unlike immigrant FulBe.	
7. Land sales	None	None
8. Herd sizes of the stock-owners	Average ca. 50 'Most' compounds have cattle.	Range: 5-100 Range: 0-50 Average ca. 20 1 in 5 compounds has cattle
9. Principal breeds of cattle	Zebu:Zebu:Bunaji	Bunaji
10. Other livestock	Pigs (Each compound has at least a breeding pair). Sheep, goats.	Pigs, sheep, goats
11. Livestock owned by farming groups.	As above	As above
12. Movements of herds	Cattle are kept in the area all year round, although in the growing season they are sent into more remote bush areas to minimise possible crop damage.	
13. Non-resident pastoral groups	None	None
14. -	-	-

15. Place of dairying in the household economy	Men milk cattle and the milk is drunk in the compound or sold informally.	Men milk cattle and the milk is drunk in the compond but not sold.
16. Interactions between farmers and pastoral groups.	Good relations	Good relations
17. Exchange relations between graziers and farmers	Cattle are allowed to graze freely on crop residues. Atsam used to hire FulBe herdsmen but no longer do so.	Cattle are not allowed to graze on crop residues as long as fertilizer is available.
18. Fencing of fields.	All arable land to be used is fenced.	Most farmland is fenced against pigs.
19. Ploughs	None	None
20. Dry-season fodder	No	No
21. House types	Rectangular mud-brick houses with thatched or zinc roofs, and a surrounding compound fenced with euphorbia cactus.	

TABLE 15

Topic	Ganawuri	Coori
1. Stockowners	Aten (=Ganawuri)	FulBe Kacecceere'en
2. Other ethnic groups	Ataka, Sholyo, Irigwe	Aten, Atsam, Sholyo, Tyap
3. Number of years stock-owners settled in area	Since the 1830's	Since 1870
4. Date when cattle-owning began	Since 1938	Indigenous
5. Stated purpose of cattle-rearing	As a store of wealth	Subsistence
6. Land rights of stock-owners	Land is vested in lineages but can be alienated with chief's permission.	FulBe have no security of tenure and must depend on the goodwill of the village-heads
7. Land sales	Sales within tribe, but leased to outsiders.	None
8. Herd sizes of stock-owners	Range: 0-115 Average: 40	Average:40-50
9. Principal breeds of cattle	Zebu: Bunaji	Zebu: Bunaji
10. Other livestock held by cattle-owners	Goats: 5-10 per compound Sheep: 1-2 per compound	Goats: 5 per compound Sheep: 10 per herd
11. Livestock owned by arable farming groups	As above	Goats, sheep, pigs, ponies
12. Movements of herds	Stay in area all year round. Dry season crop residue grazing. Sent with children into hills in wet season when crops growing Herds not split.	After the end of the cereal residues in January, the herd is split, and the milk-herd stays at the compound, while the remainder is sent to Kachia
13. Non-resident pastoral groups	Gorkanko'en, SiwalBe, Raahaaji	None
14. Movements of non-resident pastoral groups	The FulBe na'i arrive between October and December to eat the fonio residues, staying for about two weeks. They return briefly in April en route for Bauchi region.	-

15. Place of dairying in household economy	Milk is considered suitable for dogs to drink. Men may milk cattle to sell to FulBe women to market	Women control the entire processing and marketing of dairy products
16. Interactions between farmers and pastoral groups	Relations between FulBe and Aten are usually good	Relations are usually good
17. Exchange relations between farmers and pastoral groups.	FulBe of all types have free access to crop residues after the after the needs of indigenous stock-owners have been satisfied. Neither the Sholyo or the Aten buy dairy products.	
18. Fencing of fields	Fields rarely fenced	
19. Ploughs	None	
20. Dry season fodder	None	
21. House types	Traditional houses had two storeys and complex internal subdivisions, but more recently rectangular mud-brick houses joined by mud walls	Circular mud houses with internal divisions, or large grass rugas for newly settled groups.

They live in the southeastern corner of the aerial survey zone. The area may be characterised by its high rainfall, fertile soils and large indigenous population. It also supports the highest density of cattle, cultivation and arable dwellings of any of the ILCA study areas. Map XII shows the general pattern of roads and rivers in the Ganawuri survey zone. Apart from the Aten, other peoples in the region are the Atsam (Chawai), Ataka, Berom, Faran, Irigwe, Sholyo (Moroa) and Tyap (Kataf). Apart from the indigenous inhabitants, the Atsam region north of the Ganawuri escarpment also has communities of Hausa farmers. In addition, there are a variety of sedentary FulBe groups, related to those in Kurmin Biri and Abet. Few stock-routes cross the area today, because of the expansion of arable farming, although nomadic FulBe are occasionally encountered in transit.

The indigenous farmers fall into two groups culturally, the 'Plateau' peoples and the Southern Zaria peoples. The Berom and Aten speak related languages and lived on the Plateau before 1800. They probably began to move off the Plateau in the 1830's (Morrison, 1976). The Faran, Sholyo, Ataka, and Tyap all belong to the Jju (Kaje) cluster and are closely related to the peoples in Kurmin Biri and Abet. Ethnographic literature on this region includes Morrison (1976), a general survey of the history of the region, Gunn,(1953) for ethnographic summaries and Berthoud (1965, 1966, 1974) for specific material on the Aten. None of these sources deal with livestock-rearing in detail.

The present-day distribution of cattle-rearing does not respect the cultural divisions of the region. There are no muturu cattle in the region today, although these were common on the Plateau in the past, and Berom communities outside the survey area still keep them in small numbers. Morrison (1976) speculates that the cool environment and high rainfall of the Plateau originally attracted cattle-owners, both of muturu and later zebu. However, presently, zebu cattle are kept by the Atsam, Aten, Faran and Sholyo. These cattle have been acquired from the FulBe in this region during the course of this century; in the case of the Faran, only since 1980. The Ataka, Berom Hausa, Irigwe and Tyap remain primarily arable farmers.

Air survey showed that cattle numbers increase some 20% during the wet season; this can be attributed to the return of cattle belonging to FulBe and Atsam people from dry-season transhumance. The lack of temporary pastoral dwellings reflects the low numbers of FulBe na'i passing through. The 'beehive' rugas particularly in the northwest of the survey zone, are the houses built by Sholyo, Atsam and FulBe to manage their herds in the wet season, while remaining close to their farms.

Goats are widespread; both the large savannah and the smaller black dwarf breed. They play an important part in the ceremonial life of all the peoples in the region except the FulBe. Sheep are kept in small numbers; however, the FulBe rear more extensive flocks.

This pattern is familar from many regions of the SHZ; however, more unusual is the widespread presence of pigs. Pigs were only recently introduced in the Southern Zaria; they were brought by missionaries in the 1930's. There was a pig improvement centre near Kagoro in the

colonial period, from which they have presumably spread, but the origin and breed of the initially introduced animals was unknown. Pigs are raised strictly for sale; unlike among the Kofyar, east of Lafia, where a substantial amount of local production is locally consumed. Manchok is the principal pig-market, and trucks come up from the south once a week to buy from producers.

Pigs represent the most important alternative to cattle, if livestock is viewed as an investment option. Pigs are usually fed on spent grains and household refuse, which for a given family are only available in limited quantity. The number of pigs maintained by a household is therefore limited, as is the potential for increase. However, they have the advantage that they are reputedly less susceptable to disease, and capital invested can be rolled over annually. These differences have been resolved among the Atsam by a division of labour; women concentrate on pigs and men herd cattle. Among the Sholyo, pig-raising is practised by both sexes and more complex issues of choice are involved. At present the Aten and Faran do not raise pigs, although this is likely to become important in the near future. Table 14 presents data on the Sholyo and Atsam and should be compared to Table 15 with similar data on the Aten and FulBe.

3.1.6 Pambeguwa

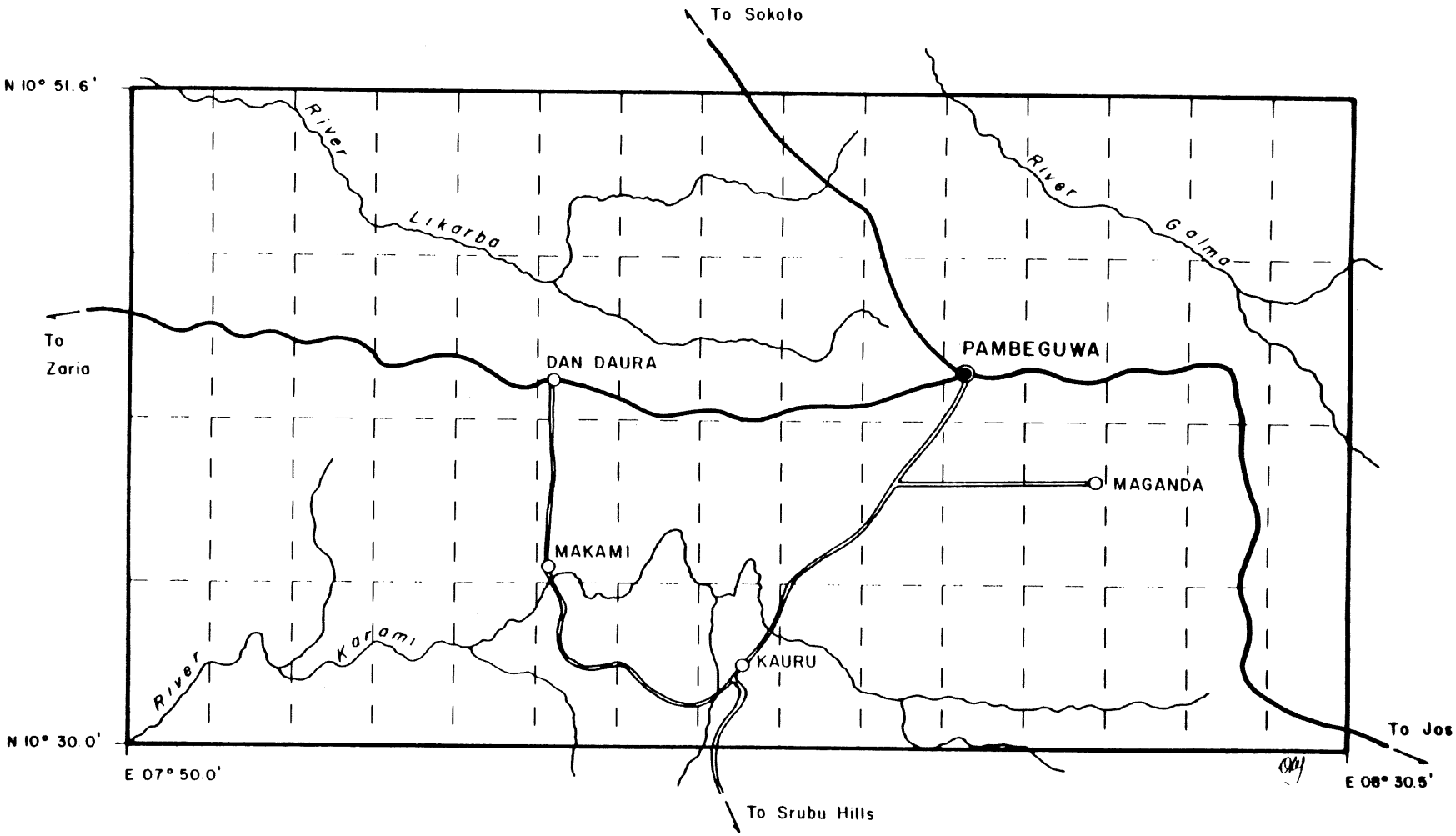
The Pambeguwa survey zone (Map XIII) is bisected horizontally by the principal Jos-Zaria road, and is also the junction for the main road north to Kano. The pattern of cultivation closely reflects this, clustering along the road and beside the Kano and Kauru roads (Milligan et al., 1984: Map 5). Population density appears to have been low in the historical period, but most of it was concentrated on the Karami river south of the road. The presence of the tarmac has attracted these riverine populations, leaving large areas devoid oh human settlement. Kauru, for example, originally an important commercial centre, has declined with the growth of the road towns. The road south from Kauru leads to the plains at the foot of the Srubu hills. The populations living there have been gradually abandoning their hill-settlements since the 1920's and moving down to farm on the plains (cf. Gunn, 1953), a process that is almost complete. The attraction of the road has caused their settlements to drift further north.

In the meantime, the lure of empty farmland has proved attractive to arable farmers undergoing a land-squeeze elsewhere. Since the mid-1970's, Saya farmers from Bauchi State and Irigwe from the Plateau have begun to settle in the vacated regions, and this trend seems likely to continue.

The region north of the tarmac road is more densely settled, mostly with Hausa farmers and settled FulBe of diverse origins. A sizeable seasonal population of transhumant pastoralists who farm in the wet season around Kano and Katsina move to the Pambeguwa area in the dry. Space is freely available at present, so there has been little

PAMBEGUWA

Map XIII



REFERENCE

Tar Road

Road

Town or Village

Main Town

River

N

0 2.5 5 km

friction. Pastoralists claim that the tsetse challenge in the region is quite low, and there has been some spraying along the river in recent years. The increase in dry season cattle numbers and the slightly larger Grazing Unit size shown by the aerial survey reflects this pattern. Another change between seasons is that cattle are more closely correlated with the main roads in the wet season, and with the rivers in the dry season. This reflects the large proportion of cattle associated with FulBe settlements along the road, that are kept around the compound in the wet, but sent to nearby rivers in the dry season.

In contrast to the other study zones discussed in this report, there has been little transfer of cattle to the arable populations. Like the Hausa farmers in the Giwa zone, the local inhabitants raise cattle for resale. Hausa compounds especially have small circular compounds for fattening cattle. Fodder is brought to the stock on a cut-and-carry basis throughout the year, although animals may be taken out to graze on residues if the labour of children is available. South of the study zone proper, this is also common among the Tumi and Vono peoples. In this case, however, cattle are integrated with the arable farming system; their manure is systematically collected and spread on fallow land. Ploughs are known to the FulBe and Hausa from their connections further north, but they are not used in the Pambeguwa region.

Sheep and goats are the principal small stock, and are of the same savannah breeds found west of Zaria. They are kept in small corrals in the wet season, so that their manure can be collected and used to fertilise the fields. Pigs are unknown, although only the area north of the tarmac raod is strongly Islamic. Donkeys and horses are also extremely rare.

Table 16 compares the production patterns of the Hausa of Makami and the settled FulBe of Dan Daura.

3.1.7 Lafia

Southeastern Lafia zone was surveyed in 1979 on the ground and by air (Bourn, 1979; Milligan et al., 1979) but logistic difficulties prevented a resurvey of the zone in 1984. Northeastern Lafia (BICOT) was surveyed in 1982 and 1984 in the dry and wet seasons, respectively. No survey has thus monitored the Lafia Agricultural Development Project (LADP) since it completed its first phase, but the establishment of Grazing Reserves and the assistance offered to arable farmers in the project area has certainly altered the dispositions of human and livestock populations in the Project area. Groundwork was not carried out in 1984, although a meeting with LADP staff produced some observations that are relevant.

In the past the region surrounding Lafia has had a low but diverse human population density. These consisted of Alago, Doma, Jili (Koro), Jukun, Kambarin Beriberi and Tiv farmers. The latter still raise a few muturu cattle in the region. Historically FulBe and their

TABLE 16

Topic	Makami	Dan Daura
1. Stockowners	Hausa	FulBe (Katsinanko'en)
2. Other ethnic groups	FulBe, Saya	Hausa
3. Number of years stock-owners settled in area	Since mid-nineteenth century	since 1982
4. Date when cattle-owning began	ca. 1970	Indigenous
5. Stated purpose of cattle-rearing	Investment of cash surpluses	Subsistence
6. Land rights of stock-owners	Land is held by the heads of compounds and their male heirs and can be alienated.	Rights to farm allocated by Hausa village-heads. Land can be held by kin-groups but not alineated.
7. Land sales	None	
8. Herd sizes of stock-owners	Range: 2-6 Average: 3	Range: 26-210 Average: 110
9. Principal breeds of cattle	Zebu: Bunaji	Zebu: Bunaji, Rahaji
10. Other livestock held by cattle-owners	Goats, sheep, poultry	Goats, sheep, poultry
11. Livestock owned by arable farming groups	As above	As above
12. Movements of herds	Kept inside or adjacent to the compound throughout the year. Fed on a cut-and carry basis.	Taken to the riverside in the dry season.
13. Non-resident pastoral groups	Katsinanko'en Gorkanko'en	Gorkanko'en, Yaabaaji, Kuranko'en, Tubanko'en
14. Movements of non-resident pastoral groups	The Katsinanko'en come in October and return in May/June to their homes further north. Gorkanko'en who do not farm arrive in December to pass south and return in May.	Some groups pass the dry season here and go elsewhere e.g. Pambeguwa for the rains. Others return to the Kano region to farm in the wet season.

15. Place of dairying in household economy	Only male animals are bought, so irrelevant.	Women have complete control over the processing and marketing of dairy products.
16. Interactions between farmers and pastoral groups	Low population density means that interactions are rare.	Good relations
17. Exchanges between farmers and pastoralists	Access to crop residues is either free or a token payment is made.	
18. Fencing of fields	None, with the exception of cassava	
19. Ploughs	None	
20. Dry-season fodder	Cattle are fed on grass or crop residues, brought to the stall	None
21. House types	Rectangular mud-brick houses with external compound wall	Large grass rugas [some with mud granaries] or mud-brick houses

zebu cattle migrated into the region during the dry season, when tsetse challenge and the associated trypanosomiasis risk were lowest, and returned northwards during the wet season. Although this pattern of movement may still persist amongst certain groups, it is generally no longer the case. Since the mid-sixties and especially after the Sahel drought of 1973/74, increasing numbers of FulBe, who previously visited the area on a seasonal basis, have settled permanently in the area. This is reflected in the aerial survey results which indicate substantially higher wet season cattle densities than during the dry season (12.7 and 16.4 animals per square kilometre in the dry season for southeastern and northeastern Lafia survey zones repectively, compared with 37.7 and 22.9 in the wet season.) Seasonal movements obviously still take place, but these are orientated to the flood plains of the Benue and across the river into regions further south still.

Since the mid-1970's, there has been increased pressure on land due to the immigration of farmers from south of the Benue. Indeed two of the grazing reserves proposed in the LADP preparation report had to be dropped because of their high population of arable farmers. As elsewhere, such immigration effectively lowers the tsetse challenge and thus attracts more zebu pastoralists. There has therefore probably been some further settlement of the FulBe in the Lafia region over the past five years, although its extent is unknown. The drought and the rinderpest epidemics are thought to have accelerated this process.

In the Lafia region, there has been no transfer of cattle to the local arable farmers; indeed there appears to be a high level of conflict based on the depredations of cattle. As the most important staple is yams in this region, and as there is little market for dairy products the significant bases for the establishment of exchange relations between farmers and graziers appears to be absent. This situation is very similar to the conflict in the Benue lowlands of southern Gongola State (RIM, 1984c).

Of the FulBe settled in the Lafia area, all farm as well as herd cattle. The average size of herds owned is 70 animals, and this requires that the herd to be split in the dry season. It is usual to leave up to 20 animals at the compound to provide milk, and send the remainder with younger sons to graze by the Benue. LADP have constructed some earth dams to assist pastoralists but they have so far been unsuccessful. Some of the settled FulBe have constructed wells and troughs near their compounds to provide water for their milk-herds in the dry season.

Draught ploughs have made little or no impact in Lafia, despite generous loan terms from the Project. However, the presence of a single successful plough-user, a FulBe who brought his skills from the Kano area, suggests that there is no inherent obstacle to their use. LADP has attempted the introduction of both Stylosanthes and Leucaena as a dry-season fodder crop, but the FulBe have so far remained unpersuaded of their virtues, probably because of the generally abundant pasture. The method used by LADP was to sow demonstration plots and allow the FulBe controlled access. However, work by ILCA staff in Kachia grazing reserve (cf. Saleem, 1984)

suggests that FulBe are unable easily to obtain sufficient land to plant forage legumes, and that it is difficult to persuade arable farmers to undersow cereals unless the economic benefits are more obvious to them.

Sheep are not common in the Lafia area, although a few are kept by the FulBe. There are some of the trypanotolerant 'Yankasa' breeds in the hands of the arable farmers. Goats are widespread and numerous, particularly the black forest dwarf goat. Pigs are becoming increasingly common, and a major item in the livestock trade feeding the large urban markets due south.

3.2 RIM Studies

3.2.1 The Toungo Block

There have been a number of studies of that part of southwestern Adamawa that is currently southern Gongola State in terms of its potential for development. Bawden and Tuley (1966) provided detailed material on patterns of land-use and the high-altitude grasslands; SOTESA (1979) reported on Gongola State as a whole; and LIDECO (1972) reported on the Mambila Plateau. RIM undertook a study of part of southern Gongola State, the Toungo Block, to provide background for a development plan subsequent to tsetse clearance.

The final RIM report on the Toungo Block (Map VI) is now available (RIM, 1984c) and represents the most complete integration of air-ground survey data that has been achieved in the Nigerian SHZ, as well as demonstrating a means of quantifying the potential of development interventions. This section summaries briefly those findings in order to facilitate the comparison with the ILCA case study areas.

Bawden and Tuley (1966) considered the trans-Benue region of southwestern Adamawa to be restricted to dry-season grazing. However, the RIM ground survey found that the Benue lowlands now have a substantial permanent population that is still increasing. The extensive internal migrations within the Toungo Block, made it possible to divide it into a number of 'Cattle Systems' (cf. Map VI) defined by the boundaries of these migrations. The population density is low, although the montane grasslands have large pastoral populations. The region is still in flux as more FulBe na'i are entering into the lowlands every year.

There are two populations, the Samba and the Mambila who have begun to herd zebu cattle on their own account, and both groups are attempting to form breeding herds. Fardon (1980) and Rehfisch (1972) studied these peoples in the era before they began cattle-rearing, and their adoption of an agropastoral economy provides an important case-study of a process that is increasingly common in the SHZ. Neither Samba nor Mambila have integrated their herds with arable farming. Ploughs are virtually non-existent and dairy products are not generally consumed by the indigenous population.

Unlike the arid and the semi-arid zones pastoralists are not constrained by pasture and water, as they are in other places where their herds have expanded to exceptional levels. Only the tsetse fly, G. morisitans , constitutes a block to their further expansion, and recent surveys suggest that this is not as widespread as had previously been thought.

Throughout the Toungo Block, pastoralists were interviewed both individually and at public meetings to discover what they perceived as the principal constraints on cattle production. They were asked to rank these in order of importance; the results were then weighed according to the number of individuals who expressed a given opinion. Table 17 summarizes their rankings according to the tree Development Regions defined by the study.

Table 17 indicates that even if the current rinderpest epizootic is ignored, disease is still the principal difficulty facing pastoralists overall. The related problems of land tenure and conflict with farmers, fall into second place. In comparison with these major overall constraints, other problems are of relatively minor significance. Nevertheless, there was some regional variation in perceived constraints and the rankings given. With these in mind options for livestock extension were conceived in terms of a series of Livestock Development Foci (LDFs), located at sites indicated by the aerial survey as having high cattle concentrations, and at the same time being generally accessible.

Table 18 shows livestock, dwellings and environment within thirty kilometers of the proposed LDFs' and indicates the development options that should be considered a priority in the light of the expressed opinions of the pastoralists in that region.

Apart from the recommendation of specific development inputs, combined air/ground surveys were able to provide a basis for the overall economic assessment of the Toungo Block in terms of for example: the net worth of the livestock populations, values for the mean annual offtake, and annual milk production. Table 19 summarises the macro-economic indicators for the Toungo Block as a whole. In addition the quantitative information provided by integrated air-ground surveys, whether for the entire zone, or for selected sub-regions of it, enables much more reliable estimation of the likely rate of return on any proposed development expenditure.

TABLE 17. RANKED PROBLEMS OF CATTLE PRODUCTION EXPERIENCED BY STOCK OWNERS.

TOPIC	TOTAL	DEVELOPMENT REGION		
		LOWLANDS	GANYE	MAMBILA
1. Rinderpest	26574	14949 (1)	4466 (1)	7159 (1)
2. Other Disease	20464	11377 (3)	3079 (3)	6008 (2)
3. Tsetse	18371	13078 (2)	3993 (2)	1300 (2)
4. Farmer Grazier Conflict	12661	8974 (4)	1200 (7)	2487 (6)
5. Land Tenure	10693	6163 (5)	175 (11)	4355 (3)
6. Dry Season Fodder	3214	0	1210 (6)	2004 (7)
7. Theft	3211	0	400 (9)	2811 (5)
8. Pasture Degradation	3136	0	0	3136 (4)
9. Credit Availability	2962	356 (8)	2156 (4)	450 (10)
10. Water Access	2689	1861 (6)	0	828 (9)
11. Bush Fires	2633	1507 (7)	881 (8)	245 (12)
12. Water Shortage	1468	8 (9)	1460 (5)	0
13. Access Roads	381	6 (10)	300 (10)	75 (13)
14. Salt Availability	330	0	0	330 (11)

Figures in brackets represent Regional Rankings.

The figures were calculated by ranking the ranked preferences of cattle-owners expressed in meetings and during interviews, and assigning them numbers from 11 to 1 in terms of decreasing significance. These numbers were then weighted by multiplying them with the numbers actually present at the meeting.

TABLE 18: LIVESTOCK POPULATIONS, HUMAN HABITATION AND WATER AVAILABILITY WITHIN 30 KM PROPOSED LIVESTOCK DEVELOPMENT FOCII, WITH DEVELOPMENT PRIORITIES.

LDF Location*		JAL	BANT	GEMB	GANY	BALI	SGID	MARA	NGUR	MBAM
Implem level		1	2	2	2,3	3	3	3	3	3
Devel Region**		-	BL	SU	GL	BL	BL	BL	SU	SU
LIVESTOCK										
Cattle No	W	1675	104100	261400	59900	24100	70700	55200	184500	226500
	D	15600	74400	145800	26900	15700	78100	26400	108400	138000
Sheep No.	W	600	9800	9400	6500	800	11800	2700	8300	6400
	D	2700	10700	17000	6100	60	11200	1200	12300	13300
Goat No.		33600	223600	90300	250500	51900	54400	86800	44300	123000
DWELLINGS										
Arable No.	©©	30800	105900	80700	105700	29100	31100	38400	84900	73200
Past. No.	W	1100	4900	6000	2100	1000	1400	2200	5400	5810
	D@	1000	3300	12300	3100	1200	2300	800	9200	10600
ENVIRONMENTAL										
mean % Cult.		14.0	6.6	11.3	10.2	2.4	6.0	3.7	9.8	12.6
% grids with Water (D)		44	42	88	48	35	27	43	94	90
DEVELOPMENT OPTION:					PRIORITY					
Information/Advice			+	+	+	+	+	+	+	+
Vetinerary assistance			+	+	+	+	+	+	+	+
Grazing Reserves			+				+	+		
Crop Residues					+					
Range Management					+					
Credit										
Sheep			+		+					
Goats					+			+		
Muturu						+		+		
Zebu			+	+	+				+	+
Land Tenure				+					+	+
Tsetse Control					+	+				
Banking						+				
Markets							+			
Roads				+					+	+

* Jal = Jalingo, Bant = Bantaji, Gemb = Gembu, Gany = Ganye, Sgid = Sabon Gida, Mara = Mararaba, Ngur = Nguroje, Mbam = Mbamnga.

** Development Regions as defined in text: BL = Benue Lowlands, GL = Ganye Lowlands, SU = Southern Uplands.

W = Wet Season D = Dry season

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TABLE 19. MACRO ECONOMIC KEY INDICATORS FOR LIVESTOCK IN SOUTHERN GONGOLA STATE.

Indicator	Wet Season@	Zonal@	Dry Season@
Total Land Area (sq. km.)		43,875	
Total Cattle Population	686,700		596,700
Value (million Naira)	349		303
Overall Cattle Density/sq.km.	15.7		13.6
Effective Cattle Density/sq.km. *	22.7		19.7
Herd** Structure			
% Males			37.6
% Females			62.4
% Calves less than 1 yr.			22.0
Total Number of Herds**	3690		3208
Mean Herd** Size		186	
Median Herd** Size (Mambila)		35	
Mean Herd** Size (Mambila)		248	
Median Herd** Size (Ganye)		75	
Mean Herd** Size (Ganye)		45	
Mean Annual Offtake (at 10%)	68,670		59,670
Live Weight (tonnes)	23,819		20,698
Liveweight Value (million Naira)	53		46
Carcass Weight at 50% (tonnes)	11,909		10,349
Annual Milk Production (tonnes)	41,500		36,000
Value of Milk Production (million Naira)	41.5		36
Pastoral Sheep Population	57,200		66,500
Value of Sheep Population (million Naira)	2.3		2.7
Goat Population		846,000	
Value of Goat Population (million Naira)		25.4	

@ Seasonal population levels and densities from text. As estimates of values for annual parameters depends on which season's figures are used, both are given to indicate range. Some of the parameters do not vary with season.

* Taking into account the proportion of land suitable for cattle.

** Herd defined as number of cattle owned by an individual, as opposed to managed in a grazing unit.

SECTION 4: SUMMARY AND CONCLUSIONS.

This synthesis highlights the essential features of integrated aerial and ground surveys carried out in Nigeria by the International Livestock Centre for Africa and Resource Inventory and Management Limited from 1979 to 1984, and illustrates some of their development applications.

Aerial survey, data collection and computer analysis techniques have been developed and are now well established. They provide a rapid, objective and cost-effective means of assessing the distribution and abundance of a wide range of natural and human resources over extensive land areas. In particular they have been used to determine the levels of such key agricultural parameters as: livestock populations, cultivation levels, cropping patterns, arable and pastoral habitation.

Systematic reconnaissance flights provide uniform sample coverage over selected areas of interest. Information is collected in the air by a combination of direct visual observation, and oblique or vertical photography, using small format cameras fitted with wide angle or telephoto lenses. After detailed photointerpretation the information is recorded on a microcomputer data base, prior to analysis and mapping using customised software.

Aerial survey results are graphically summarised in the form of computer generated maps showing the distribution pattern of selected parameters, and numerically presented in tabular form showing overall population or area estimates, as well as stratified subtotals. The latter may include breakdowns by region, development area, rainfall zone, accessibility, or populations within specific catchment areas.

All forms of remote sensing require ground validation for their interpretation. Aerial surveys are no exception, and, as we hope this synthesis has amply demonstrated, the integration of additional information obtained from complementary ground studies greatly enhances their value and relevance. Distribution patterns determined from the air provide a basis for targetting more detailed ground studies designed to assess such factors as characteristic local farming systems, livestock production modes, perceived constraints, development options, movement patterns, marketing and prices.

It is important to appreciate that agricultural projects and farming system studies in Nigeria are taking place in the context of widespread environmental change, resulting from the ever-increasing impact of human population growth, agricultural expansion and the processes of economic transformation. Indeed, the pervading impressions gained from survey work in Nigeria SHZ have been the dynamic nature of livestock production and the changing pattern of land use. Intermittent droughts and increasing competition for limited resources to the north, will inevitably continue to place more and more demands on the Subhumid zone in the future.

For appropriate agricultural development policy decisions and sound management under such circumstances, it is clearly important that: both natural and human resources be reliably assessed; their various interactions be adequately understood; and the major trends be properly identified.

Rapid resource surveys and farming system studies are intended to provide that knowledge and understanding. The present report demonstrates that such baseline information maybe used for a variety of purposes ranging from project identification, appraisal and planning, to longer term monitoring and evaluation. Economic indicators can be more reliably determined and the appropriateness of development proposals can be more objectively judged. Current distribution maps and population estimates can also provide an sound basis for assessing the allocation of government resources, the siting of development inputs and assessing target populations.

Integrated air-ground studies have recognised a variety of significant changes taking place in different parts of Nigeria. Some of those more generally relevant to livestock development in the Subhumid zone are given below:

Continued expansion into and settlement of the Subhumid zone, by arable farmers from both north and south, with commensurate increases in the extent of cultivation, very much orientated along the lines of the nation's expanding road network.

Gradual southward dispersal of cattle and pastoral populations, possibly encouraged by the declining importance of tsetse and trypansomiasis, and hastened by drought conditions and land use pressure further north.

A wide central corridor, with a recent history of relatively good communications and accessibility, is postulated to bridge the Subhumid zone and link the heavily populated regions to the north and south of Nigeria. It is suggested that the expansion of human settlement, cultivation, and livestock populations within the zone is preferentially taking place along and within this corridor, while to the east and west the pace of change is somewhat slower.

Year round presence of some 5-6 million head cattle within the Subhumid zone. Precise estimates vary depending on season and statistical assumptions, but greatly exceed the number formerly considered to be present.

In contrast to much of the surrounding lowlands, the Jos and Mambilla plateaux support major concentrations of cattle, particularly in the wet season when cattle density maybe 2-3 times greater than during the dry season. However, these highland areas are of relatively limited in extent, and their potential for increased production is not great.

The distributions of cattle and cultivation were very closely associated within most survey regions in the Subhumid zone, with cattle density increasing with the proportion of land under cultivation to peak at around 60%.

Comparison between survey regions revealed highly significant correlations between: cattle density and dry season water availability, which were positively related; and cattle density and the density of vegetation, which were negatively related. Multiple regression analysis indicated that dry season water availability and the vegetation density were the primary predictors of cattle density, in both wet and dry seasons.

Increasing sedenterisation of pastoral populations, and generally more restricted livestock movement patterns.

Evidence of limited transfer of livestock ownership to arable farmer communities.

Whilst much has been achieved during the last few years of integrated air/ground surveys in Nigeria, considerable scope remains for wider application and further development of techniques. For example, as far as ground validation is concerned, future surveys would benefit from more comprehensive assessments of characteristic ethnic building styles; typical farming system associations; livestock/habitation ratios; and average occupancy rates.

The survey work carried out in Nigeria has concentrated on the Subhumid zone. Nevertheless large areas of that zone remain inadequately sampled, especially to the west and south. There is therefore a strong argument for extending the coverage of integrated ground surveys not only within the Subhumid Zone, but also into the other zones, particularly to the north.

Finally, interested readers may wish to know that a companion report is in the course of preparation, which will review the findings of aerial surveys and related ground studies carried out elsewhere in West Africa, and will place this Nigerian synthesis in a regional setting.

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APPENDIX 1.

1. THE SURVEY METHODOLOGY

The four man survey team consists of the pilot; two observers seated behind the pilot, each responsible for recording livestock and human habitation seen to the left and right of the aircraft; and a front seat observer who navigates and records land use, vegetation and selected environmental conditions (Table 1.)

The ground area sampled is restricted to two strips, one on each side of the aircraft, and demarcated by externally mounted adjustable viewing frames. The total ground strip width, when flying at 700 feet above ground level, varies between about 400 and 800 meters depending on the equipment available. Any deviations from the desired height are recorded, and the data corrected accordingly. The overall sampling achieved thus varies between approximately 5 and 15%.

All herds (grazing units) of cattle observed within the two sampling strips are recorded, and a visual estimate of the number of animals they contained is made. When possible, grazing units of more than ten animals were photographed, so that definitive counts could be made, the daily bias of each observer calculated, and the initial estimations then corrected. The numbers of other livestock, such as sheep and goats and equines are also recorded, as are those of wild animals. Because they are easily obscured from the air, the populations of small ruminants assessed from the air are likely to be underestimated in areas of thick vegetation cover, though the relative distribution patterns obtained should be reliable. On the basis of information collected on the ground (RIM, 1984), all small ruminants recorded in such regions are considered to be sheep which belong to pastoralists. In the more open areas, however, these small livestock are more amenable to aerial survey techniques, though sheep and goats cannot be distinguished.

The type of all human settlements within the sample strips is also recorded, and the number of dwellings they contained estimated.

Once the numerical estimates have been corrected for observer bias and altitude deviation, the total population estimates for each parameter is calculated by applying the ratio method of Jolly (1969) as described by Norton Griffiths (1978) and used by Milligan et al (1979).

This ratio estimate assumes that the larger the sample unit (line of grids), the more reliable the count obtained from it. The calculation thus weights the overall variance in favour of the longer flight lines, by taking into account the co-variance between the individual sample areas and the animals counted in them. Estimates of the cattle population and the number of herds within the survey zone were computed using the following equations:

Population Total : $Y = z \cdot R$

Population Variance: $Var(Y) = \frac{N(N-n)}{n} \cdot (s^2_y - 2.Rs_{yz} + R \cdot s^2_z)$

Where:

N = the potential number of sample units in the survey region.
n = the actual number of sample units surveyed.
Z = the area of the census zone.
z = the area of any one sample unit.
y = the number of animals counted in that unit.
R = the ratio of the animals counted to the area searched.

and

s^2_y = the variance of animals counted between sample units.

s^2_z = the variance of sampled area between sample units.

s_{yz} = the covariance between counts and areas of each unit.

TABLE 20. ESTIMATED LIVESTOCK POPULATIONS IN SOUTHERN GONGOLA STATE ASSUMING DIFFERENT LEVELS OF UNDERCOUNTING DUE TO LAND DISSECTION AND THICK VEGETATION COVER (Percentage increase over actual estimate in brackets).

		Cattle		Goats
		Wet	Dry	
Actual Estimate		686,700	596,700	845,800
Proportion observed	Land Type			
0.5	Dense Cover*	692,563 (0.9)	601,616 (0.8)	850,629 (0.6)
0.25	"	698,426 (1.7)	606,532 (1.7)	855,458 (1.1)
0.1	"	745,330 (8.5)	645,860 (8.2)	894,090 (5.7)
0.5	Dissected**	750,908 (9.3)	617,524 (3.5)	850,629 (0.6)
0.25	"	815,116 (18.7)	638,348 (7.0)	942,380 (1.1)
0.1	"	1,328,780 (93.5)	804,940 (34.9)	894,090 (5.7)

* Dense cover taken as areas with vegetation density index 300.

** Dissected land identified from Bawden and Tuley (1966).

2. Evaluation of the accuracy of aerial counts

The validity of aerial counts of livestock in areas covered by dense vegetation has always been the subject of debate. To assess the accuracy of the figures upon which this report relies, the most complete data set available was used - that from southern Gongola. The overall population figures calculated for cattle (and goats) was recalculated assuming various degrees of undercounting in densely forested land.

The grid squares with dense cover were identified as those to which were assigned a vegetation density score of more than 300. This represents the interface between open canopy and savannah woodland.

Table 20 shows that if half the cattle were missed in these grids, then the total population of southern Gongola should be revised upwards by less than 1%, and that even if 90% of the animals escaped observation, the uncorrected figures are only underestimates by approximately 10%. This suggests strongly that, unless there were large numbers of cattle in closed canopy forest, which seems unlikely, then, at least in this survey, which relied on experienced observers, dense vegetation cover affected the accuracy of the counts only marginally.

Table 20 also shows the corrections necessary if cattle were undercounted in steeply dissected land. The implied errors are considerably greater than those just described. However it seems unlikely that the degree of undercounting would exceed 5 or 10% as dissection per se does little to obscure the view of the ground from above. Indeed, there is a case for suggesting that cattle numbers in such areas may be overestimated, as the effective sample strip width is larger because any deviation from the horizontal will increase the linear dimensions of the area passing through the sample band.