

INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA
SUB-HUMID ZONE PROGRAMME
AERIAL SURVEY UNIT
KADUNA, NIGERIA

DRY SEASON AERIAL SURVEYS OVER EIGHT REGIONS OF
THE NIGERIAN SUB-HUMID ZONE - MARCH/APRIL 1984

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1 SUMMARY.

Systematic low altitude aerial surveys of cattle, human habitation and land use were carried out over eight areas of the Sub-humid Zone of Nigeria, in the late dry season (March/April) of 1984. Subsequently ground studies were conducted on the basis of the preceding findings from the air. This preliminary report describes the initial results of the aerial surveys, before ground investigations were completed. In due course a more comprehensive treatment, synthesising both ground and air data will be produced.

The areas surveyed were: Kurmin Biri, Abet, Mariga, Pambegwa, Funa Funa (an extension of Mariga), Ganauri (an extension of Abet), Tegina/Minna, and West Zaria. Aerial surveys of the first three areas had previously been surveyed from the air by ILCA in the dry season of 1979. Thus, it has been possible to compare the two sets of results and identify the major changes that have occurred over the past five years.

Of the three areas surveyed in 1979, Abet remains much the most densely stocked with 33 cattle per square kilometer. However, the cattle populations of both Abet and Kurmin Biri have declined since 1979, the latter significantly so, while that of Mariga has increased. Cattle distributions have changed little within any of these areas, though minor shifts have been identified in Kurmin Biri and Mariga.

Mean herd size ranged from 27 in Mariga to 48 in Abet, which is similar in range and order to 1979. Mariga held a greater proportion (90%) of smaller herds than the other two regions, as was also the case in 1979.

Pastoral dwellings were sparsely distributed in all the repeated survey regions, at densities of 0.3 to 1.0 per square kilometer. The lowest levels were found in Kurmin Biri. Most were "settled" Fulani and very few were "agropastoral". An apparent decline in pastoral habitation is being investigated on the ground.

Cultivation intensities in 1984 remained at levels similar to those found in 1979 (10-20%) Abet being the most densely cropped. This confirms that of the three established case study areas, Abet is the most heavily utilised.

In the five newly surveyed regions, cattle densities ranged from 2.9 per square kilometer in Funa Funa, to 24.4 per square kilometer in Ganauri and West Zaria. Small herds were most frequent in Funa Funa, as in neighbouring Mariga. Larger herds were more common in Tegina-Minna and Pambegwa, where the mean herd sizes were similar, at 40 or more, to those found in Abet.

Pastoral habitation density varied from 0.2 per square kilometer in Funa Funa, to 1.7 per square kilometer in West Zaria. These densities were therefore similarly low to those in the established case study areas.

Three of the areas contained a high proportion (47-71%) of "nomadic" Fulani dwellings - Pambegwa, Funa Funa and West Zaria, while Ganauri and Tegina-Minna are more similar to the repeated areas. Two areas - Tegina-Minna and Ganauri - supported relatively high proportions (25-45%) of "agropastoral" dwellings. In Pambegwa a few Fulani settlements atypically contained granaries.

Mean cultivation levels varied widely (8-33%), with Ganauri having the highest.

Significant positive correlations are established between cattle density and, both, mean percentage cultivation (p 0.02), and density of pastoral dwellings (p 0.05). A less significant positive relationship is demonstrated between cultivation and pastoral habitation.

2 INTRODUCTION.

Soon after its establishment in Nigeria, the International Livestock Centre for Africa's Sub-Humid Zone Programme began an innovative series of systematic low altitude aerial surveys. The objectives of the surveys were to assess the seasonal distribution and abundance of cattle; and to determine the patterns of land use and human settlement in selected regions of the sub-humid zone (Milligan, Bourn and Chachu, 1979). The survey regions, themselves, subsequently become the subject of detailed ground investigation, as ILCA Case Study Areas.

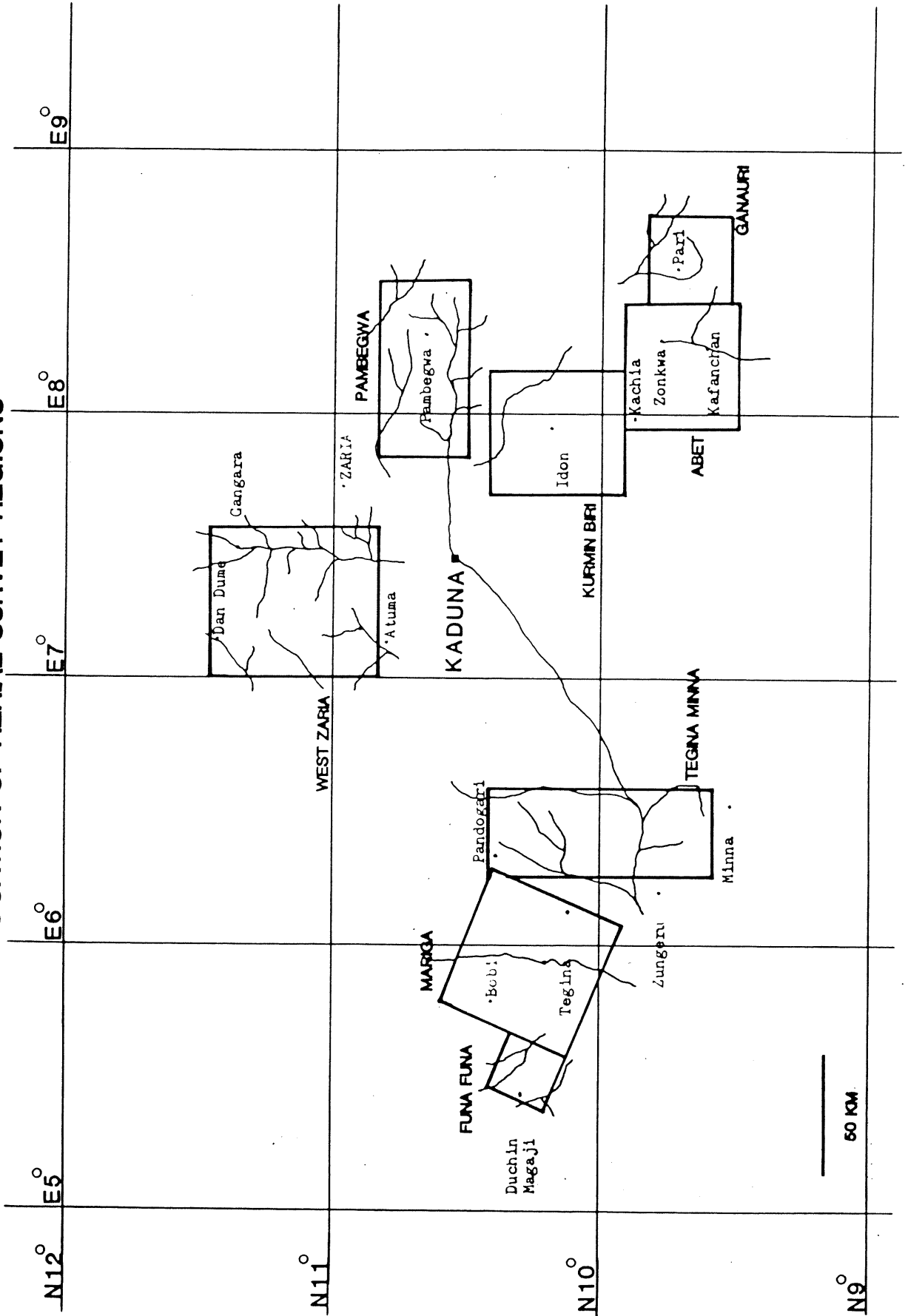
Five years later, for comparative purposes, it was considered desirable to carry out repeat surveys over three of the original areas study areas: Kirmin Biri, Abet and Mariga. In addition aerial surveys were also carried out over five new areas: Pambegwa, Funa Funa, Ganauri, Teginna-Minna and West Zaria. The location and relative size of these eight areas are indicated in Map 1. This report presents the results of a preliminary analysis of the aerial survey data obtained in March/April 1984 - during the late dry season.

Following on from these dry season aerial surveys, brief but intensive socio-economic ground studies were instigated, with special attention being focussed on cattle owners in those areas where concentrations of cattle had been revealed. These ground investigations have only recently been completed and will be reported on separately.

Further aerial surveys are planned towards the end of the 1984 wet season, the results of which will be included in a final comprehensive report.

MAP 1

LOCATION OF AERIAL SURVEY REGIONS



3 METHODS.

The aerial survey, data collection and data analysis techniques employed, were the same as those used for the earlier ILCA aerial surveys, and described in detail by Milligan, Bourn and Chachu, (1979).

Essentially, a series of regularly spaced parallel flight lines, was flown over each survey area, at as near constant height above ground as possible. Each flight line was divided up into portions of equal length; thus establishing a systematic grid sampling pattern over each area.

Depended on the area surveyed, flight line spacing was either 5 or 10 kilometer, and flying altitude was either 700 or 1,000 feet above ground level.

As well as the pilot, three observers were employed on each survey. The front seat observer, who, in addition to acting as navigator, was primarily responsible for recording land use and environmental conditions. Two backseat observers counted and/or photographed, the number of cattle and "shoats" in each herd, and the number of arable and pastoral dwellings, lying within fixed strips of land on each side of the aircraft. The width of each strip of land was defined by visual projection through two parallel rods attached to the wing struts, and depended on the flying altitude and the predetermined rod spacing.

The sampling intensity of each survey varied between 5 and 15 %, depending on the particular combination of flight line spacing, flying altitude and strip width.

Although the kind of information collected in both the 1979 and 1984 was virtually the same, one important change was made by redefining pastoral habitation into three sub-categories on the following basis:

"Agropastoral": Dwelling with associated corral(s), and cropland.

"Settled": Typical Fulani "beehive" rugga with corral(s).

"Nomadic": Shelters with corral(s); often made of cut branches and leaves with blue plastic, or from crop stalks, and "wigwam" like in appearance.

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

This modification to data recording precludes exact comparison of the 1979 and 1984 pastoral populations

4 RESULTS.

The eight aerial survey regions occupied a total land area of some 19,015 square kilometers of the Sub-humid Zone in Niger and southern Kaduna States, and contained an estimated 350,450 head of cattle. Overall cattle density was 18.4 animals per square kilometer, or alternatively there was an average of 5.4 hectares per animal. The survey zones ranged considerably in size. At 750 square kilometers, Funa Funa was the smallest, and Tegna-Minna was the largest, occupying a land area of 3,390 square kilometers. As expected a wide variation in cattle density was encountered in different zones, and the distribution within any one zone was far from uniform.

In the following sections the results for the three survey zones, which had previously been surveyed in 1979, are considered first; followed by the newly surveyed areas.

4.1 Repeated Survey Areas.

4.1.1 Kurmin Biri.

Quantitative results for both the 1979 and 1984 dry season aerial surveys of the Kurmin Biri area are summarised and compared in Table 1. 1984 distribution patterns of cattle, pastoral habitation and cultivation are illustrated in Map 2. Comparable distribution maps for 1979 are to be found in Milligan, Bourn and Chachu, (1979).

In 1984 the total cattle population was estimated to be some 19,790, with a standard error of 18%. This represents a mean density of 7.9 animals per square kilometer, or a stocking rate of 12.6 hectares per head. The majority of cattle were concentrated to the north-west and south-east of Kurmin Biri Grazing Reserve, located in the centre of the study area. The highest densities were recorded in the south-eastern quadrant, towards Abet, while to the north-east, despite the general proximity of the Kaduna river, the area was almost completely devoid of cattle.

A total of some 510 cattle herds were estimated to be within the area. Mean herd size was estimated to be 37 (SE=3). 58% of all herds contained less than 40 head, while a comparatively high proportion (28%) fell within the range 41-60 animals.

An estimated total of some 670 pastoral dwellings were found within the area - equivalent to one per 3.7 square kilometers, or 0.27 per square kilometer. Of these 64% were considered to be "settled" Fulani, 17% "nomadic" Fulani, and 19% "agropastoral".

Cultivation intensity was low, with a mean level being about 10%, and only rarely exceeding 20% within any one 25 square kilometer grid cell. The distribution patterns of cultivation and cattle broadly coincided with each other.

At 19,800, the 1984 cattle population was less than half the 43,200 estimated in 1979. The difference is significant, and corresponds with a substantial reduction in the total estimated number of herds, and mean herd size from 51 in 1979 to 37 in 1984. This would seem to indicate a reduced presence of larger transhumant herds during the 1984 survey.

The overall pattern of cultivation was similar in both surveys, but the estimated proportion of land under cultivation appeared to have declined from 15% in 1979 to 11% in 1984. However, within the limits of error, this difference is not significant.

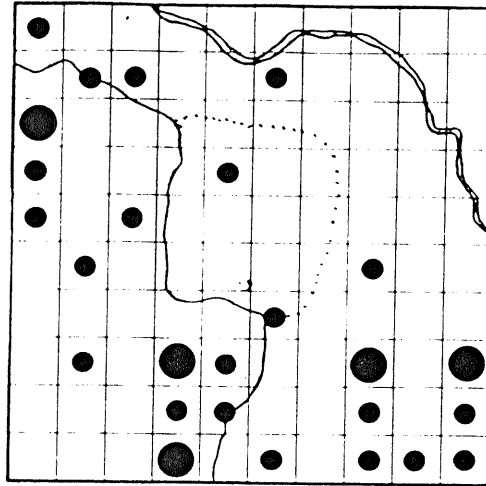
TABLE 1: SUMMARY OF CATTLE, PASTORAL HABITATION AND CULTIVATION IN KURMIN BIRI.

	1984	1979
<u>FLIGHT INFORMATION:</u>		
Area Surveyed - sq.km.	2,500	2,500
Date Flown	21 March	23 February
Flying Altitude - feet	1,000	1,000
Sample Intensity - %	14.7	14.7
<hr/>		
<u>CATTLE:</u>		
Total Population (%SE)	19,800 (18)	43,200 (9)
Density Cattle - per sq. km.	7.9	17.7
Stocking Rate - ha./hd.	12.6	5.6
Total Herds	510	860
Mean Herd Size (SE)	37 (3)	51 (4)
<hr/>		
<u>PASTORAL HABITATION:</u>		
Total dwellings	670	
Density - per sq. km.	0.3	
Settled Fulani - % Total	64	
Nomadic Fulani - % Total	19	
Agro-pastoral - % Total	17	
<hr/>		
<u>CULTIVATION:</u>		
Mean %	11	15

KURMIN BIRI

CATTLE

- 40+ /sq km
- 10-40 /sq km
- 0-10 /sq km



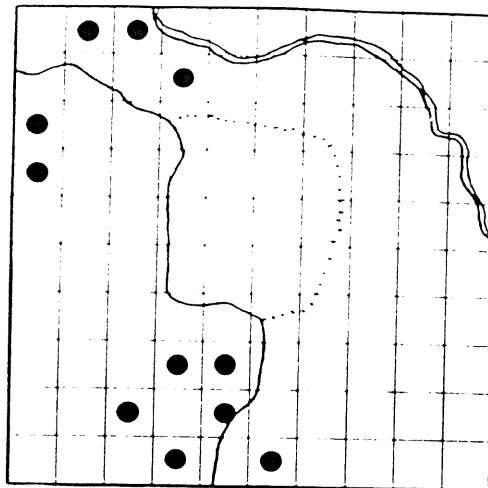
TOTAL
19,800

DENSITY /sq km
7.9

PASTORAL

DWELLINGS

- 6+ /sq km
- 1-6 /sq km
- 0-1 /sq km



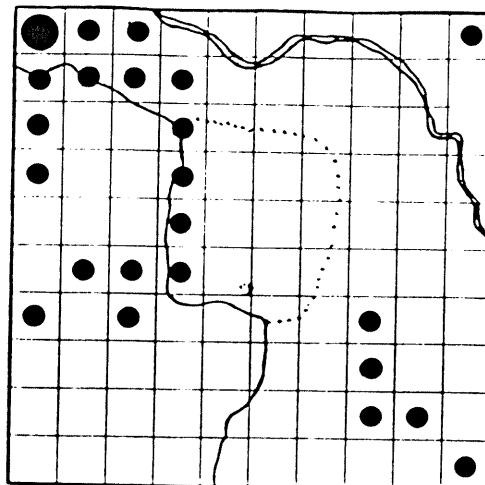
TOTAL
670

%Settled 64 %Nomad 19

%Agropastoral
17

%CULTIVATION

- 30+ %
- 11-29 %
- 0-11 %



MEAN %
11

4.1.2 Abet

Table 2 summarises the results for both the 1979 and 1984 dry season surveys of the Abet area. The 1984 distribution patterns of cattle, pastoral habitation and cultivation are indicated in Map 3. Comparable distribution maps for 1979 are to be found in Milligan, Bourn and Chachu, (1979).

The 1984 dry season total cattle population in the Abet area was estimated to be 81,200 (S.E.=12%), equivalent to a density of 32.2 cattle per square kilometer, or a stocking rate of 3.1 hectares per head. The 1984 cattle population was lower than the 1979 figure of 92,500, though not significantly so.

The distribution pattern of cattle has not changed substantially over the past five years. As in 1979, the greatest 1984 concentrations were found in the south-west quadrant of the survey area, including the western portion of the Grazing Reserve. Relatively few cattle were found to the east and south-east.

A total of some 1,710 cattle herds were estimated for the 1984 dry season, 12% fewer than the 1,940 in 1979. Half the 1984 herds contained less than 40 animals, and the mean herd size was 48 (S.E.=2.6). The latter figure was identical to the number determined in 1979. In comparison with the other areas surveyed, Abet was characterised by having the lowest proportion of small herds and the largest mean herd size.

The number of pastoral dwellings within the Abet survey area was estimated to be 2,810, at an mean density of 1.1 per square kilometer. 82% were of the "settled" Fulani type - the highest proportion in any of the areas surveyed; 8% were of the "nomadic" Fulani type; and 10% were "agropastoral". As in 1979, "settled" Fulani ruggas were scattered throughout the study area, with the highest densities coinciding approximately with the major cattle concentrations in the west, but mainly outside the Grazing Reserve.

The mean level of cultivation was estimated to be 20% in 1984, slightly but not significantly lower than the 24% estimated for 1979.

TABLE 2: SUMMARY OF CATTLE, PASTORAL HABITATION AND CULTIVATION IN ABET.

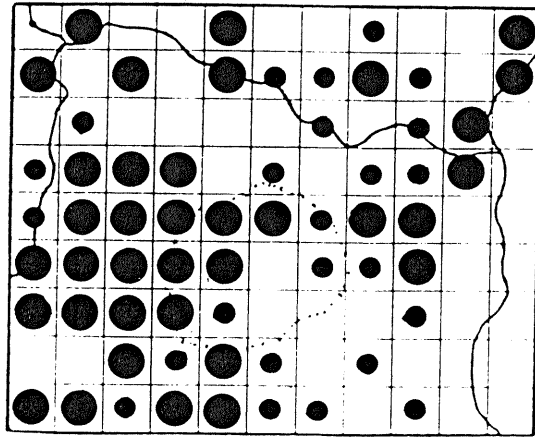
	1984	1979
<u>FLIGHT INFORMATION:</u>		
Area Surveyed - sq. km.	2475	2475
Date Flown	22 March	24 February
Flying Altitude - feet	1000	1000
Sample Intensity %	14.7	14.7
<hr/>		
<u>CATTLE:</u>		
Total Population (%SE)	81,200 (12)	92,500 (13)
Density Cattle - per sq. km.	33	37
Stocking Rate - ha./hd.	3.1	2.7
Total Herds	1,710	1,940
Mean Herd Size (SE)	48 (3)	48 (2)
<hr/>		
<u>PASTORAL HABITATION:</u>		
Total Dwellings	2,800	
Density - per sq. km.	1.1	
Settled Fulani - % Total	82	
Nomadic Fulani - % Total	8	
Agro-pastoral - % Total	10	
<hr/>		
<u>CULTIVATION:</u>		
Mean %	20	24

MAP 3

ABET

CATTLE

- 40+ /sq km
- 10-40 /sq km
- 0-10 /sq km

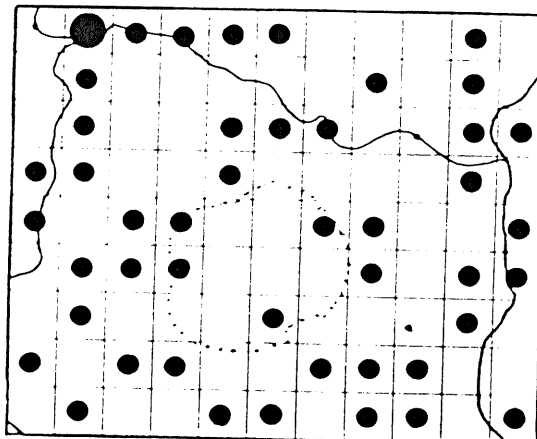


TOTAL
81,200

DENSITY /sq km
33

PASTORAL
DWELLINGS

- 6+ /sq km
- 1-6 /sq km
- 0-1 /sq km



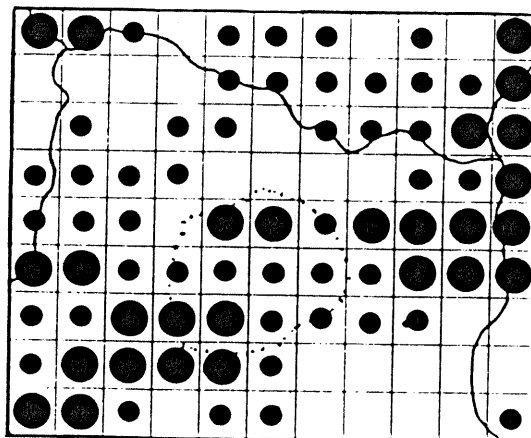
TOTAL
2,800

%Settled 82 %Nomad 8

%Agropastoral
10

%CULTIVATION

- 30+ %
- 11-29 %
- 0-11 %



MEAN %
20

4.1.3 Mariga.

Table 3 summarises the results of both the 1979 and 1984 dry season aerial surveys of Mariga. The 1984 distribution patterns of cattle, pastoral habitation and cultivation are illustrated in Map 4. Comparable distribution maps for 1979 are to be found in Milligan, Bourn and Chachu, 1979.

The cattle population in the Mariga survey area was estimated to be 25,800 (S.E.=17%), that is 9.4 per square kilometer, or 10.7 hectares per head. These levels are somewhat greater than the total of 18,200 (S.E.16%) estimated for 1979, but the difference is not statistically significant. The major concentrations in 1984 were recorded in the north-west, bordering the Teginna-Minna study area, and in the south. These concentrations tended to surround, rather than overlap the regions of greatest water availability.

Some 940 cattle herds were estimated to be within the Mariga area during the 1984 aerial survey. Mean herd size, at 27 (SE=2.9), was similar to the figure of 25 animals calculated for 1979, and was the lowest determined for any of the eight survey areas. Not surprisingly, herd size distribution was more heavily skewed towards the smaller cohorts than for any of the other areas, with some 90% of herds having less than 40 head.

The area contained an estimated total of some 2,730 pastoral dwellings, at an overall density of 1 per square kilometer. "Settled" Fulani comprised 59% of the total, while 24% were considered to be "nomadic" Fulani, and 17% "agropastoral". The majority of the "settled" Fulani were seen in the north-east of the study area.

As in Kurmin Biri, mean cultivation levels were low, - approximately 10% - and no grid was recorded as being more than 30% cultivated. Most of the cultivation was found in the east and the north-east. The 1984 distribution pattern of cultivation was similar to that of 1979, except that less cultivation was found in the north-western sector. The overall proportion of cultivated land fell from 13% in 1979 to 10% in 1984, but again this difference is not statistically significant.

TABLE 3: SUMMARY OF CATTLE, PASTORAL HABITATION AND CULTIVATION IN MARIGA.

	1984	1979
<u>FLIGHT INFORMATION:</u>		
Area Surveyed sq. km.	2,750	2,750
Date Flown	23 March	25 February
Flying Altitude - feet	1,000	1,000
Sample Intensity - %	14.7	14.7

<u>CATTLE:</u>		
Total Population (%SE)	25,800 (17)	18,200 (16)
Density Cattle - per sq. km.	9.4	6.6
Stocking Rate - ha./hd.	10.7	15.1
Total Herds	940	740
Mean Herd Size (SE)	27 (3)	25 (9)

<u>PASTORAL HABITATION:</u>		
Total Dwellings	2,730	
Density - per sq. km.	1.0	
Settled Fulani - % Total	59	
Nomadic Fulani - % Total	24	
Agro-pastoral - % Total	17	

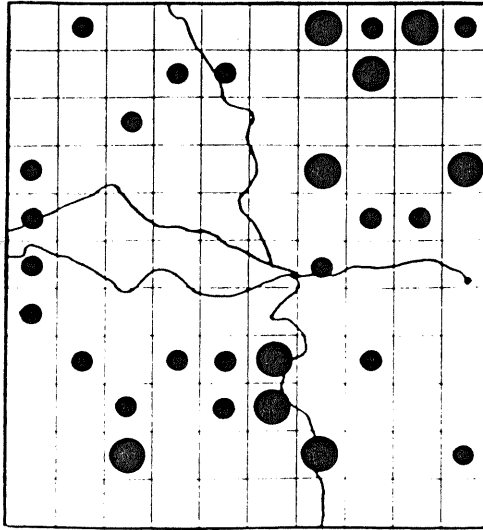
<u>CULTIVATION:</u>		
Mean %	10	13

MAP 4

MARIGA

CATTLE

- 40+ /sq km
- 10-40 /sq km
- 0-10 /sq km

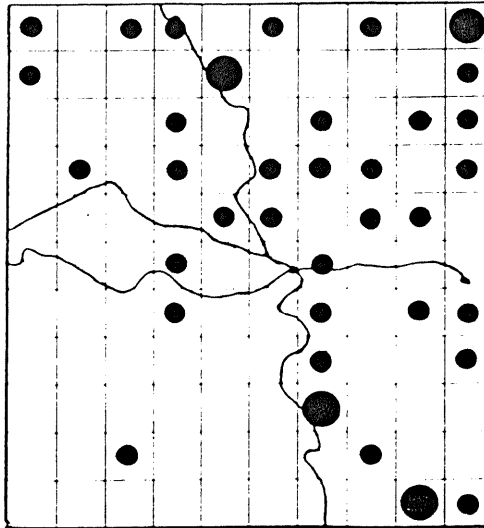


TOTAL
25,800

DENSITY /sq km
9.4

PASTORAL
DWELLINGS

- 6+ /sq km
- 1-6 /sq km
- 0-1 /sq km



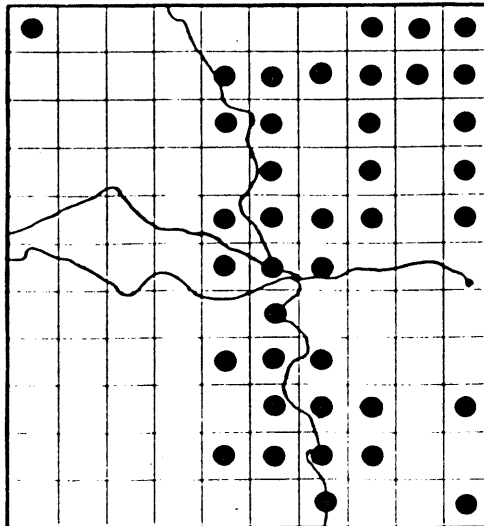
TOTAL
2,730

%Settled 59 %Nomad 24

%Agropastoral
17

%CULTIVATION

- 30+ %
- 11-29 %
- 0-11 %



MEAN %
10

4.2 New Survey Areas.

The results for the five new survey areas are summarised and compared in Table 3, and the distribution patterns of cattle, pastoral habitation and cultivation illustrated in Maps: 5 - 9.

4.2.1 Pambegwa.

The Pambegwa survey area (Map 5), to the east of Kaduna town, contained an estimated cattle population of some 54,600 (S.E.=11%), at a mean density of 18.2 cattle per square kilometer, equivalent to a stocking rate of 5.5 hectares per head.

The cattle were concentrated in the northern central zones, and in the south west corner, while the north western region, and to a lesser extent the eastern and southern borders, were only sparsely populated. The highest densities were recorded in the middle of the area, and reached a maximum of 86 per square kilometer.

Mean herd size was estimated to be 42 (SE=3.9) reflecting the presence of large herds.

The number of pastoral dwellings was estimated to be 5200, which were widely scattered throughout the area at an average density of 1.7 per square kilometer. 53% of the dwellings were of the settled Fulani type and, as rather an unusual feature, some 30% of these had associated granaries. The remaining 47% being of the "nomadic" type. The Pambegwa area, thus possessed a relatively high proportion of "nomadic" Fulani in comparison to the other areas surveyed.

The mean level of cultivation was estimated to be some 25%, with the most heavily cultivated regions broadly coinciding with those of cattle concentration in the central and northern parts of the area. The northwest corner and the southern borders were least cultivated, with grid cells values rarely exceeding 15%.

TABLE 4: SUMMARY AND COMPARISON OF CATTLE, PASTORAL HABITATION AND CULTIVATION IN PAMBEGWA, FUNA FUNA, GANAURI, TEGINA-MINNA AND WEST ZARIA.

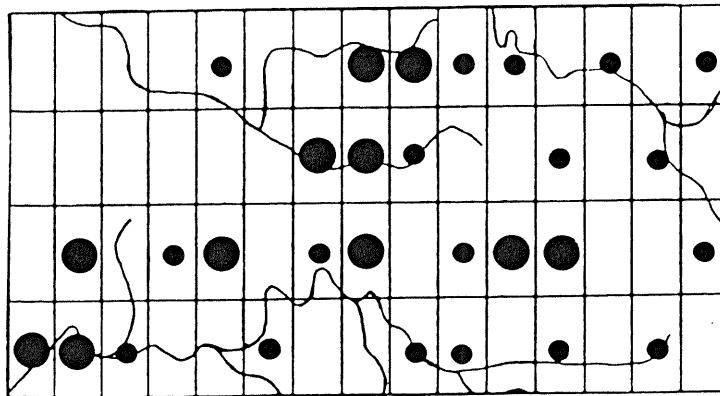
	PAMBEGWA	FUNA FUNA	GANAURI	TEG/MINNA	W.ZARIA
<u>FLIGHT INFORMATION:</u>					
Area Surveyed - sq. km.	3,000	750	800	3390	3350
Date Flown	24 March	5 April	24 March	5 April	6 April
Flying Altitude - feet	1,000	1,000	1,000	700	700
Sample Intensity - %	7.4	14.7	14.7	5.1	10.3
<u>CATTLE:</u>					
Total Population (%SE)	54,620 (37)	2,170 (37)	19,450 (14)	65,800 (16)	81,610 (7)
Density Cattle - per sq.km.	18.2	2.9	24.3	19.4	24.4
Stocking Rate - ha./hd.	5.5	34.5	4.1	4.9	4.1
Total Herds	1,290	68	570	1,390	2,560
Mean Herd Size (SE)	42 (4)	31 (9)	34 (3)	47 (7)	32 (1)
<u>PASTORAL HABITATION:</u>					
Total Dwellings	5,200	160	1,340	7,720	3,960
Density - per sq. km.	1.7	0.2	1.7	2.3	1.2
Settled Fulani - % Total	52	29	73	46	50
Nomadic Fulani - % Total	48	71	2	9	50
Agro-pastoral - % Total	-	-	25	45	-
<u>CULTIVATION:</u>					
Mean %	25	8	33	8	23

MAP 5

PAMBEGWA

TOTAL
56,620

DENSITY /sq km
18.2



- 40+ /sq km
- 10-40 /sq km
- 0-10 /sq km

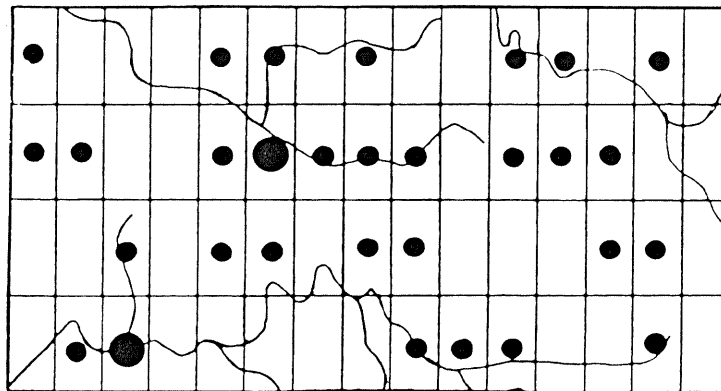
CATTLE

TOTAL
5,200

%Settled
52

%Nomad
48

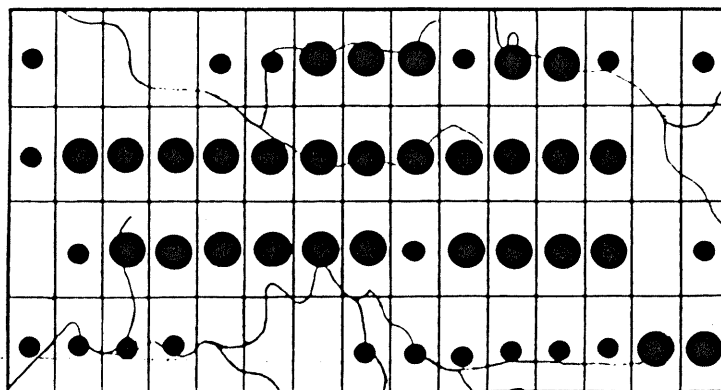
%Agropastoral
0



- 6+ /sq km
- 1-6 /sq km
- 0-1 /sq km

PASTORAL DWELLINGS

MEAN %
25



- 30+ %
- 11-29 %
- 0-11 %

%CULTIVATION

4.2.2 Funa Funa

The Funa Funa survey zone (Map 6) occupied a land area of only 750 square kilometers (30 grid cells) and is rather too small for the results to be very meaningful on their own, but was surveyed as an extension to the Mariga case study area.

The area held an estimated 2175 head of cattle (S.E.=37%) at a density of 2.9 animals per square kilometer, equivalent to a stocking rate of 34.5 hectares per head. The highest densities were recorded in the south-west quadrant, that is, away from the neighbouring Mariga area. In over half the grids, those to the north west, south and south west, no cattle were recorded at all.

Only 10 herds were seen, giving an area total of 68. Mean herd size was low - 31 head - and the size distribution was heavily skewed to the left as 8 (i.e 80%) of the herds were of less than 40 cattle. Thus, the herd sizes and size distribution was very similar to that of the neighbouring Mariga area.

The pastoralist populations were also low, at 0.22 dwellings per square, (total = 163), of which the majority (71%) belonged to the "nomadic" Fulani in the centre of the area.

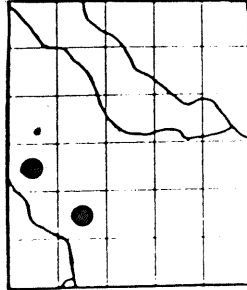
Approximately 8% of the area was under cultivation, most of which was in the northern half of the area, where individual grid cell values of up to 20% were recorded.

MAP 6

FUNA FUNA

CATTLE

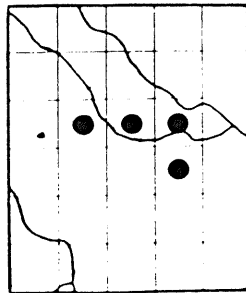
- 40+ /sq km
- 10-40 /sq km
- 0-10 /sq km



TOTAL
2,170
DENSITY /sq km
2.9

PASTORAL DWELLINGS

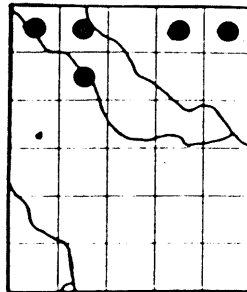
- 6+ /sq km
- 1-6 /sq km
- 0-1 /sq km



TOTAL
160
%Settled 29 %Nomad 71
%Agropastoral
0

%CULTIVATION

- 30+ %
- 11-29 %
- 0-11 %



MEAN %
8

4.2.3 Ganauri.

The total cattle population of Ganauri (Map 7), another relatively small survey zone occupying a land area of 800 square kilometers, was estimated to be 19,450 (S.E.=14%). Of the eight survey zones, this area is second only to the neighbouring Abet case study area in terms of cattle density, with 24.3 animals per square kilometer, or 4.11 hectares per head. Cattle were found throughout the zone, but occurred at highest concentration to the south-east, in the Manchock area.

Mean herd size was estimated to be 34 (SE=3). Alone amongst the areas described in this report, the most frequent cohort in Ganauri was 21 - 40 animals which contained nearly 40% of the herds seen. In all other regions the most frequent cohort was that containing less than 20 cattle.

The density of pastoralist dwellings was also comparatively high, at 1.7 per square kilometer (total = 1340). 73% were of the settled Fulani type, while a relatively high proportion (25%) were agropastoral, and only 2% were of the "nomadic" Fulani type. The Agropastoral dwellings were limited to the eastern half of the area, near or actually on the Jos Plateau to the east, while the settled Fulani were restricted to the the more low lying areas to the south and west.

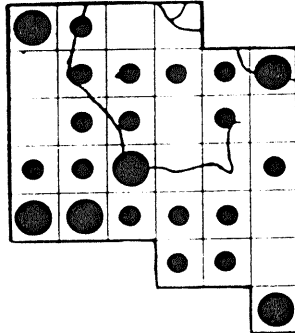
Cultivation levels were the highest of all the study areas, the mean being 33%, individual grid cell values often reaching 50-70%. The lightest cultivation was recorded to the east of Pari, and the heaviest to its south and west.

MAP 7

GANAURI

CATTLE

- 40+ /sq km
- 10-40 /sq km
- 0-10 /sq km

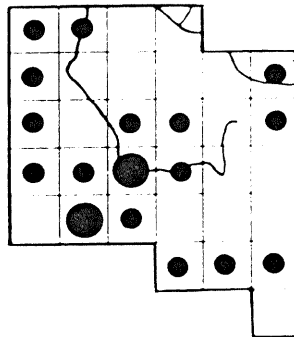


TOTAL
19,450

DENSITY /sq km
24.3

PASTORAL DWELLINGS

- 6+ /sq km
- 1-6 /sq km
- 0-1 /sq km



TOTAL
1,340

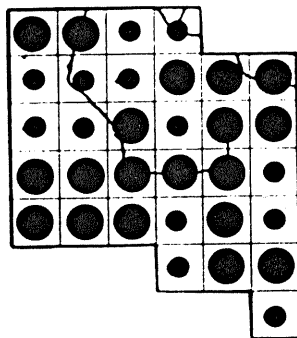
%Settled
73

%Nomad
2

%Agropastoral
25

%CULTIVATION

- 30+ %
- 11-29 %
- 0-11 %



MEAN %
33

4.2.4 Tgina-Minna.

This area an estimated 65,800 head of cattle (S.E.=16%) at a mean density of 19.4 per square kilometer (Map 8), equivalent to a stocking rate of 4.9 hectares per head. Most of the cattle were found in the northern half of the survey zone, with very few the south and east. The highest densities (193 per square kilometer) were encountered some 40 km to the east of Tgina, with a minor concentration along the Kaduna River to the east of Zungero.

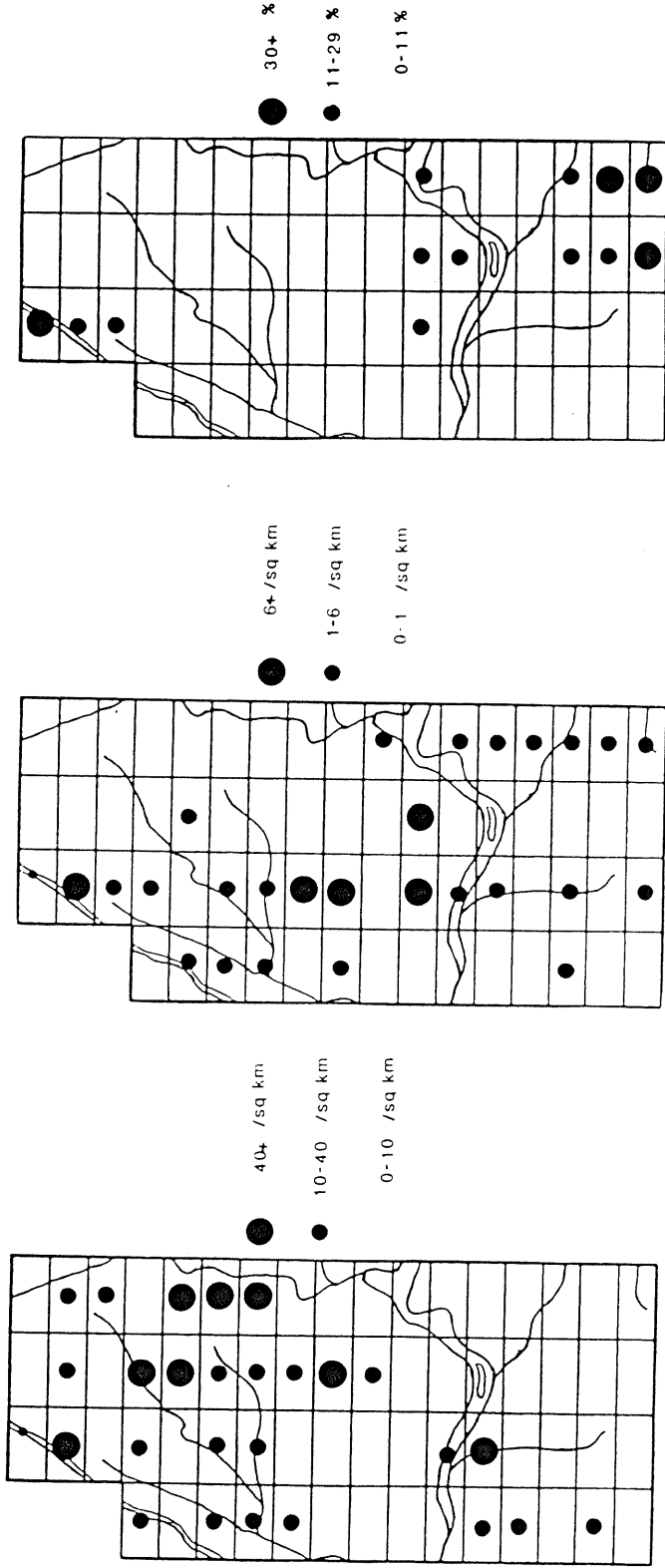
Estimated mean herd size at, 47 (SE=7.4), was relatively high, reflecting the presence of large herds in the area.

The density of pastoral dwellings was also high, at 2.3 per square kilometer, giving an estimated total of some 7,720 within the area. Compared to the other study areas, the proportion of pastoral dwellings of the settled Fulani type was relatively low (46%), while that assigned to agropastoralists (45%) was exceptionally high. It is interesting to note, however that the settled Fulani ruggas were found in the southern and northwestern parts of the area, while the agropastoral dwellings were strictly limited to the central zone to the north of the Kaduna river and east of Tgina.

This area was sparsely cultivated, the mean level being 7.5%. Maximum intensities of 30% were recorded to the north of Minna, where cattle populations were sparse, and also near Pandogari in the North.

MAP 8

TEGINA MINNA



CATTLE

TOTAL
65,800

DENSITY /sq km
19.4

PASTORAL DWELLINGS

TOTAL
7,720

% Settled 46 % Nomad 9

% Agropastoral 45

% CULTIVATION

MEAN %
8

4.2.5 West Zaria.

The cattle concentrations in the West Zaria survey region (Map 9) were greater than those of Pambegwa and Tegna-Minna. The mean density was estimated to be 24.4 animals per square kilometer (4.1 hectares per head), giving a total population of 81,610 (S.E.=7%). Cattle were distributed throughout the study area; the highest concentrations were found to the north, and the lowest in the south east quadrant.

Estimated mean herd size was relatively low at 32 (SE=1.4), with herd size frequencies show a linear decline with increasing cohort size.

The density of pastoral dwellings was also relatively low (1.2 per square kilometer). The total number within the area was estimated to be 3,960, which, as in the Pambegwa, were equally divided between "settled" and "nomadic" Fulani. The "settled" Fulani dwellings were found mostly in the north and east of the area, while the majority of the "nomadic" dwellings were recorded in the south and west.

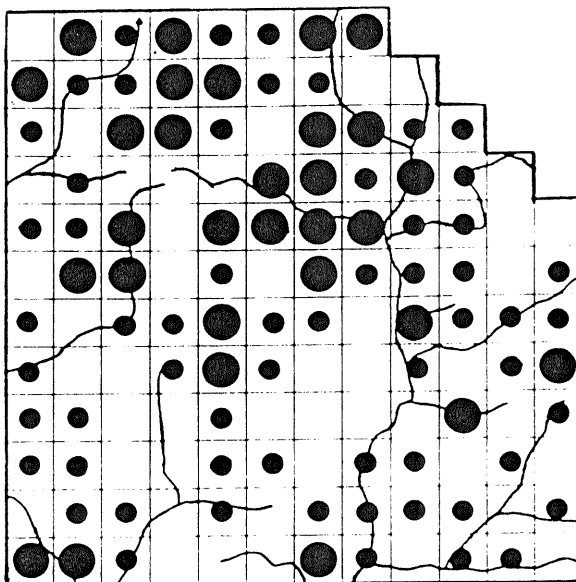
Approximately 23% of the area was cultivated. Most of the cultivated land was in the northern half of the zone, where intensities of 60 - 70% were common. However, the southern half of the area was only lightly cultivated, rarely exceeding 10%.

MAP 9

WEST ZARIA

TOTAL
81,610

DENSITY /sq km
24.4



CATTLE

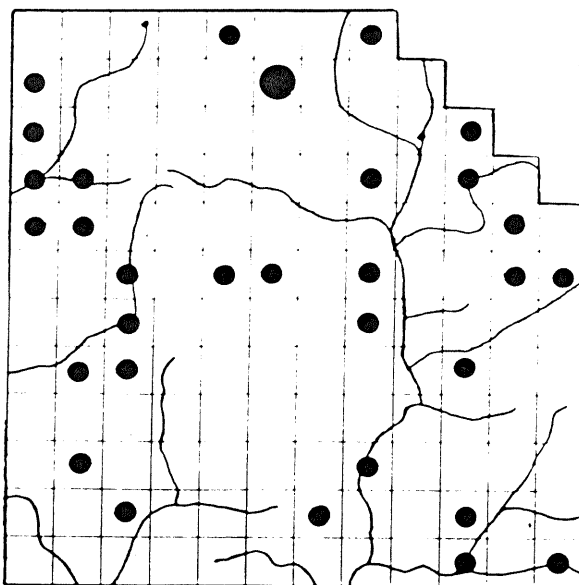
- 40+ /sq km
- 10-40 /sq km
- 0-10 /sq km

TOTAL
3960

%Settled
50

%Nomad
50

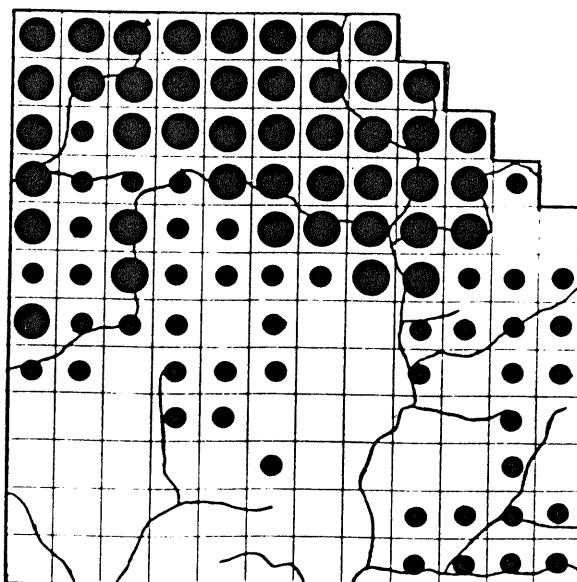
%Agropastoral
0



PASTORAL DWELLINGS

- 6+ /sq km
- 1-6 /sq km
- 0-1 /sq km

MEAN %
23



%CULTIVATION

- 30+ %
- 11-29 %
- 0-11 %

4.3 Interrelationships.

As a means of comparing and contrasting the major features evident from the eight dry season aerial surveys, regional interrelationships between cattle, pastoral habitation and cultivation were investigated by regression analysis.

As illustrated in Figures 1 and 2 cattle density was found to increase significantly with both the level of cultivation and the density of pastoral habitation. Figure 3 shows a positive, but less significant, correlation between cultivation and pastoral habitation.

These correlations emphasise the close association between cattle concentrations and proximity to high levels of cultivation. In turn, this is indicative of an increasing interdependence between pastoralists and arable farmers, as reflected by the high proportion of "agropastoralism" in Ganauri and Tegna-Minna.

Examination of Figures 1, 2, and 3 enables a broad categorisation of the eight survey regions into three groups:

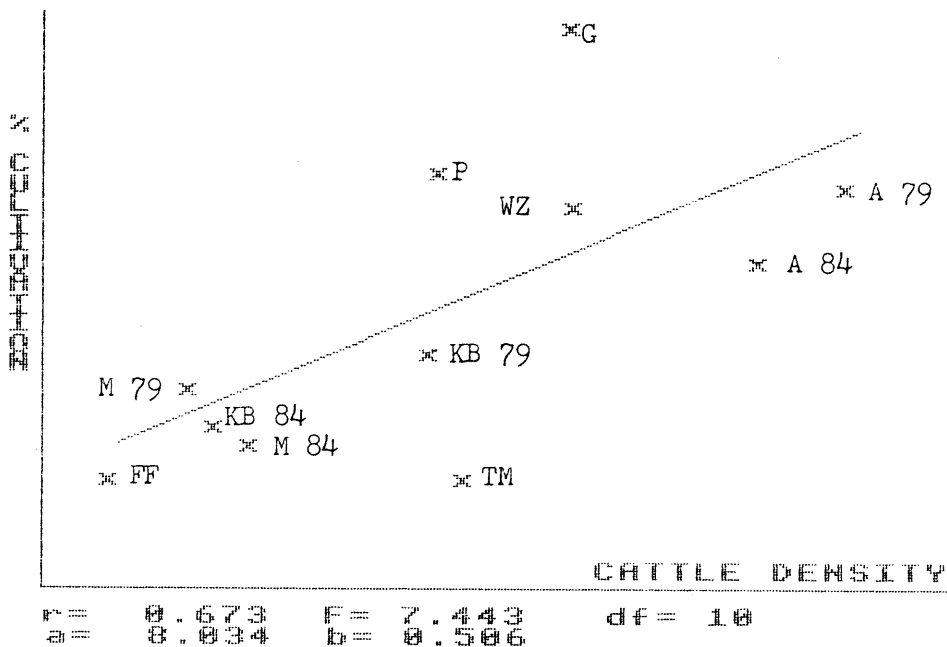
Mariga, the adjoining Funa Funa zone and, in 1984, Kurmin Biri were characterised by having little cultivation, few cattle and sparse pastoral habitation.

In contrast, both Abet and Ganauri were densely populated with cattle and heavily cultivated.

The remaining areas, Tegna-Minna, West Zaria and Pambegwa fall into an intermediate group.

FIGURE 1

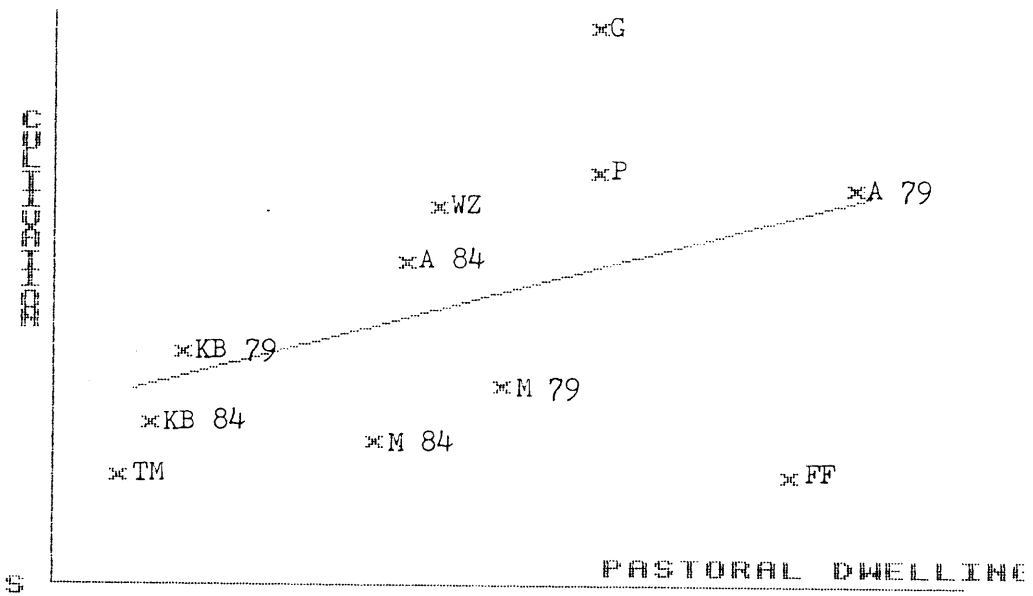
CATTLE DENSITY : % CULTIVATION (1979&1984)



KB = Kurmin Biri A = Abet M = Mariga
 P = Pambegwa FF = Funa Funa G = Ganauri
 TM = Tegina Minna WZ = West Zaria

FIGURE 2

PASTORAL DWELLINGS : CULTIVATION

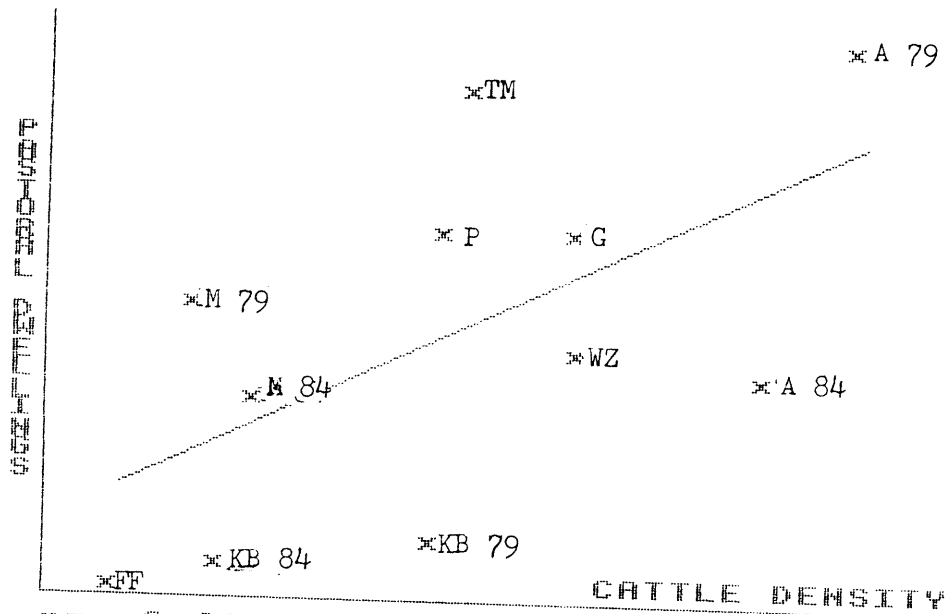


$r = 0.431$ $F = 2.056$ $df = 10$
 $a = 11.467$ $b = 4.628$

KB = Kurmin Biri A = Abet M = Mariga
P = Pambegwa FF = Funa Funa G = Ganauri
TM = Tgina Minna WZ = West Zaria

FIGURE 3

CATTLE DENSITY : PASTORAL DWELLINGS



$r = 0.614$ $F = 5.436$ $df = 10$
 $a = 0.469$ $b = 0.043$

KB = Kurmin Biri A = Abet M = Mariga

P = Pambegwa FF = Funa Funa G = Ganauri

TM = Tegna Minna WZ = West Zaria

5 REFERENCES.

MILLIGAN K., D.BOURN and R.CHACHU, 1979. Dry and Wet Season Patters of Cattle and Land Use in Four Regions of the Nigerian Sub-Humid Zone. Report to the International Livestock Centre for Africa Sub-Humid Programme. November 1979. pp123.

6 ACKNOWLEDGEMENTS.

The analysis and writing of this report has been overshadowed by the tragic death of Kevin Milligan, whose drive and enthusiasm was fundamental to the success of ILCA's Aerial Survey Unit, and the completion of the surveys described here. His presence is sorely missed.

We would like to thank all memebers of the ILCA Sub-humid Programme for their assistance and support, in particular: the Team Leader Ralph von Kaufmann, Sam, and Neil MacDonald. Finally, but by no means least, we would like to express our appreciation to Jack Meunier, the pilot of the ILCA aircraft, who kept on flying under difficult circumstances.