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Fodder Resources and Grazing Management in a Savanna Environment: an Ecosystem Approach

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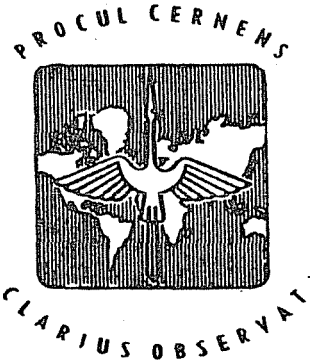

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I. INTRODUCTION AND GENERAL METHODOLOGY

1.1 Introduction

The desirability for students of social and natural sciences to pool their abilities and resources in investigations concerned with man and his environment has often been noted, but genuine efforts in this direction are conspicuously less frequent. Admittedly, examples could be quoted of studies which synthetise the findings of individual researchers, many of which have been commissioned by those involved in the planning for and implementation of development. But few cases are known to the present authors of researchers who have tried to improve on the relevance, consistency, and coherence of their basic investigations into different, though related, aspects by seeking right from the start an interdisciplinary approach to a jointly delimited theme. Even among students of strongly interdependent disciplines such as geography and ecology, as represented by the present authors, these 'joint ventures' are believed to be rare. Those who set out on this challenging path therefore not only have to face occasional difficulties due to different frames of reference and jargon, but also and more important, the problem of designing a functionally integrated approach without being able to resort to previous endeavours for guidance.

It is common knowledge that man and environment should be viewed in conjunction since they affect each other intimately and evolve together, but the rigorous conventional separation of the natural and social sciences has tended to render each one incapable of fully grasping the complexity of a given situation. The present popularity of system-theoretic thinking in the man-land sciences is no doubt largely due to its assumed theoretical capacity to break through this unfortunate dualism in a logical and comprehensible fashion.[1] It is this frame of reference that has directed us in our endeavours to unify man and his natural environment in a single framework. In particular, we have drawn upon ecosystem and ecological complex ideas as they are presently emerging.[2] As concepts, ecosystems and ecological complexes share the attributes of systems in general of being structured and dynamic in their functioning and of being open to external influences. But they suffer at the same time from a serious weakness; considerable generalisation and simplification is bound to occur even when one seeks to apply this framework of thinking to a relatively simple situation.

Our aim has been to identify some major variables of the Fulani pastoral ecology in northern Nigeria and to expose their interrelationships. In addition to being instrumental to an understanding of the varied pattern which cattle husbandry takes in a savanna environment, this should also facilitate the work of people involved in formulating plans for the development of the cattle industry.

1.2 General Methodology

A preliminary socio-economic survey covering 18 Fulani migratory units was undertaken in Katsina Province in 1967 in order to obtain insight into the Fulani way of life and to identify the salient features and

problems of the economy. The interviewing was done through an interpreter[3] and consisted of inquiries into such matters as the life history of the group, its size and age-sex composition, size and composition of the herd, division of labour and nature of cooperation, year-round organisation of herding, attitude towards cattle and willingness to dispose of animals, grazing habits and animal behaviour, fodder resources, and diseases.[4] In order to facilitate an informal exchange during the interviews care was taken not to unnecessarily evoke suspicions in respondents by completing questionnaires on the spot, and use was therefore made of a concealed cassette-recorder.

This reconnaissance survey served the purpose of reaching a better understanding of the existing differentiation of Fulani ecologies and facilitated the selection of pastoral units which were believed to be sufficiently representative to warrant further investigation. Furthermore, it helped to identify the variables that needed closer measurement and provided valuable information for the way in which to conduct the surveys. The surveys subsequently undertaken were the following:

(1) the crop residues analysis carried out in the dry season of 1967-1968 and 1968-1969, the findings of which have already been published,[5]
(2) the savanna fodder resources analysis of the Ruma-Kukar-Jangerai Forest Reserve in Katsina Province and of the surroundings of Zaria in Zaria Province in the period 1967-1969, and
(3) the year-round management survey of cattle-raising groups in Katsina Province and Zaria Province from 1968-1970.

The description of the results of the several surveys, including an account of the methodology and the sample procedures that were adopted, has been organised into three distinct sections. Section 2 will examine the potential of the fodder resources available in the Sudan and Northern Guinea Savanna. The distribution of dry matter and protein over the year is summarised in Table 1. Sections 3 and 4 will focus on the livestock keepers and the ways in which they have organised their activities. Particular attention will be given to two major pastoral management systems that have evolved, i.e. the nomadic and the sedentary systems. Their efficiency in meeting the animal requirements for maintenance and growth and some implications for the development of the livestock industry will be elaborated in Section 5.

2. FODDER RESOURCES

2.1 Introduction

The major fodder resources on offer to Fulani stock kept under traditional systems of management are grasses, browse and crop residues. Between 1967 and 1970 surveys were conducted to assess the fodder capacity of Sudan and Northern Guinea zone savanna, both in terms of dry matter supply over the year and its quality. Sample plots were cut and weighed in all major vegetation types throughout the year, while herbage was analysed for dry matter (DM) and crude protein (CP) and digestible crude protein (DCP). Of the range of crops grown on upland and fadama, only guinea corn, cotton, groundnuts and cowpeas classify as fodder. The procedures followed for sampling these residues have been described earlier.[6]

2.2 Grass Herbage in Upland Savanna

The open savanna woodland and tree savannas in the Katsina area have a high proportion of fine-leaved and thorny species, while the herbaceous cover consists of annual grasses up to 120 cm tall. From the sample data collected, a generalised growth curve has been constructed which shows that herbage production increases almost linearly with time from 200 kg in June to 1500 kg DM/ha in October/November (Table 1). Yields vary considerably depending on species composition and the edaphic condition of the site; at the end of the growing season there may be as little as 300 kg DM/ha on a stony or gravelly slope, while stands on deep soils or in the shade of trees may produce up to 4000 kg DM/ha.

In contrast, broad-leaved trees and shrub predominate in the Zaria area, where the tree cover is usually taller and denser and the herbaceous layer consists mainly of perennial grasses, which produce twice the amount of forage as measured in the Katsina area. In terms of quality, however, there is little difference between the two types of grass cover; crude protein content drops from a high of 12-14 percent during the early rains to a low of 2 percent in standing dry season foggage. Much higher values are recorded in new growth of perennial grasses after burning or intensive grazing.

2.3 Grass Herbage in Fadama[7]

Grass herbage is found in depressions, some of which might be subject to seasonal waterlogging. Depressions which never turn into swamps may yet retain a partially green grass cover far into the dry season because the groundwater is close to the surface, while temporarily flooded fadama produces an abundance of nutritious fodder after the floodwater has withdrawn. Thus, the productive cycle of fadama grasslands either extends over a longer period or does not start until upland herbage becomes increasingly scarce and less nutritious. Depending on the depth of the groundwater table, duration of flooding and the species composition, fadamas contain a wide variety of grazeable herbage, ranging from young shoots containing up to 20 percent of CP to mixed stands of green and dry material of varying quality, with yields of between 3500 and 7,500 kg DM/ha (Table 2). Fresh regrowth becomes established in fadamas as early as March after burning and intensive grazing.

2.4 Browse

It is difficult to quantify this fodder component as browsing is a very selective process. Although sometimes whole branches are consumed, browsing usually amounts to nibbling of leaves, flowers and fruits within the reach of stock. Therefore the value of browse does not lie in providing bulk but should be regarded as a supplement rich in nutrients; over 80 percent of the browse samples analysed contained more than 10 percent CP (Table 2).

The availability of browse is governed by climate; young shoots and leaves develop late in the dry season when relative humidity and temperatures rise. Most species remain green until the early dry season, many being leafless for several months between December and March.

2.5 Crop Residues

Sorghum residues become available immediately after the grain harvest: mid-November in Katsina and late November in the Zaria area. Yields of edible material vary depending on soil fertility, crop density and management, and also on whether the crop is planted singly or in mixture. Although quality is low sorghum residues are by far the most important, both in terms of acreage grown and of total available forage, presenting over 80 percent of all residues in Katsina province, and 32 percent of all crops grown in the Zaria survey area.[8]

The remaining residues, from cotton, groundnuts and cowpeas, though providing much less fodder per ha, are far superior in quality (Table3). While cotton residues are being grazed during January and February, the legume hays are rarely left for pastoral herds as most hay is carefully stored and ration-fed to sheep, goats and other farmer-owned stock.

2.6 The General Fodder Situation in the Two Survey Areas

As a corollary to the analysis of the fodder potentially available for pastoral grazing, the general fodder situation should be stressed. This has been attempted by evaluating the quantity and quality of all sources of roughage on a monthly basis in three 'classes', i.e. high, medium and low (Table 4). The monthly outcomes for the different sources of supply are then combined into a generalised score for each month, rendering it possible to divide the year into periods characterised by a set of similar conditions. The extent to which the potentials of these periods are actually utilised is clearly dependent on the users and their skills. Careful examination of two other major variables is thus called for, i.e. the people and the management systems that have been developed.

3. THE PASTORAL USERS

3.1 The Fulani

Cattle husbandry in northern Nigeria is particularly associated with the Fulani; even though the ownership of cattle is distributed over the several ethnic groups that inhabit this savanna region, the rearing is almost exclusively in their hands. However, great variation exists in Fulani cattle husbandry. In an earlier study an attempt has been made to give a typology. By relating differential mobility to cultural values, language, and socio-economic organisation, two distinct categories were obtained, i.e. the nomadic and the settled Fulani cattle rearers.[9]

3.2 The Nomadic - Settled Dichotomy

The nomadic category comprises genuine nomads who depend exclusively on their livestock and the semi-nomadic Fulani who also engage in some arable cultivation. In several parts of Nigeria, the nomads are known as Bororo. Despite age-long contacts with the Hausa-speaking peasantry, they all have Fulfulde as their first language and still adhere to the traditions and values which for so many centuries have given meaning to their pastoral existence. Though recognising such wider groupings as lineage and clan, foremost in the mind of the Bororo is the much

smaller migratory unit. The group that is able to move autonomously in search of pasture and water is the primary sphere of cooperation and mutual solidarity. The migratory unit is self-sufficient for labour and food at all seasons, its men tending the common herd and its women milking the cattle and preparing the food. In its minimal form this corporate group answers to a nuclear family, but most often it consists of several such families as primary male relatives tend to stay together, at least until the time when they have sons who are capable of herding. Although pastoralism may favour fragmentation, the labour force of one corporate group cannot fall below three herdsmen without serious repercussions on economic efficiency and leisure.

The Bororo live in a state of perpetual wandering, moving south in the dry season and north in the wet season. Though at liberty to vary place and time, the annual cycle of migration of each group usually describes a distinct orbit which over the years has proved to meet most adequately the location of markets and the seasonal variation in the distribution of fodder, of water and of human and bovine disease. Many Bororo are reported to shift camps at least every fortnight and at most every two or three days. Though less frequent moves occur, particularly during the wet season, the Bororo corporate groups have no fixed homesteads. Even when group elders are left behind with some milch cows, their homesteads become meeting points at most, in the neighbourhood of which the other members of the group build temporary shelters.

Practising some cultivation, mainly of millets, the distinctiveness of the semi-nomads lies in their having other than grazing titles to land, although cropping is clearly secondary to cattle rearing. Near the farm a permanent homestead is found where the elders stay throughout the year, to be joined by all or some other members of the group at the beginning of the wet season when tillage has to be organised. Though herding is easiest in the wet season and the men then have time to spare, the semi-nomadic Fulani have enough of the nomad in them to disdain agricultural work, and they will recruit labourers whenever possible. They are typical pastoralists who esteem cattle more than anything else. Though their herds are smaller in size than those of the nomadic Fulani, their techniques of animal husbandry, social organisation and forms of economic cooperation are comparable. They speak Fulfulde and are as individualistic, elusive, suspicious of strangers, proud and tough as the Bororo. They also share the nomad's appreciation of the ceremony that so highly tests the courage of the Fulani boy, the 'sharo' or beating ceremony. In short, the semi-nomadic Fulani feel and think as the genuine nomads do and in the Zaria area they are normally not distinguished from the Bororo. Several cases have been reported in which they have again taken up a fully nomadic life. On the other hand, many members of this group have opted for a more settled life.

The settled category concerns Fulani pastoralists to whom both cropping and livestock rearing constitute more or less equally important aspects of life. They have fixed habitats where they remain throughout the year except perhaps for a few months in the dry season when fodder is scarce and the farms do not demand attention. The size of the cattle herds is considerably smaller than that of the Fulani discussed earlier. In a village near Zaria it was found to lie between 5 and 60 animals. Hausa is their first language. They do not share

the nomad's contempt of land labour and his aversion to inter-marriage with non-Fulani. They do not take part in the beating ceremony, nor feel strongly about other traditions their ancestors adhered to. In particular the fact that they do not compete in the beating ceremony is interpreted by the nomadic Fulani as a sign that they have ceased to be Fulani and have 'become Hausa'. During part of the year, however, their way of life resembles that of the nomads. In the first half of the dry season the herdsmen still return nightly to the village, or camp so close to it that the women can bring them their food and collect the milk. But in January and February they embark upon a gradual movement southward and the greater distances make it imperative for the women to join them. Stalk huts and even simpler shelters will serve them as abodes until just before the start of the rains when they return to their elders and children in the village.

The roles of these two pastoral systems and their contributions to the socio-economic life and appearance of the areas in which they occur are distinctly different. The settled Fulani cattle rearers constitute an integral part of a wider human environment, as all are incorporated in the social, economic and administrative framework of their direct surroundings. This area is their sphere of life; here they build houses, clear fields, tend crops and animals, and introduce other changes into the local landscape. Here also they take their places in the social setting as determined by birth and achievement.

The nomadic Fulani, on the other hand, have intentionally refrained from active participation in the life of the areas in which they wander. Taking little interest in anything but their cattle, the nomadic pastoralists keep aloof from the daily affairs of the sedentary communities as long as these do not directly affect them. Frequent attendance at the markets of both men and women cause them to meet many people but these contacts remain superficial, their main concern being the sale of milk, the purchase of necessities and the collection of information relevant to the wellbeing of their animals. The markets are also the places to contact the cattle trader. That the contribution of the nomadic component of the cattle-rearing population is more strictly an economic one is further exemplified by the arrangements which presently obtain in the period of crop residue grazing, when contacts between pastoralists and sedentarists are closer than during any other part of the year. Although gift exchanges may occur and the farmer and pastoralist may share a meal on occasion, both tend to remain reserved, the main reason of their mutual appreciation being the benefits to be derived from the other's main activity, i.e. milk and manure as opposed to foodstuff and fodder. The most that thus has been reached by way of integration is a partial economic interdependence. Accordingly, the pattern of relations between the nomadic pastoralists and sedentarists could best be described as one of symbiosis, since it is mutually beneficial and at the same time enables both parties to preserve their cultural and physical identity.[10]

3.3 The Pastoral Calender

Whatever the differences between nomadic and sedentary pastoralists, it should be noted that a range of adjustments in response to prominent environmental realities displays a good deal of correspondence. The diverse ecological experiences of both pastoral sections over the year

is reflected in a fairly refined differentiation of the seasons. To people who live in such close contact with their environment and are so much dependent on even minor changes in their ecology, the simple contrast between wet and dry season bears little meaning. Since the conditions by which seasons are defined tend to fluctuate quite considerably from year to year in their duration and in their being beneficial or severe, simple equations as contained in the ecological calendar below may be deceptive. It should therefore be stressed that these periods are merely approximations of sets of ecological conditions that vary from year to year in their occurrence in time and in their intensity. In line with the theoretical setting previously outlined, the seasons distinguished by Fulani pastoralists will subsequently be referred to as 'ecoperiods'. The pastoral calendar consists of at least five major ecoperiods and two minor ones.

(i) Seeto (April/May/June)
The stormy period with occasional rains that precedes the start of the rainy season proper. Conditions are critical and pastoralists and farmers alike are in expectation of more abundant rainfall to set in. The period in which most cattle starvation occurs.

(ii) Dungu (June/July/August/September) and Yuka
The wet season proper. Grazing conditions improve quickly. The three weeks of excessive rains in the middle of the wet season are denoted as a distinct ecoperiod (Yuka). In the Yuka, both herdsmen and cattle have to be on the move continuously in search for relatively dry grazing grounds.

(iii) Yamde (September/October/November/December) and Nyaile
The hot dry season after the rains, but also the time of plenty since in this period both human and animal foodstuffs are readily available. A new ecoperiod, the 'Nyaile', begins in the course of November when the Fulani shift their attention from the savanna to the harvested fields which have been released by the farmers. Crop residue grazing continues until well into the cold dry season.

(iv) Dabunde (December/January/February)
The ecoperiod when the cold, dust-laden wind from the Northeast (harmattan) is at its strongest. Fodder resources become scarcer and grazing days are long. Grass grazing and browsing again take prominence over residue grazing.

(v) Cheedu (February/March/April)
The hot dry season that accompanies the decline and final retreat of the harmattan. Grazing conditions further deteriorate and cattle are strongly dependent on browse and regrowth for survival.

The calendar as employed by the pastoralists is in line with the findings contained in Table 4. However, in understanding the Fulani way of life environmental factors take a genuine significance only if the year-round organisation of their day-to-day endeavours is studied in greater detail.

4. THE ORGANISATION OF GRAZING

4.1 Methodology

The major division is thus between settled and nomadic Fulani cattle rearers, and an exponent of each has been subjected to closer

examination in respect of the organisation of grazing. Selection of a particular group representing the settled category has been influenced by considerations of representativeness and proximity and by the availability of information. Since a good deal of information was already available regarding the Hanwa Fulani close to the location of the authors and there was no indication of their being a-typical, this community was taken as the survey-group.[11] But to decide on a representative sample of the nomadic category posed considerably more difficulties as this involved both a nomadic and semi-nomadic variant. Although it would have been most relevant to undertake an extensive survey of each, in view of the resources available a choice had to be made between them. For several reasons, a semi-nomadic example was preferred. Firstly, the semi-nomadic Fulani can be surveyed more readily as their grazing orbits are shorter and their movements less unpredictable than those of the Fulani nomads. Secondly, as a group the semi-nomadic are reasonably well-documented. In this context, reference may be made to the studies of Fricke, Hopen and particularly Stenning.[12] Thirdly, the semi-nomadic category is believed to possess a higher capacity for change and could more readily be integrated in the society and economy of Nigeria if proper insight were available into the major constraints that work against further settling. The actual semi-nomadic group selected has the northwestern part of Katsina Province, between Dutsin Ma and the border with Sokoto Province, as its grazing territory.

In view of the unusual way in which the grazing management survey was conducted, some comments are necessary on the method of measurement employed. The day-to-day following of Fulani groups clearly being beyond our possibilities and also beyond the Fulani's willingness to facilitate such an undertaking, a much less ambitious approach had to be accepted. With the one exception of the senior author following a Fulani migratory group for several weeks in succession, this consisted of selecting certain days which were believed to reflect experiences during a distinct period of the pastoral calendar. The aim to select dates which were indicative for a longer period implied that the recordings could not evenly be distributed over the year. Since the dry season is the time of excessive stress and environmental conditions are then subject to greatest variation, Fulani herds have been followed most frequently during that period (November to May). Care was taken, however, to have at least one recording for each month. The chances of serious errors in selection and interpretation were further reduced by frequent interviewing throughout the survey period 1967-1970.

Discussion of the results of the grazing management survey focusing on grazing practices and fodder composition will further elaborate the attributes of the several ecoperiods in the pastoral calendar and the human adjustments made. In addition to a time-scale on a monthly basis, most diagrams drawn to reflect diverse experiences over the year will therefore also indicate the approximate position of the Fulani ecoperiods. December recordings have been selected as benchmarks on either side of the time-scale. This was done for no other reason than to make the critical period, i.e. the period of greatest nutritional stress, fall in the centre of the diagrams, thus facilitating the visual effect.

4.2 The Grazing Day

Two types of grazing days may be distinguished. One involves a grazing orbit that originates at and leads back to one and the same camp and cattle kraal, while the other is accompanied by a simultaneous shift of both camp and kraal. In the latter case, the move might be over a distance of no more than a few kilometers or might entail a long day of trekking for both herd, herdsmen and dependents. Whereas the first move is normally undertaken to obtain more ready access to grazing grounds and watering points in the neighbourhood, the second is usually part of periods of successive days of intensive trekking that make up a seasonal long-distance migration.

The way in which the grazing day is organised has been surveyed with particular attention to its length, the daily distance covered, the intensity of grazing, the time devoted to trekking and watering, and some additional management practices.[13]

4.3 The Length of the Grazing Day

The time of departure from and return to the cattle kraal have been taken as determinants of the length of the grazing day. During most of the year (June-February), the departure of the semi-nomadic groups falls between 8 and 10 am. In the rainy season in particular there is a tendency to leave fairly late, especially when it is expected that the dew that clings to the grasses will soon evaporate. The reluctance of Fulani to let their animals graze on moist terrain is prompted by fear of certain diseases and also by the consideration that the animals suffer from excessive intake of wet grasses because the appetite is satisfied too quickly. Usually the herds return home between 5 and 6 pm, producing grazing days of 8-10 hours duration from June to February. From March to May, the herds leave camp between 6.30 and 8 am and return between 6 and 7 pm. Most daylight hours are thus utilised for grazing and related activities in the second half of the dry season. We also have some evidence of night-grazing being practised in the dry season by animals that stray from the kraal over short distances, but were unable to verify the information that occasional herding would also occur. On the average the grazing day of semi-nomadic groups lasts for approximately 10 hours with a minimum of $7\frac{1}{2}$ hours in August and a maximum of $12\frac{1}{4}$ hours in May.

Among settled pastoralists the times of departure and return tend to be later, ranging from 9 am (April) to 11.30 am (August) and from 5 pm (November) to 7 pm (May) respectively. On the whole, settled herdsmen appear to come home about dusk. If they return earlier it is not unusual that animals not in milk are again taken out for grazing until dark. But the total length of the grazing day is much lower among settled pastoralists and so is the variation from season to season. Approximately eight hours are spent outside the cattle kraal on the average with a minimum of six hours in July and a maximum of $9\frac{1}{2}$ hours in May.

The year-round pattern of the length of the grazing day in two grazing management systems is depicted in Diagram 1.

4.4 Daily Distances and Average Speed

In order to estimate the number of kilometers covered by pastoral herds, the time devoted to such distance-involving activities as walking and grazing were measured. Four speeds have been employed in recording animal mobility; these are $3\frac{3}{4}$ km, $1\frac{1}{2}$ km, 3 km and 5 km per hour. The selection of somewhat peculiar measures in the lower range and the width of the intervals applied were prompted by the grazing behaviour of the herds. At speeds of 3 km and less, the animals often engage in rather distinct rhythms of combined grazing and walking; above this limit walking with incidental bites gives way quickly to mere walking. Speeds below $3\frac{3}{4}$ km/hour have not been differentiated further. Nor have we made allowance for speeds above 5 km per hour, although the distortion thus caused might be more serious since higher speeds occur regularly. When trekking to watering points, for example, it may be hard to keep pace with the walking herd. The sight of herdsmen and herd running over a considerable distance is more unusual, but it was observed in the stubble period, the nyaile, the meaning of which is best expressed by the phrase 'rush and finish'.

The actual daily distances covered under the two traditional systems of grazing management are presented in Diagram 2 which clearly shows the differences in terms of average daily totals per month and general pattern. The distances covered by nomadic cattle are indeed striking. They average 16 km per day with a minimum of 7 km and a maximum of 30 km as compared to 9,4 and 14 km per day respectively for the cattle of settled pastoralists, and thus walk approximately twice as far. A straight comparison of the two systems is somewhat misleading, however, since the time spent on grazing and related activities also varies. Two curves expressing the difference and variation in average speed per hour have therefore been added. The diagram shows that nonetheless the discrepancies remain quite pronounced.

4.5 Intensity of Grazing

In recording grazing behaviour, intensive and extensive grazing were distinguished. If there was clear lack of uniformity in the intensity of grazing, the behaviour of the greater part of the herd was taken as indicative for the herd as a whole.

The results of the measurements of grazing intensity are summarised in Diagram 3. It may be noted that the time actually spent on grazing is more or less the same in both grazing systems. The several results have been averaged out on an annual basis in Diagram 4 to facilitate overall comparison. Diagram 4 shows that settled pastoralists combine a considerably shorter grazing day with a much higher rate of intensive grazing.

4.6 Watering

Although watering expressed in time does not account for a large proportion of the total time afield, the search for water and the location of waterpoints is a decisive factor in the strategy of daily movement. In Katsina the watering facilities differ dramatically when the herd is in the grazing reserve and when it is outside during the crop-residue season. In the reserve the herd can rely on two dams which provided year-round water during the period of the survey and actual

watering-time took between two and 19 minutes per watering, whereas outside the reserve it took from two to as much as 65 minutes. The higher value was associated with the laborious and time-consuming operation of drawing water by calabash from shallow holes in a river bed and filling a wooden water trough, where at the most four cattle could be watered at one time. It took more than a minute for each animal to be watered. In addition, special journeys were made to these water holes, involving up to one hour of fast walking with subsequent rest-periods of between 20 and 30 minutes before the trek back to the grazing grounds. These walking and resting periods took up a large proportion of the non-grazing time in the February to May period. The stress associated with watering is further increased by the fact that during the dry season watering is often done more than once a day.

In Zaria the search for water is much less strenuous. The river Kubani, situated in the centre of the grazing orbit, provided water for most of the year and even at the end of the dry season there are many shallow, easily accessible water holes. Watering-time was therefore fairly constant and varied between 2 and 8 minutes per watering. Distances covered from the grazing area to the water point though variable were small; it appeared that during most of the year watering was part of the daily grazing movements and no specific treks to water holes were observed, except in March and April, when movements to and from water accounted for about an hour of special trekking.

4.7 Intake Composition

The composition of the intake throughout the year of cattle kept under two pastoral systems of management has been estimated by assessing the relative time spent on various fodders during a grazing day. Crop residue grazing is an important feature in both systems. Intensive grazing of crop residues commences in November and stubble, stover and legume hays constitute the principal sources of fodder for several successive months. But nomadic pastoralists terminate the grazing of crop residues rather abruptly. Once the supply of bulk providers of dry matter such as guinea corn residue falls below a certain level and the protein-rich cotton residue becomes scarcer, they have no alternative but to leave the farmed area, to switch camping sites to the forest and to resort to savanna grazing. Usually, this shift occurs in the second half of February. The settled pastoralists face similar constraints, but being exclusively dependent on nearby resources they have adopted a different strategy. They tend to make a more selective use of crop residues; often they first graze the fields belonging to other farmers thus conserving the residues on their own field until the time that fodder becomes increasingly scarce. This practice offers the additional advantage that the own farms are intensively manured shortly before the planting of the new crop.

In the context of crop residue grazing, the contribution made by cowpea hay should be mentioned. Cowpea is grown by many settled pastoralists and the residues supply important fodder for their cattle in December. Nomadic cattle seldom have access to this very nutritive fodder since farmers reserve it for their own livestock or for sale.

The herds of settled and nomadic pastoralists depend mainly on grasses before and after the residue period, but there is great difference in the type of rangeland grazed. The sampled group of

settled pastoralists relies heavily upon fadama herbage to the extent that two-thirds of grazing time is devoted to it. Nomadic pastoralists concentrate on fadama grazing in October only, fadama herbage contributing no more than 35 percent of the intake in any other month. There is little doubt that it is the scarcity of low-lying land in their grazing area that forces them to search for other resources, and not avoidance of fadama by preference. The high value for October, despite the fact that the fadama might still be muddy and partly flooded, reflects the value attached to fadama herbage and the eagerness to benefit from the little there is.

Finally, the significance of regrowth and browse should be stressed. Regrowth, i.e. the protein-rich young grass that emerges in the second half of the dry season, covers 45 percent of the grazing time of nomadic cattle in May. Obviously, this should not be taken to imply a corresponding proportion of the intake. Regrowth produces little dry matter and ample scope should be given for foggage-grazing if energy requirements are to be met. Browsing is practised throughout the year by both sample herds, though there is a difference. Browsing is subject to greatest fluctuation in the nomadic system whereby particular reference may be made to the contrast between the first and second part of the dry season. This relates to the phenology of the area of occupance by the nomadic group surveyed. Most savanna shrubs are leafless in NW Katsina from the start of the harmattan in November until March when a rise in temperature and humidity induces the trees and shrubs to produce a fresh flush of shoots and leaves. Such periodicity is much less pronounced in Hanwa in Zaria Province, the area of inhabitation of the sample group of settled pastoralists.

4.8 Nutritive Value of the Grazed Diet

In taking the daily consumption of digestible crude protein as a measure of the diet's nutritive value, it is possible to arrive at a rough estimation of the variation throughout the year and between the two systems of management. In preparing these estimations, it has been assumed that daily DM intake is a constant related to liveweight, though it is realised that in times of scarcity consumption may be lower. A constant intake of 7 kg DM has been used as representative for a 300 kg Zebu animal.

The contribution of various fodders to the daily intake has been determined by relating the grazing time devoted to various sources to average values of DM and DCP (Table 6). This method clearly does not allow for the fact that the intake is likely to increase with quantity per unit area and also ignores the effect of selective grazing on ration quality, rendering it likely that the importance of bulk fodders such as sorghum residue and fadama herbage, and of sparse low re-growth, cotton residue and browse, is under- and over-estimated respectively.

To make due allowance for fluctuations in intensity of grazing, the nature of available fodders, the ease of grazing them, and the diverse opportunities for selective grazing to be applied, a number of adjustments were made. Firstly, it has been assumed that cotton residue, browse, and regrowth provide 50 percent less dry matter per unit time than other fodders. Secondly, DCP values were adjusted. While minor increases were allotted to upland savanna, groundnut hay

and stover, the average DCP estimations of grazed fadama herbage and cotton residue were doubled since these two fodders have a high internal variation as to nutritious value and are grazed selectively.[14]

Table 8 gives the array results of adjusted DCP estimates as compared to DCP requirements for maintenance. DCP needs have been established by applying data given by Boudet and Riviere (1967) as adapted to distances trekked by a 300 kg animal unit (A.U.) (Table 7).[15] The data clearly indicate that the settled pastoral management system is more efficient in meeting qualitative requirements for animal maintenance and growth. Not only is the ratio between DCP surplus and DCP deficit months more favourable, deficits are also less extreme in the settled system.

5. DISCUSSION

5.1 General

A number of clear differences have emerged in the description of the two pastoral management systems. Among these are cultural differences relating to ideals and values, to socio-economic organisation and to language. The settled pastoralists also differ from the nomads in having permanent homesteads and in being more or less fully integrated in the social setting and the administrative framework of the area in which they live. Since the present paper has focused on fodder supply and grazing management, these several discrepancies will only be elaborated if relevant to an understanding of the organisation of grazing and herding. In addition to comparing the overall efficiency of the two pastoral management systems in meeting animal requirements for maintenance and growth under relatively harsh conditions, we shall identify the reasons for and consequences of certain management practices. Though the development potential dimension will be brought up in this context, the tentative nature of our views should be stressed.

5.2 Comparison of Two Pastoral Management Systems

In presenting the results of the management surveys, several points were made explicit:

(1) settled pastoralists take out their herds for grazing much later than do nomadic pastoralists and the time of return also tends to be later;
(2) settled pastoralists spend considerably fewer hours afield with their herds;
(3) the daily grazing orbit of settled pastoralists tends to be much more confined than that of nomadic pastoralists;
(4) the distance covered in grazing and trekking and the average hourly speed are much higher in the nomadic system;
(5) the duration of actual grazing time is rather similar in both systems but the ratio between intensive and extensive grazing is less favourable in the nomadic system;
(6) trekking is more prominent in the nomadic system;
(7) watering of cattle tends to be much more time-consuming in the nomadic system;

(8) the nomadic system displays much greater fluctuation over the year in terms of time devoted to grazing and related activities and to distances covered;
(9) herbage, crop residues, browse and regrowth are the most important fodders in both systems;
(10) the fodder composition of nomadic cattle is slightly less varied;
(11) certain fodders are more seasonally bound in the nomadic system;
(12) the efficiency of the settled system in meeting the nutritive requirements for animal maintenance and growth is considerably higher than in the nomadic system.

All in all, the grazing management system of the settled pastoralists compares favourably to that of the nomadic pastoralists in that the herd is provided with a steady supply of fodder with less effort for the animals. Whereas the settled pastoralists succeed in securing sufficient supplementary fodder and water in a relatively confined area, the nomadic pastoralists need an extensive grazing territory. This contrast is no doubt related to differences in inherent qualities of the habitats of the two groups surveyed. Reference has been already made to the relative abundance of low-lying land in Hanwa. The large supply of fadama herbage greatly contributes to the carrying capacity of the grazing grounds of settled pastoralists.

The importance of ready access to water should also be repeated in this context. Seasonal fluctuations in rainfall and groundwater level tend to be more strongly felt by the nomadic pastoralists since their grazing orbits often include areas that are void of water. When grazing outside the savanna on farmed land, there is the additional complication of securing access to water and of reaching it without long diversions. The location of accessible surface water and water holes is therefore a decisive factor in their strategy of daily and seasonal movement. Seasonal and spatial variation in the distribution of water obviously affects the settled pastoralists too but to a lesser extent. Their continuous confinement to the surroundings of the village presupposes the permanent availability of water nearby, otherwise they would not have settled there in the first place. The area, for example, that is occupied by the surveyed group of settled pastoralists has a river running right across the main grazing area; even at the end of the dry season many shallow ponds are left.

But though the natural habitat is important, it does not provide sufficient explanation for the noted differences. The relatively favourable position of the settled pastoralists reflects natural as well as advantageous human conditions. Settled pastoralists have an intimate knowledge of the area in which they make a living. Admittedly, nomadic pastoralists are also fairly acquainted with their grazing territory since the orbits they describe tend to change little from year to year. But the familiarity of nomadic pastoralists with the diverse areal resources and with the detailed arrangements that apply to its utilisation seldom matches that of the settled pastoralists. Nor can nomadic pastoralists exploit other advantages that commonly derive from the establishment of more permanent ties with the environment and its occupants through settling down and engaging in cultivation. To settled pastoralists animal breeding and cropping are more or less equally important activities and it was already noted that residues are sometimes conserved for periods of stress. In addition, they are able to utilise an extensive network of local relationships to obtain

access to fodder resources over which they have no control. Nomadic pastoralists, on the other hand, find it increasingly hard to secure and safeguard sufficient fodder resources, especially in the dry season. As has been described elsewhere,[16] the farmer-nomad relationship has been subjected to significant changes over the last few decades to the extent that the traditional pattern of utilisation of crop residues has been considerably upset. The farmer admits that a system of implied consent once prevailed, i.e. residue could be grazed when it was evident that the harvest had been completed, but it is felt that times have changed. He now wants clearer recognition of his title and insists that the pastoralists ask permission to enter his farm. It also happens that compensation is demanded, sometimes in kind but more usually in cash.

Finally, the way in which herd size and animal behaviour can contribute to better utilisation of fodder resources should be assessed. The size of the herds of settled pastoralists was found to lie between 5 and 60 head of cattle, while the nomadic herds surveyed were in the range of 100 to 300. This variation in herd size has a direct bearing on comparative ease of movement and grazing opportunities. Whereas the settled pastoralists can lead their herds through farmed land and take advantage of even small pockets of foggage without much difficulty, nomadic pastoralists with their larger herds run considerable risk of causing damage to standing crops, thus evoking dispute with the farmers. In this context reference may also be made to certain animal adjustments. Though all sample herds show a heavy predominance of so-called Bunaji (White Fulani) stock, cattle kept under the nomadic system appear to be less docile. Even when grazing a newly released stubble field the animals move about extensively; the herd might even leave the sea of plenty after some time to graze much poorer fields in the neighbourhood, only to return to the original field after a couple of hours. As soon as a senior animal, not seldom a cow, leads the way, the remainder of the herd follows unless the herdsmen interfere.

5.4 Conclusion

In this paper we have identified main features of pastoral management in northern Nigeria. We have also evaluated some major constraints; shortage of protein has been presented as most critical, with dry matter supply and water availability taking second place. While the low nutritive status of fodder causes poor utilisation of bulk energy sources, such management aspects as the magnitude of unproductive trekking and extensive grazing aggravate the effect even more. Consequent losses in weight and condition are particularly striking in the dry season.

Major improvements are readily conceivable. Provisions that are particularly relevant to the present work are the following:

(1) production of protein supplements (groundnut cake, cotton seed cake, urea blocks, buiret blocks) and distribution in periods of stress;
(2) oversowing rangeland with legumes (e.g. Stylosanthes humilis);
(3) the establishment of strategic fodder reserves through planting productive grasses (Andropozon gayanus mainly), special fodders (maize), or crops that provide protein-rich residue (cowpea, groundnut);

(4) the continuous allocation of existing forest areas to grazing;
(5) the creation of new grazing reserves to facilitate the emergence of a network of grazing grounds that are not too widely spaced;
(6) the development of a network of watering points (water holes, dams);
(7) the delimitation and safeguarding of an adjusted network of cattle tracks;
(8) improvement of the accessibility of fodder resources by the control and elimination of diseases (e.g. tse tse eradication).

Together these provisions will facilitate a reduction of unproductive trekking and will allow more intensive grazing to occur. The emphasis on these aspects also shows the direction which cattle husbandry in Nigeria should take. The comparative study that was undertaken proved that the management system of the settled pastoralists is clearly superior to that of nomadic pastoralists in terms of energetics. Having a permanent homestead, the settled pastoralists can more easily benefit from several of the provisions mentioned above. Having titles to land and being more fully integrated in the organisational framework, settled pastoralists are furthermore in a better position to diffuse and implement other innovations.[17]

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FOOTNOTES

1. Hans G.T. van Raay, "A Case for Regional Planning", Development and Change, II.3 (1970-1971), pp. 1-21.

2. D.R. Stoddart, "Organism and Ecosystem as Geographical Models" in R.J. Chorley & P. Hagget (eds), Models in Geography (London, 1967). J.G. Lambooy, "De agrarische hervorming in Tunesië; proeve van een sociaal-geografisch onderzoek" (Agrarian Reform in Tunisia; Assen, 1969), pp. 3-12; O.D. Duncan, "Human Ecology and Population Studies" in P.M. Hauser & O.D. Duncan (eds), The Study of Population (Chicago, 1969), pp. 678-717; C. van Paassen, "Geografische structurering en oecologisch complex" (Geographical Structuring and Ecological Complex; TKNAG, 1962), pp. 215-233.

3. The considerable assistance and devotion of the interpreter, Ali Umaru Misau, former student at the Institute of Administration of Ahmadu Bello University, is hereby acknowledged.

4. Results to be published shortly.

5. Hans G.T. van Raay and Peter N. de Leeuw, "The Importance of Crop Residues as Fodder", TESG, May-June 1970.

6. Ibidem.

7. Fadama (Hausa) is low-lying land that might be subject to seasonal water-logging.

8. D.W. Norman, "Crop Mixtures under Indigenous Conditions in the Northern Part of Nigeria", Factors of Agricultural Growth in West Africa (Inst. of Stat. Soc. Econ. Research, Ghana, 1973), pp. 133-144.

9. Hans G.T. van Raay, "Animal Husbandry", in M.J. Mortimore (ed), Zaria and its Region (Occasional Paper 4, Department of Geography, Ahmadu Bello University, Zaria, 1970).

10. Hans G.T. van Raay, "Rural Transformation in Northern Nigeria", in Proceedings of the Commission on Regional Aspects of Development (International Geographical Union, Canada, in print).

11. The authors wish to acknowledge the benefits derived from having access to data of the Rural Economic Research Unit of Ahmadu Bello University.
Hanwa is a village 5 km north of Zaria.

12. W. Fricke, "Cattle Husbandry in Northern Nigeria", in H. Werhahn, W. Fricke, F. Hunger, F. Weltz, H. Gottschalk, H. Saager, The Cattle and Meat Industry in Northern Nigeria (Frankfurt, 1965). C.E. Hopen, The Pastoral Fulbe Family in Gwandu (London, 1958); D.J. Stenning, Savanna Nomads (London, 1959).

13. The principal co-recorders were S.O. Magaji, M. Oche and M. Ajuba, and the authors wish to acknowledge their unceasing enthusiasm and accuracy.

14. DCP values for browse were left unaltered since the seasonal variation between species and plant parts eaten is so great that no justifiable adjustments seem to present themselves.

15. G. Boudet & R. Rivière, Emploi pratique d'analyses fourragères pour l'appréciation des pâturages tropicaux (IEMVPT, France, 1967). The requirements mentioned are mere approximations and make no allowance for the genetic adaptation in the Zebu breed to the harsh conditions of the environment. Many workers, particularly in Africa and Australia, have found that Zebu stock need less energy and nutrients and digest low quality feeds better than exotic breeds. These considerations, i.e. the great ability of Zebu stock to select a better-than-average diet together with their low nutrient requirements, may explain why, in spite of the nutritional stresses inherent to savanna grazing, many Fulani herds come through the dry season in such surprisingly good condition.
For calculations of DCP percent the equation DCP % = 0.957 CP % - 3.75 is used. For Shorthorn cattle adapted to low-quality savanna in Australia, Robinson and Steward found another equation: DCP % = 0.865 CP % - 2.21. Zero digestible protein occurs at levels of 3.9 and 2.5 respectively, indicating that the adapted cattle showed a more efficient protein digestibility. D.W. Robinson and G.A. Steward, "Protein Digestibility in Sheep and Cattle in North West Australia", Australian Journal of Experimental Agriculture and Animal Husbandry, VIII (1968), pp. 419-424.

16. Hans G.T. van Raay, "Rural Transformation in Northern Nigeria".

17. For a detailed account of developmental constraints and potentialities, see Hans G.T. van Raay, Rural Planning in a Savannah Region (University Press, Rotterdam, forthcoming).

TABLE 1 CUMULATIVE YIELDS AND NUTRITIVE VALUE OF UPLAND SAVANNA IN THE KATSINA AND ZARIA SURVEY AREAS, 1967-69

Katsina Survey Area: Upland Savanna	May	June	July	Aug	Sept	Oct	Nov	Dec-May
DM Kg/ha	50	200	400	600	800	1200	1500	1000
Average CP Content (% DM)	14.0	14.0	12.0	7.0	6.0	5.0	3.0	2.0
DCP Content* (% DM)	10.0	10.0	7.7	3.0	2.0	1.0	0.0	0.0
Adjusted DCP** (% DM)	10.0	10.0	9.0	4.0	3.0	2.0	1.0	0.0
Zaria Survey Area: Upland Savanna and Fallows								
DM Kg/ha	300	700	1000	2500	2500	3000	3500	300
Average CP Content (% DM)	12.0	12.0	7.0	6.0	5.0	5.0	4.8	3.0
DCP Content* (% DM)	7.7	7.7	3.0	2.0	1.2	1.2	1.0	0.0
Adjusted DCP** (% DM)	8.0	8.0	5.0	3.0	2.0	2.0	1.0	0.0

*) DCP % is derived from the equation
DCP = 0.957 CP - 3.75

**) Adjusted DCP to allow for fodder quantity per unit area and opportunities to engage in selective grazing.

TABLE 2 NUTRITIVE VALUE OF FADAMA GRASSES AND BROWSE IN THE KATSINA ZARIA SURVEY AREAS, 1967-69

	Fadama Grasses* (% DM)	Browse** (% DM)
Average CP Content	6.6***	14.4****
DCP Content	3.0	10.0
Adjusted DCP	6.0	10.0

*) Number of samples: 47

**) Number of samples: 48

***) As to the frequency distribution it may be noted that 38% of the samples contained < 5% CP and 45% of the samples 5-10% CP

****) 41% of the samples contained 5-10% CP and 40% of the samples 15% CP and more.

TABLE 3 YIELDS AND NUTRITIVE VALUE OF CROP RESIDUES IN THE KATSINA SURVEY AREA, 1967-69

Residues	DM Yield (kg/ha)		CP Content (% DM)		DCP Content (% DM)		
	Mean	Range	Mean	Range	Mean	Adjusted	Range
Sorghum	1700	1500 - 2100	2.2	1.6 - 4.5	0.0	0.5	0.0 - 0.5
Cotton	280	200 - 360	8.0	6.6 - 14.6	4.0	8.0	2.6 - 10.2
Groundnut	510	350 - 750	9.2	8.1 - 10.4	5.5	6.0	4.0 - 6.2
Cowpea	260	-	10.0	-	5.8	5.8	-

TABLE 4. EVALUATION OF GRAZING RESOURCES IN KATSINA AND ZARIA PROVINCES 1967 – 1969

MONTH	AREA	UPLAND HERBAGE DM	UPLAND HERBAGE CP	FADAMA HERBAGE DM	FADAMA HERBAGE CP	GRASS REGROWTH DM	GRASS REGROWTH CP	BROWSE DM	BROWSE CP	SORGHUM RESIDUE DM	SORGHUM RESIDUE CP	OTHER RESIDUES DM	OTHER RESIDUES CP	GENERA FODDER SITUATI
JUNE	KATSINA	●	●	●	●●	●	●●●	●●	●●●					● or ●
	ZARIA	●●	●	●	●●	●	●●●	●						●●
JULY	KATSINA	●	●●●	●	●●●			●●	●●●					●●
	ZARIA	●●	●●	●	●●●			●	●●●					●●●
AUG	KATSINA	●●	●●	●	●●●			●●	●●●					●●●
	ZARIA	●●●	●●	●	●●●			●	●●●					●●●
SEPT	KATSINA	●●●	●●	●	●●			●●	●●●					●●●
	ZARIA	●●●	●●	●	●●●			●	●●●					●●●
OCT	KATSINA	●●●	●	●●	●●			●●	●●●					●●
	ZARIA	●●●	●	●	●●●			●	●●●					●●●
NOV	KATSINA	●●●	●	●●	●●			●	●●●	●●	●	●	●●	●●
	ZARIA	●●●	●	●●	●●●			●	●●●	●●	●	●	●●	●●●
DEC	KATSINA	●●		●	●●			●	●●●	●●●	●	●	●●	●●●
	ZARIA	●●		●●●	●●●			●	●●●	●●●	●	●●	●●	●●●
JAN	KATSINA	●●		●	●●			●	●●	●●●		●●	●●	●●●
	ZARIA	●●		●●●	●●			●	●●	●●●		●●	●●	●●●
FEB	KATSINA	●●		●	●●			●	●●	●				●●
	ZARIA	●●		●●●	●●			●	●●	●●		●	●●	●●●
MAR	KATSINA	●		●	●●			●●	●●●					●
	ZARIA	●●		●●●	●●			●	●●●					●●
APR	KATSINA	●		●	●●	●	●●●	●●	●●●					●
	ZARIA	●●	●	●●●	●●	●	●●●	●	●●●					●●
MAY	KATSINA	●		●	●●	●	●●●	●●	●●●					●
	ZARIA	●●	●●	●●	●●	●	●●●	●	●●●					●●

* Dependent on rainfall distribution

●●● – HIGH POTENTIAL (>1000 KG DM/Ha ; >10% CP ; >6% DCP)

●● – MEDIUM POTENTIAL (500-1000 KG DM/Ha ; 5-10% CP ; 1-6% DCP)

● – LOW POTENTIAL (<500 KG DM/Ha ; <5% CP ; <1% DCP)

TABLE 5 FODDER COMPOSITION OF CATTLE IN TWO PASTORAL MANAGEMENT SYSTEMS (% OF GRAZING TIME), 1968-70

Cattle of Nomadic Pastoralists, Katsina Survey Area	Dec	Jan	Feb	March	April	May	June*	July**	Aug	Sept***	Oct	Nov
Upland Savanna	-	7	40	73	84	40	57	85	95	65	36	54
Regrowth	-	-	-	-	-	45	23	-	-	-	-	4
Fadama grassland	29	-	-	12	-	-	-	2	3	29	54	31
Browse	-	1	2	15	16	15	20	13	2	6	10	11
Sorghum Residue	65	58	24	-	-	-	-	-	-	-	-	-
Millet Residue	-	-	13	-	-	-	-	-	-	-	-	-
Cotton Residue	-	24	15	-	-	-	-	-	-	-	-	-
Groundnut Hay	5	10	6	-	-	-	-	-	-	-	-	-
Cowpea Hay	1	-	-	-	-	-	-	-	-	-	-	-
Cattle of Sedentary Pastoralists, Zaria Survey Area												
Upland Savanna and Fallow	9	29	15	25	32	15	96	96	98	95	90	98
Fadama grassland	-	19	67	41	45	79	2	-	-	-	-	-
Browse	-	2	3	5	6	6	2	4	2	5	10	2
Sorghum	54	40	11	8	3	-	-	-	-	-	-	-
Groundnut Hay	11	5	-	-	-	-	-	-	-	-	-	-
Cowpea Hay	23	1	-	-	-	-	-	-	-	-	-	-
Cotton seed ****	3	4	4	21	14	-	-	-	-	-	-	-

*) Interpolation between late May and early July.

**) Interpolation between early July and Middle August.

***) Interpolation between middle of August and early October.

****) In 1969, the rather exceptional condition existed of cotton seed lying unattended in the vicinity of the B.C.G.A. store close to Hanwa. This abnormal but readily accepted windfall of free supplementary feed was occasioned by the high cotton yield of 1969 and the resulting shortage of storage space for cotton seed.

TABLE 6 DCP INTAKE* OF CATTLE IN TWO PASTORAL MANAGEMENT SYSTEMS, 1968-70 (GRAM/DAY)

Fodders \ Months	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov
Cattle of Nomadic Pastoralists, Katsina Survey Area												
Upland Savanna	-	-	-	-	-	-	-	458	200	91	30	-
Regrowth	-	-	-	-	-	315	161	-	-	-	-	-
Fadama grassland	61	-	-	25	-	-	-	-	-	-	-	-
Browse	-	7	14	105	112	105	140	91	14	42	70	77
Sorghum residue	-	-	-	-	-	-	-	-	-	-	-	-
Millet residue	-	-	-	-	-	-	-	-	-	-	-	-
Cotton residue	-	67	42	-	-	-	-	-	-	-	-	-
Groundnut hay	23	39	23	-	-	-	-	-	-	-	-	-
Cowpea hay	7	-	-	-	-	-	-	-	--	-	-	-
Total	91	113	79	130	112	420	301	553	220	194	213	170
Cattle of Sedentary Pastoralists, Zaria Survey Area												
Upland Savanna and Fallow	-	-	-	-	-	81	517	202	133	80	76	69
Fadama grassland	-	40	141	86	95	167	4	-	-	-	-	-
Browse	-	14	21	35	42	42	14	28	14	35	70	14
Sorghum	-	-	-	-	-	-	-	-	-	-	-	-
Groundnut hay	42	19	-	-	-	-	-	-	-	-	-	-
Cowpea hay	93	4	-	-	-	-	-	-	-	-	-	-
Total	135	77	162	121	137	291	535	230	147	115	146	83

*) Unadjusted.

TABLE 7 THE EFFECT OF CATTLE MOVEMENT ON ENERGY AND DCP REQUIREMENTS FOR NORTHERN NIGERIA

Distance (Km/day)	Energy requirement (% increase)	DCP requirement per animal unit (g/day)	DCP (% increase)
0	100*	150**	100
10	122	192	128
20	144	232	154
30	166	273***	182

*) Energy requirement for maintenance at 0 km is 100%

**) DCP requirement for maintenance at 0 km is 150 gram/day.

***) The increase of the DCP requirement for maintenance progresses at a rate of approximately 4g DCP/Km.

TABLE 8

ADJUSTED* DCP INTAKES AND REQUIREMENTS OF CATTLE IN TWO PASTORAL MANAGEMENT SYSTEMS, 1968-70

Month / g DCP/A.U./day	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov
Cattle of Nomadic Pastoralists, Katsina Survey Area												
Adjusted DCP Intake	172	143	89	111	56	217	154	630	221	241	327	226
Adjusted DCP Requirement for Maintenance	183	197	213	262	244	273	248	231	213	195	175	191
Deficit	11	54	124	151	188	56	94	-	-	-	-	-
Surplus	-	-	-	-	-	-	-	399	8	46	152	35
Cattle of Sedentary Pastoralists, Zaria Survey Area												
Adjusted DCP Intake	162	135	312	251	249	449	558	351	211	149	154	73
Adjusted DCP Requirement for Maintenance	172	199	184	203	206	172	186	181	182	192	187	194
Deficit	10	64	-	-	-	-	-	-	-	43	33	121
Surplus	-	-	128	48	43	277	372	170	29	-	-	-

*) For adopted procedure, see text.

DIAGRAM 1. THE LENGTH OF THE GRAZING DAY IN TWO PASTORAL MANAGEMENT SYSTEMS

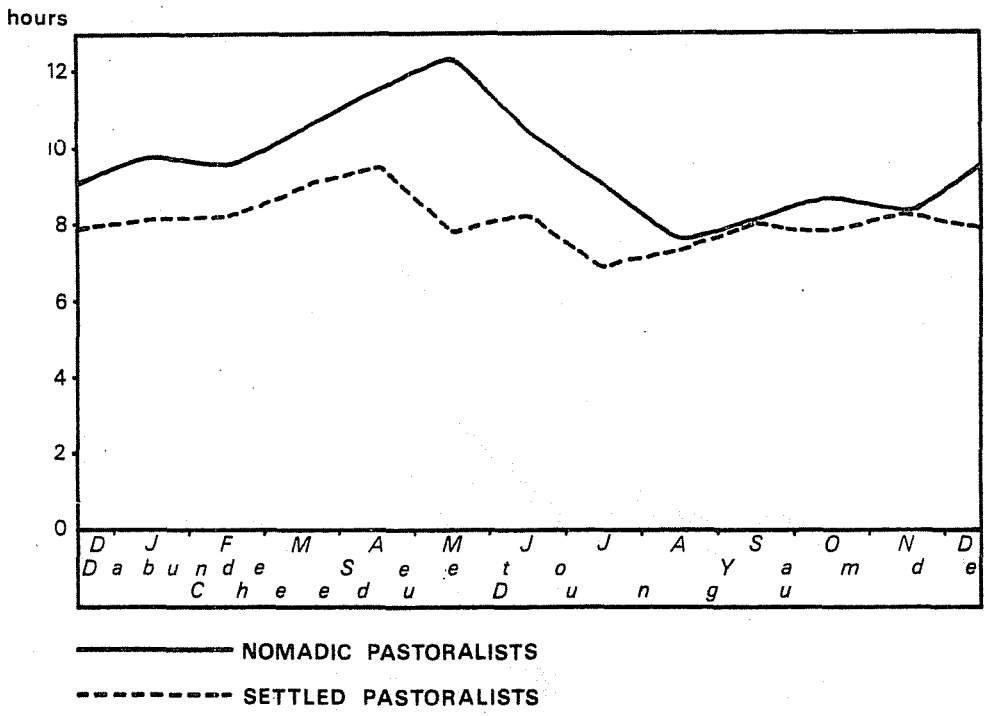

DIAGRAM 2 DAILY DISTANCES AND AVERAGE SPEED PER HOUR OF HERDS IN TWO PASTORAL MANAGEMENT SYSTEMS

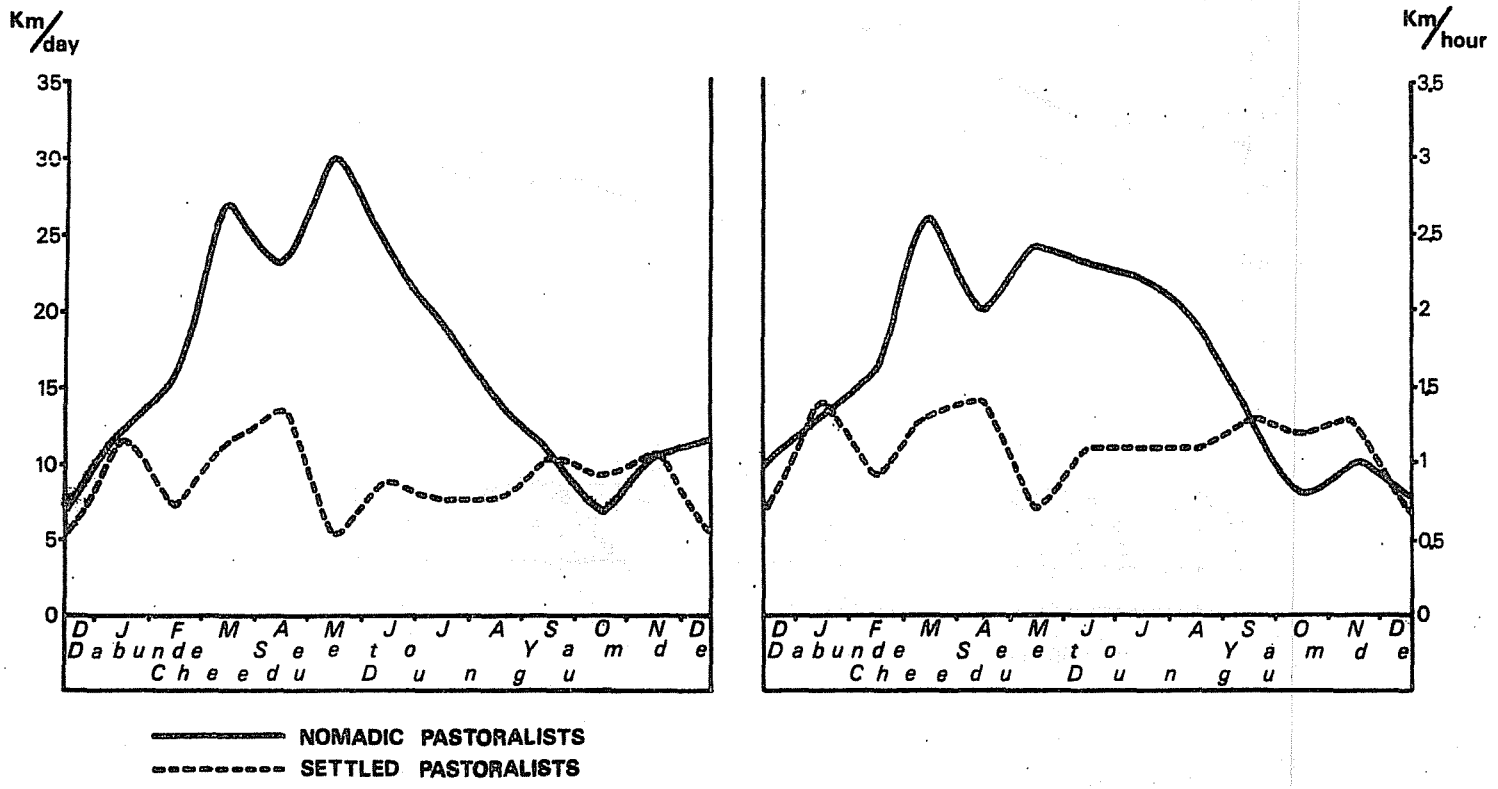

DIAGRAM 3. INTENSITY OF GRAZING IN TWO PASTORAL MANAGEMENT SYSTEMS

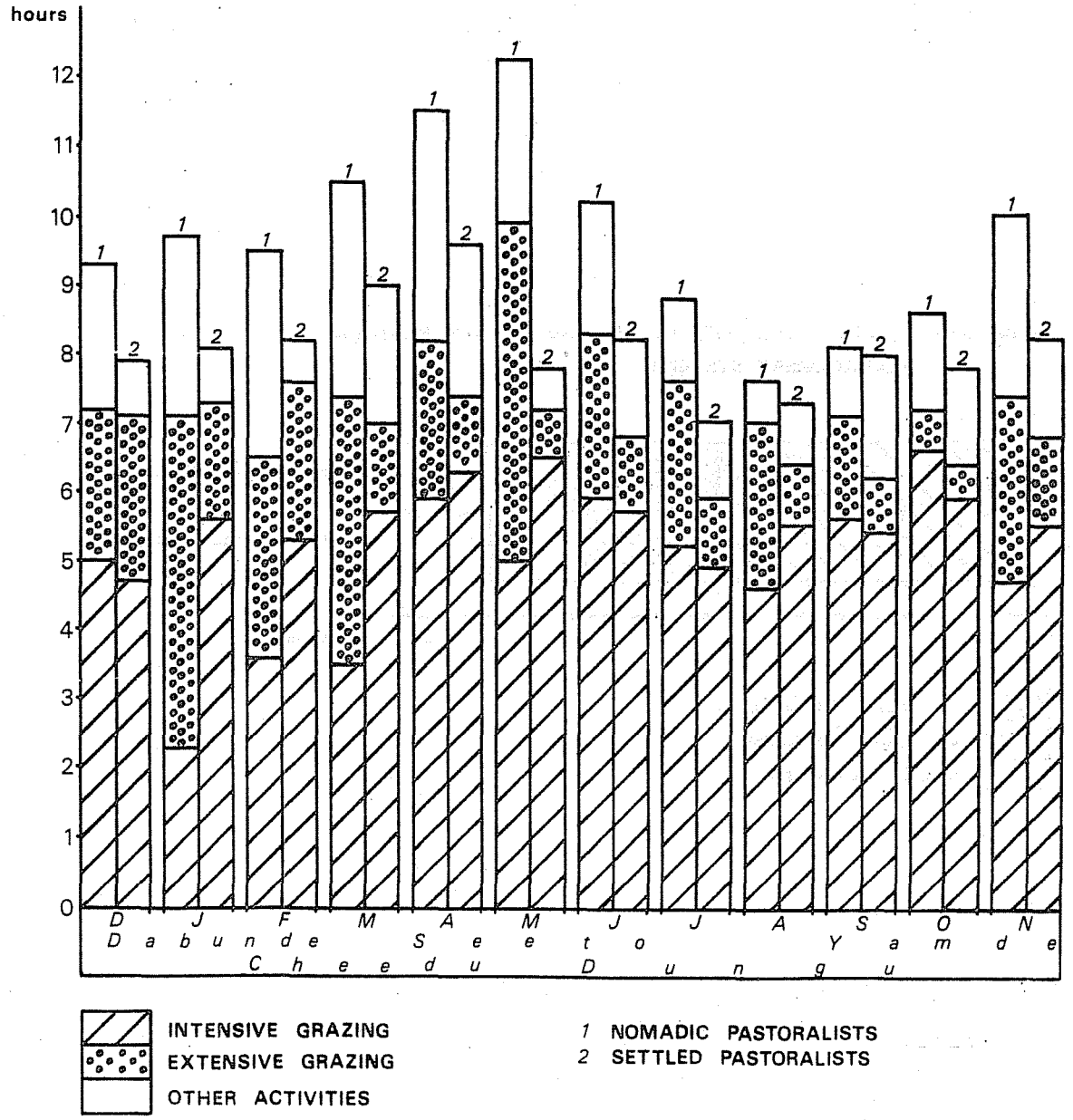

DIAGRAM 4. AVERAGE INTENSITY OF GRAZING IN TWO PASTORAL MANAGEMENT SYSTEMS

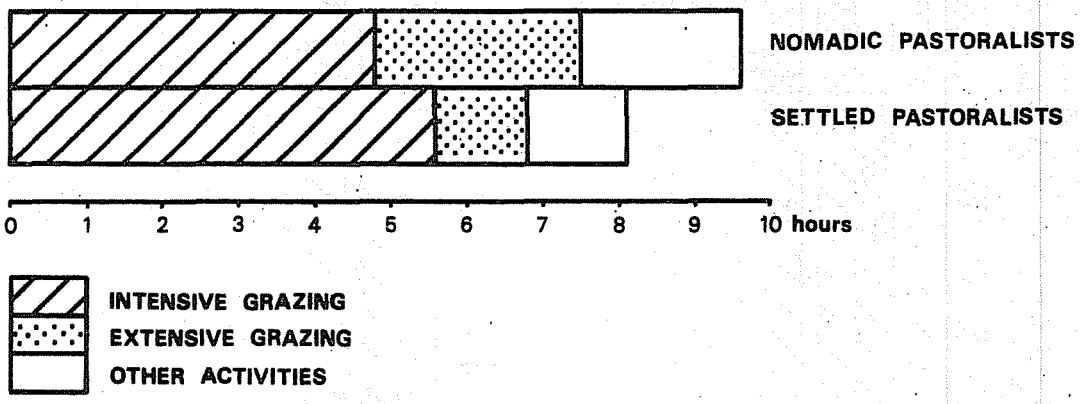

DIAGRAM 5. TIME DEVOTED TO DAILY TREKKING AND WATERING OF HERDS IN TWO PASTORAL MANAGEMENT SYSTEMS