

Cropping by Fulani agropastoralists in central Nigeria

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Summary

THIS PAPER presents the results of a survey to determine the extent and methods of crop production in the Fulani agropastoral system in central Nigeria, and to identify the possibilities for increasing forage resources for the Fulani by cropping.

Central Nigeria is a region in which the pastoral Fulani are increasingly becoming settled farmers. ILCA's aerial surveys have revealed a positive correlation between cattle and cultivation densities up to cultivation levels of 20 to 40%. The two areas studied were around Abet and Kurmin Biri. Abet is an area where the Fulani have settled among farming groups. In contrast, the Kurmin Biri area lies within a government grazing reserve where the Fulani are being encouraged to settle.

Cropping has become important to the Fulani, since their cattle do not then have to be sold in order to purchase grain. The area under cultivation among the 25 Fulani households studied ranged from 0.23 to 2.19 ha with an average of 0.87 ha/household. Positive correlations were found between farm size and household size in both Abet and Kurmin Biri, indicating that farm size increased with household consumption needs or with household labour supply.

Sorghum and maize, either sole cropped or grown in combination, accounted for about 70% of the total area cultivated. Cattle manure was widely used by keeping herds overnight on the land which was to be cropped. Almost all the Fulani used some chemical fertilizer although application was confined to small areas and little was apparently known about application rates or timing. With cattle manure, Fulani agropastoralists were obtaining grain yields comparable to those of the neighbouring specialised crop farmers who rely mainly on chemical fertilizer.

Crop residues are a highly valued feed resource and were ranked by the Fulani, along with the early rainy period, as being responsible for increased cattle productivity. However, the quantity of crop residues produced from the Fulani cropping system is insignificant, so they continue to rely on grazing the harvested fields of neighbouring farmers.

Herd size relative to cultivated area becomes an important consideration in improving cattle nutrition through crop and forage integration. Because the areas cultivated by the Fulani are small, any increase in forage production is likely to be minimal. It appears that innovations aimed at increasing feed resources from cultivated land would be best addressed to agropastoralists, either ex-herders or ex farmers, who cultivate enough land to ensure that forage growing would have a noticeable effect on animal nutrition.

Introduction

Improved animal nutrition during the 6month dry season is essential for raising cattle productivity in the subhumid zone of West Africa (ILCA,1979). Under growing population and cultivation pressures, and the consequent reduction in grazing areas, an increase in fodder

resources from cropped land is needed to maintain even current levels of animal production. ILCA's team has found it difficult to induce agricultural landowners to try new methods of cropping which would increase fodder production; there is no incentive for them to grow forage for cattle owned by the Fulani pastoralists. Where cattle raising and cropping are under the same ownership, as in the case of Fulani agropastoralists, the benefits from increased forage production are immediately appreciated.

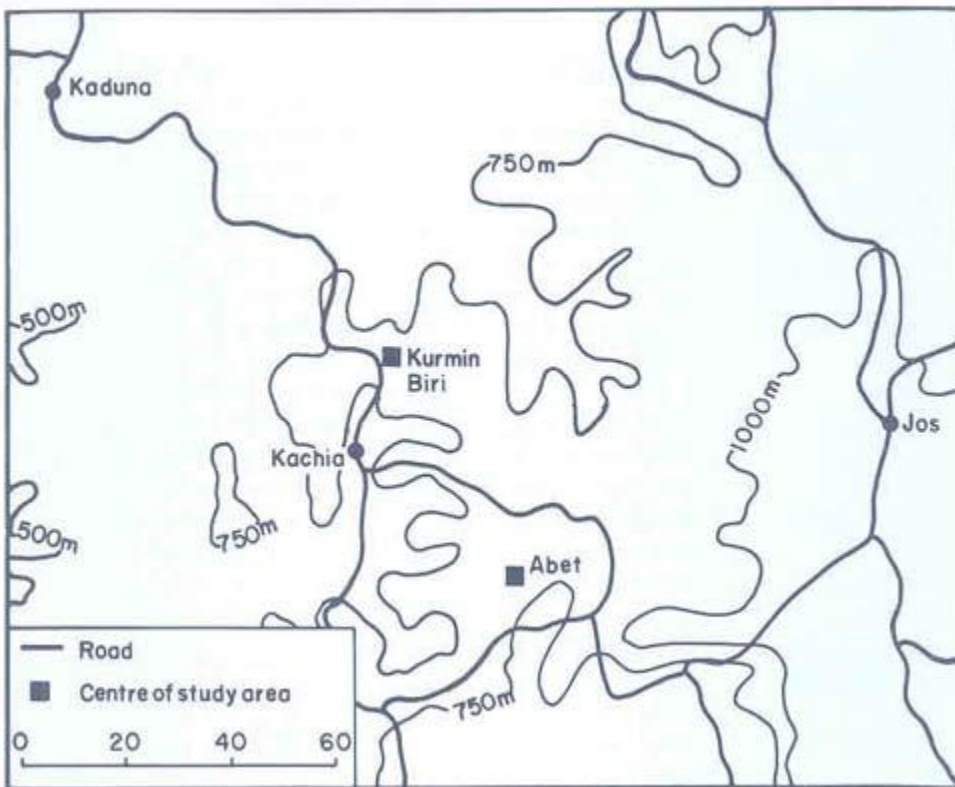
This paper presents the results of a survey to determine the extent and methods of crop production by the Fulani agropastoralists studied by ILCA in central Nigeria. The study examined the present methods of crop production in order to identify the potential for and possible limitations to increasing forage resources by cropping. The growing tendency of Fulani cattle owners to settle permanently and develop links with indigenous farming groups are discussed in light of the growing competition for access to and control of land for cropping.

Study area

Previously considered a dry season retreat for Fulani transhumant herders, central Nigeria is now a region of increasing Fulani settlement. Some of the Kachichere Fulani have been settled in southern Kaduna State for generations, although they may change their exact locations every few years. ILCA's aerial surveys have revealed a positive correlation between cattle and cultivation densities up to cultivation levels of 20 to 40% (Bourn and Milligan, 1984). Some farmers also keep cattle, and Fulani herders are evidently attracted to areas that are already cultivated by indigenous crop farmers: besides the feed resources, principally crop residues and fallow land grazing, and the social and economic advantages of living close to farmers, the Fulani are now seeking good cropland for themselves.

The Subhumid Zone Programme's two case study areas of Fulani settlement in central Nigeria, Abet and Kurmin Biri (Figure 1), have similar soils and climates but different livestock and cultivation densities. Average rainfall in both areas is about 1300 mm.

Figure 1. *The location of the Abet and Kurmin Biri study areas in the subhumid zone, central Nigeria*



Abet (9°40'N, 8°10'E) represents an area where the Fulani have settled among farming groups. The population and cultivation densities in an area of 2475 km² around Abet are relatively high at 70 people/km² and 24% of the available area respectively (Milligan et al, 1979). Settled Fulani comprise approximately 10% of the total population in the 60 km² area immediately around Abet (Waters-Bayer and Bayer, 1984). Land is held by the indigenous farming groups Kaje and Kamantan, with whom the Fulani negotiate for settlement and cultivation rights.

Kurmin Biri (10°5'N, 8°0'E) lies within a government grazing reserve where the Fulani are being encouraged to settle. Over a 2500 km² area which includes the grazing reserve, the population density is 12 persons/km² and the cultivation density is 15% (Milligan et al, 1979). However, on the grazing reserve alone, which covers 12% of this total area, population and cultivation densities are lower. The 35 Fulani households now settled on the 31000 ha reserve have immigrated from nearby areas during the past 5 years in search of permanent land rights. Crop farmers in this region own few livestock, most of these being goats and pigs.

The traditional practice between the separate livestock-owning and farming populations has been the exchange of their respective resources meat, milk and manure for grain and land. However, as the Fulani seek more land for cultivation from the farming landowners, and consequently purchase less grain, these formerly complementary interactions are being weakened. At the same time, the farmers are becoming less dependent on the Fulani for manure because of the widespread use of subsidised chemical fertilizer. Conflicts over crop damage and land requirements have already prompted the movement of some Fulani from relatively densely cultivated areas into the less heavily populated grazing reserve.

The study

The study was initially conducted in Abet during October and November 1982 with the heads of 13 Fulani households. One to four households live together in a ruga¹; cattle may be jointly managed and cooked food may be shared, but household heads generally farm individually and control separate stores of grain. Fulani women are involved only slightly in farming.

1. Ruga is a Hausa word meaning a Fulani encampment including people, buildings and livestock.

Cultivated areas were estimated by pacing the perimeter of blocks, and information on inputs, cultivation practices and constraints to production was obtained through structured interviews and observations.

In November 1983 the same procedure was followed with 12 Fulani households in Kurmin Biri. The cropping data for the two sites thus represent two successive years. In 1983, harvest yields of the main crops were estimated from 100 m² plots at each site.

Results and discussion

Cropping pattern

The majority of the 25 Fulani had been farming for most of their lives, even though on a limited basis. However, their cropping had expanded over the years to offset the rising price of food grains. Cropping became important as a way of avoiding the necessity of selling livestock in order to buy grain. The purpose was not to produce marketable products, though surplus supplies were sold and a few Fulani were experimenting with soya bean as a cash crop. The similarity in cultivation practices between the Fulani and the local crop farmers, as well as the Fulani's own comments, indicate that the Fulani have learned their farming techniques from the neighbouring crop farmers.

Cultivated area

The area under cultivation by the 25 Fulani household heads ranged from 0.23 to 2.19 ha, with an average of 0.87 ha/household. This was about one third of the crop area cultivated by the Kaje farmers in the area. Delgado (1979) found that in central Upper Volta, Fulani were cultivating an average of 2.46 ha/household or about two thirds of the crop area of neighbouring farmers.

Farm size, household size and herd size for Abet and Kurmin Biri are given in Table 1. Positive correlations were found between farm size and household size in both Abet ($r = 0.55$; $P < 0.05$) and Kurmin Biri ($r = 0.70$; $P < 0.01$). In Kurmin Biri there was a positive correlation ($r = 0.68$; $P < 0.01$) between farm size and the number of working males in the household. This relationship did not hold for Abet, perhaps due to the lack of land to engage available males in farming, the greater availability of labour for hire so that men did not have to farm and/or the greater opportunities for off-farm employment. Although the sample was small, the negative but not significant correlation ($r = -0.42$) between farm size and herd size found in Kurmin Biri may indicate competition between cropping and cattle husbandry for labour.

Table 1. Fulani farm, household and herd sizes in Abet (1982) and Kurmin Biri (1983).

Location	No. of households	Household size		Farm size (ha/household)	Herd size ^a (cattle household)/
		No. of persons	No. of active males		
Abet	13	mean: 9	3	0.67	49
		range: 2–19	1–6	0.23–1.19	10–182
Kurmin Biri	12	mean: 12	4	1.10	53 ^b
		range:3–22	1–7	0.40–2.19	4–86

^a Fulani herds also include about 20% of sheep.

^b Calculated for nine herds because six households combined herds into three management units.

The average cultivated area per household in Kurmin Biri was nearly twice that of Abet. Household size was somewhat larger in Kurmin Biri than in Abet, but the difference in average farm size is largely explained by the greater availability of land in Kurmin Biri.

Settlement rights

In Abet all land is claimed by the indigenous farming groups, and a relatively high percentage of the land is already under cultivation. When a Fulani settles in Abet, he is expected to negotiate with the farming landowner, or the chief in cases of settlement on unoccupied land, for settlement rights which are usually for an indefinite time period although considered by both parties to be temporary.

Preferred settlement sites include land close to the *ruga* suitable for cultivation. Additional land may be acquired from crop farmers often on a yearly and per field basis and for a payment of ₦ 4 to 6 (US\$ 5 to 8) or a bag of fertilizer or manure deposited on the respective farmer's cropland. The Fulani in Abet stated that their farming would expand if more land could be acquired. Unoccupied land requires considerable work for initial clearing, and farmers may then reclaim it. The Fulani therefore prefer to lease previously cultivated land for cropping.

One of the prime motives for settling in the Kurmin Biri grazing reserve where more land is available, is the desire to acquire an adequate area of land for cropping; but the area which can be cropped depends on the labour available for land clearing and subsequent crop management tasks. Once the initial high labour investment is made to clear land, the Fulani in Kurmin Biri expect to have secure and permanent rights to the land, which is not the case in Abet.

Crop enterprises

In Kurmin Biri 22 crop enterprises involving 12 different crops were identified, compared to 12 crop enterprises with 10 different crops in Abet (Table 2). Sorghum (*Sorghum bicolor*) and maize (*Zea mays*), either sole cropped or in combination, accounted for about 70% of the total area cultivated by the 25 Fulani. Millet (*Pennisetum typhoides*) ranked third with 13% of the total

area under cultivation. The concentration on these cereal crops, which are staples in the Fulani diet, is in keeping with the Fulani's aim to meet household consumption needs. Rice and yams are also important in the Fulani diet but are considered special foods; in the main they are still purchased, owing to the limited availability of low-lying land suited to rice cultivation and the hard work required in preparing yam ridges.

Table 2. Crop enterprises of the settled Fulani in Abet (1982) and Kurmin Biri (1983).

Crop enterprise	Abet			Kurmin Biri		
	No. of plots	Cultivated area (ha)	% of total cultivated area	No. of plots	Cultivated area (ha)	% of total cultivated area
Sorghum/maize	13	3.38	39	18	6.12	46
Sorghum	9	1.80	21	17	2.89	22
Millet	9	1.41	16	18	1.52	12
Rice	26	0.78	9	1	0.01	<1
Sweet potato	10	0.29	3	17	0.68	5
Maize	4	0.57	7	6	0.54	4
Others	21 ^a	0.47	5	28 ^b	1.43	11
Total	92	8.70	100	105	13.19	100

^a Maize/cocoyam and iburo represented 2% and 1% respectively of the total cultivated area; 21 other enterprises representing less than 1% each involved the above-mentioned crops plus yams, okra (*Hibiscus esculentus*) and spinach (*Amaranthus* spp.).

^b Yam represented 3% of the total cultivated area; 28 other enterprises representing less than 1% each involved the above-mentioned crops plus cassava (*Manihot esculenta*), cocoyam, cowpea (*Vigna unguiculata*), soya bean (*Glycine max*), pepper (*Capsicum annuum*) and tomato.

The other cereal crop grown by the Abet Fulani, namely iburo (*Digitaria iburua*), was planted by broadcasting seed in scattered small plots where cattle had been kept overnight. It involved no cultivation or subsequent management. Iburo was not grown by the Fulani in Kurmin Biri; resources such as manure were rather used for sorghum, maize and millet. Sweet potato (*Ipomoea batatas*) was the predominant tuber in Kurmin Biri, followed by yam (*Dioscorea rotundata*) and cocoyam (*Xanthosoma sagittifolium*).

Sole cropping versus intercropping

In Kurmin Bid the Fulani devoted 46% of the area under cultivation to sole cropping—mainly sorghum and a late variety of millet transplanted from nurseries—and 51% to two-crop mixtures compared with 57% and 41% respectively in Abet. In contrast to the Fulani, indigenous crop farmers in Abet practised more typical mixed cropping; 38% of the total cultivated area was sown to two-crop, 26% to three-crop, 6% to four-crop, and 5% to five-crop mixtures and only 25% to sole crops (Powell, 1981).

The greater reliance on sole cropping in the Fulani system, and the absence of the diverse mixtures commonly sown by crop farmers in the region, are attributed to the higher yields for less labour (an expressed Fulani aim) obtained in sole cropping, and a greater dependence on

the three staple grains. Delgado (1979) likewise found the Fulani in Upper Volta practising a less labour-intensive mode of cultivation than the farming groups, principally because of conflicts in labour requirements between cropping and herding² In northern Nigeria mixed cropping required a 62% higher annual labour input/ha than sole cropping, although this difference fell to 29% during the peak labour period (Norman et al, 1982).

2. Delgado reported an average herd size of 43 head compared with 49 and 53 in this study. Even though 60% of the cattle within the herd were entrusted cattle, the labour required for cattle management in the two studies is comparable.

Management techniques

Traditional crop varieties are used exclusively in Abet and Kurmin Biri, except for an improved variety of maize which has been distributed through the local political party and is widely cultivated. Like the crop farmers, the Fulani commonly establish millet nurseries in mid-July and transplant seedlings during August and September in order to spread the work more evenly. In Abet the Fulani either received their transplants free from the neighbouring farmers, or obtained from them the goat manure used for fertilizing nurseries since they themselves generally do not keep goats. The Fulani in Kurmin Biri planted their own nurseries and used cattle manure—a less favoured fertilizer as it is thought to stimulate fast growth resulting in weak transplanted plants which are susceptible to lodging and breaking.

Striga (*Striga hermonthica*), a parasitic weed associated with low fertility conditions, was a major problem in established sorghum and maize fields in Abet, but not in Kurmin Biri where land has more recently come under cultivation. The crop farmers rotate sorghum and/or maize with millet to suppress striga, a practice widely adopted by the Fulani as well. Head smut (*Sphacelotheca reiliana*) on sorghum and downy mildew (*Sclerospora graminicola*) on millet were also more prevalent in Abet than in Kurmin Biri. Many Fulani used seed dressing, but the prevalence of these diseases suggests incorrect usage.

Cropping inputs

Labour

In general, the Fulani have become skilled cultivators. Only three of the 25 Fulani interviewed expressed a disdain for cultivation and had hired out all farm work apart from planting and harvesting, the latter taking place at a time of acute shortage of hired labour. Twelve of the 25 Fulani hired no labour, either because it was not available, or because their small farms needed only household labour, or because money was lacking. Only a few Fulani, however, worked in the fields throughout the day; most confined their farm work to the morning hours. The Fulani employed one or more of four systems:

- Self: all work was done by the man with perhaps some help from children and/or wife (wives);
- *Adashe*: an arrangement among a group of relatives or friends who cooperated in cultivating each individual's farm in turn; usually comprises only the strenuous tasks such as ridging and weeding;

- *Gaiya*: group work for a specific task with food and drink given in return; the group did not necessarily include only Fulani; and
- Contract: labour was hired, generally by the job; might include tractor hire.

Labour costs varied with the crop, the operation and soil conditions, and ranged from ₦ 20 to 286 (US\$ 26 to 380) per household, the highest figure being paid for tractor hire on the largest cultivated area. In 1983, two of the 12 Fulani interviewed hired tractors to prepare their land. Ridging and weeding were the operations most commonly hired out, especially yam ridging which requires considerable skill and labour.

Three labour peaks were identified: May to early June when land was being prepared for sorghum and maize planting; the end of July to September when sorghum and maize were being weeded and millet was being cultivated; harvest time when herding had to be the most closely supervised. As grazing areas are reduced during the cropping season, careful herding is necessary to prevent crop damage. Most of the Fulani had sons or hired herder boys skilled enough to manage the herds. Any household head who lacked herding help had to farm before 10:30 a.m. at which time, in the rainy season, the cattle were taken for grazing. During harvest, however, in the more densely cultivated areas such as Abet, most household heads and all available labour helped with herding, with often three to four men and boys tending each herd in order to keep the cattle out of unharvested fields.

The ability of the individual household to meet the labour demands for combined cropping and livestock production appeared to be mainly a function of the number of non-schooled children in the household available to help with livestock management, principally herding. The Nigerian Universal Primary Education Programme, and the priority the Fulani give to the education of their children, meant that few children were available for herding. The Fulani have various ways of alleviating household labour shortages, including cooperative labour exchanges, joint herding, lending of family members, and employment of a herder in exchange for cattle. Nevertheless, all the Kurmin Biri Fulani gave labour conflicts between cropping and livestock management as the major constraint in cropping. They had land but needed extra labour; hired labour was unavailable because of the low farming population in the area.

Draught power

None of the Fulani interviewed had ever used animal draught power. Animal traction had been introduced in Abet and was being used as late as 1980 by one crop farmer. Only four other farmers in Abet had used animal draught power; the principal deterrents to continued use were the labour required to graze the animals and the inadequate extension support in providing training and replacement stock. None of the Fulani interviewed expressed any interest in using cattle for farming, citing as reasons for this their opinion that soils were heavy and studded with bush, equipment was expensive and cattle would suffer. Tractor hire was preferred but it was limited in availability.

Fertilization

Cattle manure was widely used by keeping herds overnight on fields to be cropped. Two systems of manuring were practised: during the early wet season the herd was tied in pairs for 2 to 3 nights at each location and was moved systematically to cover the crop area. The time spent in each field depended on the number of fields to be manured (ideally each field every

second year), field size, herd size, and the time available between the first rains and planting. Dry season manuring was generally done on land which had not been farmed previously: animals were tied in pairs but were moved at intervals of 5 nights.

In Abet dry season manuring was most commonly done on farmers' fields, for which the Fulani were paid in cash or kind. In the 1982/83 dry season, half of the 22 farmers surveyed in Abet hired Fulani to manure the fields intended for ginger (a cash crop) cultivation; the Fulani earned a value, excluding settlement rights, of about ₦ 6.50 (US\$ 8.50) per week (Powell and Waters-Bayer, 1984). When the rains began, the Fulani preferred to move their herds back to their own cropland. None of the Kurmin Biri Fulani manured farmers' fields; they used their herds on their own cropland during both the dry and the wet season. This was probably due to the smaller number of farmers living close to the Fulani in Kurmin Biri, and the lack of established cooperation.

Wet season manuring was valued by the Fulani more than dry season manuring, mainly because it was thought to have a superior effect on soil fertility and subsequent crop yields. However, wet season manuring was said to lead to soil compaction which made cultivation more difficult; hired labourers demanded higher wages for working such land. Dry season manuring was not thought to compact the soil, but it did not give the high yield response as wet season manuring and led to an increase in weeds. However, grain yields obtained by eight farmers in Abet on fields manured in the dry season were 25 to 115% higher than on the adjacent non-manured fields (Powell and Waters-Bayer, 1984).

Almost all of the Fulani (21 out of 25) used some chemical fertilizer, although applications were generally confined to small areas and little was known about the rates or timing of application. Most of the Fulani stated a preference for chemical fertilizer because it was considered to give higher grain yields than cattle manure. A disadvantage was that chemical fertilizer had to be applied annually, whereas manure had a residual effect lasting 2 to 3 years. The uncertain availability of fertilizer also meant that most of the Fulani continued to rely on cattle manure. Sorghum and maize received the greater part of the available fertilizer in keeping with their place as the most important crops.

Cropping output

Grain yields

Data recorded under traditional farmer management at three locations in central Nigeria from 1980 to 1982 showed average sorghum yields of 1040 kg/ha as a sole crop and 920 kg/ha as a single intercrop; maize yields of 860 kg/ha as a single intercrop; and millet yields of 650 kg/ha as a sole crop (Federal Ministry of Agriculture, 1983). The yields of sorghum, maize and millet from Fulani fields in 1983 did not attain these levels in either Abet or Kurmin Biri (Table 3) owing to an unusual rainfall pattern in both areas: the early rains were erratic and the rains ended abruptly 4 weeks earlier than normal. Although the total wet season rainfall (1310 mm) in Abet was close to average, this was due to an abnormally wet period in late July. In Kurmin Biri total rainfall (1060 mm) was below average.

Table 3. Grain yields from Fulani fields in Abet and Kurmin Biri, 1983.

Location	Cropping enterprise	No. of plots ^a	Mean grain yield ^b (kg/ha)		
			Sorghum	Maize	Millet
Abet	sorghum/maize	6	800 (170)	490 (170)	–
	Millet	4 ^c	–	–	370 (40)
Kurmin Biri	sorghum/maize	8	630 (120)	510 (230)	–
	millet	6 ^c	–	–	530 (160)
	sorghum	3	740 (90)	–	–

^a Number of 100 m² areas.

^b Standard deviations are given in parentheses.

^c Excludes 2 plots grazed by cattle.

In 1983 sorghum and maize intercrop yields in farmers' fields in Abet were lower by 21% and 52% respectively and those of sole cropped millet by 49% compared with the two previous (normal) wet seasons. Combined sorghum/maize yields of 1290 kg/ha and millet yields of 370 kg/ha obtained by the Fulani in Abet from the 1983 harvest were approximately the same as the sorghum/maize and millet yields (1410 kg/ha and 390 kg/ha) obtained by the local farmers.

In Kurmin Biri lower rainfall was blamed for the reduced sorghum/maize yields (1140 kg/ha). However, the millet yields (530 kg/ha) were 40% higher than those obtained by either the Fulani or the farmers in Abet. The higher millet yields obtained in Kurmin Biri were attributed to a more timely transplanting of millet.

These data indicate that the Fulani, who relied principally on cattle manure and whose cropping labour was in competition with cattle management, were obtaining yields comparable to those of neighbouring specialised crop farmers who used almost exclusively chemical fertilizer. Two millet fields at each site were grazed by the owners' herds just before harvest, reflecting a disadvantage of cropping and herding in close proximity.

Grain output and household energy needs

The average contribution of sorghum, maize and millet to annual household energy requirements was higher in Kurmin Biri than in Abet, although there was considerable variability in both areas (Table 4). The larger cultivated areas and subsequent greater overall grain output at Kurmin Biri would account for the higher contribution of these grains.

Table 4. *Sorghum, millet and maize grain contributions to annual household energy requirements in Abet and Kurmin Biri, 1983.*

Location	No. of households	Contribution ^a to annual energy requirements (%)	
		mean	range
Abet	13	33	9–90
Kurmin Biri	12	42	18–93

^a Assumes 20% grain loss in storage, 18.8 MJ energy/kg of grain dry weight and annual energy requirement of 3500 MJ/adult equivalent.

Five household heads in both areas said that their crop yields of sorghum, maize and millet were sufficient and that they would not need to buy these grains. Another seven Fulani said that they had met household requirements in either sorghum and maize or millet production. Of the five households that were reportedly self-sufficient in the three grain crops, one produced enough annually for sale. The percentage contributions of these cereals to the energy needs of the remaining four self-sufficient households were 25, 41, 44 and 75% respectively, perhaps reflecting different preferences for other foods.

It has been estimated that milk provides approximately 10% of the annual energy requirements of settled Fulani households (Waters-Bayer, 1984). Meat and, 'backyard' food crops also supply some energy, but the bulk of the deficit must still be made up through purchases.

Crop residues

Crop residues are a highly valued feed resource and were identified by the Fulani, along with the early rainy period, as being responsible for increased cattle productivity. However, as the quantity of crop residues produced from the Fulani fields (8.7 ha in Abet and 13.2 ha in Kurmin Biri) was insignificant, they continued to rely on grazing the harvested fields of neighbouring farmers.

Using previously established relationships between sorghum/millet grain and DM yields and stover edibility (Powell, 1983), the quantities of stover available for grazing from both Fulani cropping systems could be estimated. Assuming an average cattle body weight of 200 kg and a daily intake of 5 kg DM/head with 70% of intake coming from stover, Fulani sorghum and millet fields in Abet would provide only 5 grazing days for the 13 herds, while in Kurmin Biri the 12 herds would deplete the stover on harvested fields in 9 days.

Besides grazing their own limited crop residues, the Fulani competed for access to farmers' harvested fields. In Kurmin Biri, where the cultivation levels in close proximity to the Fulani rugas were low, many Fulani sent their herds to nearby farming villages for a 2-week stay at the beginning (the most valuable time) of the crop residue grazing period. None of the Fulani stored crop residues for later dry season feeding, nor is there yet a market in the area for stored crop residues as there is further north. For these Fulani the expected benefit was not worth the labour required to harvest and store crop residues.

Conclusions

The Fulani cannot be viewed solely as cattle keepers, as cropping is becoming increasingly important in their production system. The Fulani's involvement in grain production is changing their linkages with the indigenous farming groups: the Fulani are becoming less dependent on farmers for grain and the farmers are becoming more reliant on chemical fertilizer, although a decrease in the government's present fertilizer subsidy might modify this latter reliance³.

3. The 75% fertilizer subsidy is to be reduced to 50% in 1984 and to 25% in 1985 (Suleiman, pers. comm., 1984).

Where the Fulani can secure land, as in the government grazing reserve or through guaranteed occupancy rights, labour supply for herding and cropping may become the next limitation if hired labour is seasonally unavailable. When land, hired labour and fertilizer are available, the Fulani appear willing to expend livestock earnings in order to increase crop production. In northern Nigeria around Zaria, for example, Norman et al (1982) found Fulani cattle owners cultivating larger farms than non-cattle-owning farmers (3.7 ha versus 2.2 ha), apparently because their livestock revenues made it possible for them to purchase usufructuary rights and to hire more labour.

Since meeting subsistence grain needs is a major goal, the Fulani are not likely to jeopardise food production in order to increase forage production if there are alternative dry season feed resources. Undersowing and inter-row sowing of *Stylosanthes* into sorghum stands substantially increases the quantity and quality of crop residue DM, but grain yields may be reduced (Saleem, 1980).

ILCA's research is now looking for ways to intercrop grain or dual-purpose legumes in order to increase both total grain and crop residue DM yields. The sole cropping and sorghum/maize intercropping currently practised by the Fulani may indicate a lack of available labour for more intensive mixed cropping. Maize is important in the Fulani system but, although the heads are harvested before the end of the rains, it is frequently intercropped, and the stover is subject to further weathering before it becomes available for grazing, and therefore is often not palatable. If a legume were undersown into maize prior to harvesting in September, the legume would benefit from 2 months' rainfall and stored soil moisture.

Most Fulani do not have access to any crop extension service; they learn their cropping techniques from neighbouring farmers and through their own experimentation. The extension of adaptable, high-yielding, pest-resistant cultivars along with information about sowing rates and methods, fertilizers and seed dressings, and improved crop management would increase both grain and crop residue DM yields.

Herd size relative to cultivated area becomes an important consideration in trying to improve cattle nutrition through integrating crop and forage production. But just as herders are taking up farming, so too are farmers investing in cattle (Toulmin, 1983; McCown et al, 1979; Diarra, 1975). Innovations aimed at increasing fodder production from cultivated land would be best addressed to agropastoralists, either ex-herders or ex-farmers, who have both cattle and land and who can cultivate sufficient land so that forage growing would have an impact on animal nutrition.

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List of abbreviations

AI	Artificial insemination
a.s.l.	Above sea level
cf.	Compare
CIF	Cost, insurance and freight
DM	Dry matter
ECF	East coast fever
EEC	European Economic Community
FOB	Free on board
ha	Hectare
IBRD	International Bank for Reconstruction and Development (USA)
ISCDD	International Scheme for Coordination of Dairy Development (FAO, Rome)
KCC	Kenya Cooperative Creameries Ltd
Ksh	Kenya shilling
LSU	Livestock unit (250 kg)
LW	Liveweight
SMS	School milk scheme (Kenya)
t	Metric tonne
WFP	World Food Programme (Italy)