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STALL FEEDING OF CATTLE IN THE MANDARA MOUNTAINS OF

NORTHERN CAMEROON

by

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ABSTRACT

This paper describes a cattle stall-feeding enterprise practiced by smallholders in a semi-arid region of Northern Cameroon, the Mandara Mountains. It is based on one year of original research, conducted in 1980-81. Stall-feeding contributes to the economic viability of permanent cultivation in land scarce, hilly areas, where soils are poor and eroded, and where agricultural production is low and variable. Smallholders collect and apply stall-fed cattle manure to loose, incohesive soils, which improves soil structure and augments grain yields. Sales of stall cattle and beef from slaughtered stall animals also generate income for small farmers, as well as enabling producers to continue building capital. Since the Mandara Mountains region is isolated and poorly linked with the surrounding Moslem dominated areas, there are few alternative employment opportunities available to small farmers.

1.0 INTRODUCTION

Most livestock raising in the semi-arid zones of Africa is extensive range-fed husbandry. Yet intensive livestock production has become increasingly common in densely populated regions where cattle can be purchased at the end of the rainy season for dry season feeding, feed resources are available in sufficient supply during the dry season, and urban centers of demand are nearby. Significant intertemporal cattle price differentials encourage crop-livestock farmers to purchase cattle at low prices at the end of the rainy season for fattening during the three to six month dry season. Cattle are fattened on agricultural by-products and sold for attractive prices later in the dry season, when cattle supply has contracted. Such seasonal fattening enterprises are found in Northern Nigeria (White, 1986), South-central Niger (Thomas-Peterhans, 1982), along the Niger River near Niamey (Wardle, 1979), in the hills surrounding Tananarive, Madagascar (Serres, 1969), in the Harrar highlands of Ethiopia (Blanc, 1974), in the Shire Highlands and the Lilongwe Plains of Malawi (Thomas and Addy, 1977), and outside of Dakar, Senegal and Ouagadougou, Burkina Faso. The primary output of these intensive livestock production systems is fattened cattle, which are sold to urban butchers and cattle traders for slaughter in urban markets.

This paper describes a quite different type of intensive livestock production system. It examines stall-feeding of cattle in a densely populated, mountainous region of Northern Cameroon, the Mandara Mountains. In this region smallholders enclose cattle for periods of two to three years, during which cattle manure is collected and applied to fields near the household compound to maintain soil fertility and augment grain yields. This intensive livestock production system is essentially a manure driven system, similar to production systems found on the slopes of Kilimanjaro in Tanzania (Zalla, 1982), on the island of Ukaru in Lake Victoria (Ludwig, 1968), and in the Kofyar inhabited regions of south central Nigeria (McNetting, 1965 and 1968). All of these stall-feeding enterprises

are found in densely populated, land scarce regions where permanent cultivation is practiced. Cattle manure from these enterprises helps to maintain soil structure and fertility in areas where soils would become rapidly depleted in its absence. Beef and dairy products are secondary yet important joint products of these stall-feeding enterprises. In the Mandara Mountains stall-fed cattle are slaughtered for traditional festivals or sold to butchers or traders after two or more years of enclosure.

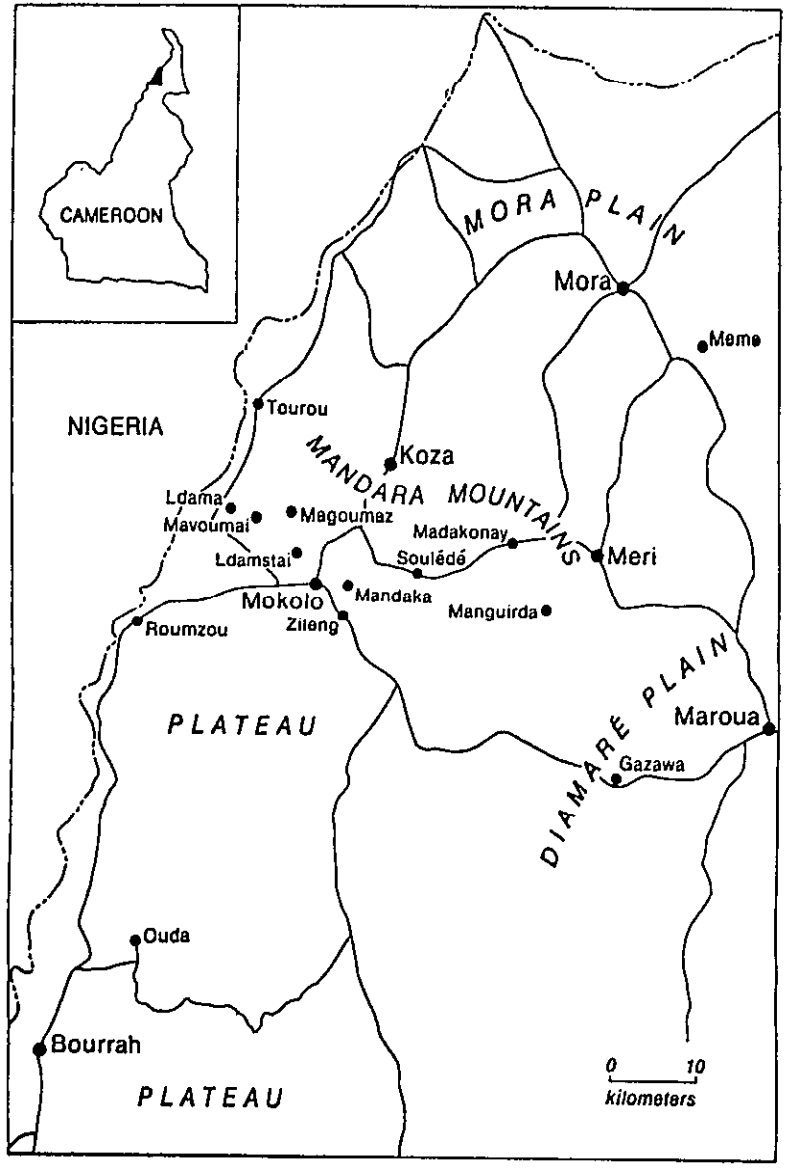
2.0 OVERVIEW OF THE GEOGRAPHY, POPULATION AND STALL-FEEDING ENTERPRISES OF THE MANDARA MOUNTAINS REGION (see Campbell, 1981)

Study Description. The findings of this study are based upon one year of survey research (April 1980-March 1981) conducted in eight villages of the mountainous zones of the Mandara Mountains. A team of applied researchers from Michigan State University spent one year based in Mokolo, departmental seat in the Mandara Mountains region. An initial extensive socioeconomic survey of 288 respondents in 36 randomly selected villages was followed by an intensive, multiple visit survey of cropping systems in five villages (Madakonay, Manguirda, Ldama, Roumzou and Ouda), representative of different agroecological subzones and agricultural groups, an intensive, multiple visit survey of cattle stall-feeding enterprises in two Mafa villages (Magoumaz and Mavoumai), a single visit survey of cattle stall-feeding households in five villages (Magoumaz, Mavoumai, Ldamtsai, Zileng and Mofole), and surveys at three livestock markets and two slaughter slabs.

Geography. The Mandara Mountains region is one of the more environmentally, agriculturally and ethnically diverse regions of West Africa. It is located in the semi-arid tropics between the latitudes of 10^{o} and 11.5^{o}. This falls within the Sudano-Sahelian belt, a zone which is wetter and more highly vegetated than the Sahelian zone lying to the north. Figure 1 shows the Mandara Mountains region in Northern Cameroon. The climate of the region is characterized by a six-month rainy season (May through October) and a six-month dry season (November through April). The region can be divided into

FIGURE I

MANDARA MOUNTAINS REGION



four ecologically distinct zones: the mountains, the plateau, the plains and the piedmont. The mountainous zone (900-1400 meters), where stall-feeding of cattle is concentrated, comprises approximately one-third of the land area of the region. The mountain soils, which are decomposed granite, are generally coarse, granular, incohesive and severely eroded. Rainfall varies widely within the mountains across years and villages, ranging between 600 and 1100 mm. per annum.

The Mandara Mountains border Nigeria to the west and the Diamare Plains to the east. The Diamare Plains are heavily populated by Fulani pastoralists and their cattle herds. This cattle surplus region supplies the Mandara Mountains region with an estimated 31% of its slaughter cattle, which are typically old and infertile cows, as well as over three-quarters of the bull calves for stall-feeding enterprises (Holtzman, 1982). The most important cattle markets of Northern Cameroon, including Bogo, Gazawa, Moulvouday and Doumrou, are located in the Diamare Plains. These markets attract cattle from as far away as Chad and traders from other regions of Northern Cameroon, as well as Nigeria. For many years trade cattle have flowed from east to west in response to interregional and international cattle price differentials.

Population. The population of the Mandara Mountains region was estimated to be 547,748 in the 1976 national census. This population is ethnically diverse, with twenty different groups found in the 7,893 square kilometers area. The multitude of languages and cultures in the mountainous areas has left the region politically, socially and economically fragmented, which contrasts markedly to adjacent areas of the plains, where large areas have been dominated by more politically unified and cohesive groups such as the Fulani, the Mandara and the Bournoua. The Mafa population is highest among the agricultural groups in the mountains and piedmont. An estimated 156,000 Mafa were concentrated in the mountains to the north of Mokolo, on the high plateau to the east of Mokolo, and in the plains near Koza in 1980 (projected from estimates of Podlewski, 1960). The survey research on stall-feeding was conducted in Mafa inhabited zones.

At least 90% of the population of the Mandara Mountains region resides in rural areas, while some five to ten percent of the population is urban. The principal towns at the time of the 1976 census were Mokolo (5,196), Mora (4,487), Meme (3,755), Bourha (5,212) and Koza (2,500) (Republique du Cameroun, 1980). Although the Mandara Mountains is the least urbanized of any of the regions in Cameroon, urban population is expanding steadily in these major towns.

The mountainous zone of the Mandara Mountains region is densely populated, exceeding 200 inhabitants per square kilometer in some mountainous areas which are intensively cultivated. Land holdings per household range between one and three hectares, depending on the availability of arable lowlands and the population density. Cultivation takes place on terraced hillsides in most mountain villages. Lowlands are reserved for cultivation during the growing season, but grazed during the dry season. Livestock are enclosed during the rainy season, when grasses are hand-cut and carried to the animals.

Prevalence of Stall-Feeding. Survey research findings show that one in four households (26%) stall-feed cattle in the mountainous zone of the Mandara Mountains region (Campbell, Lev and Holtzman, 1980). From the survey data and Livestock Service estimates of the cattle population, the author estimates that some 12,900-13,400 cattle were stall-fed in the entire region in 1980-81 (Holtzman, 1982). Eighty-five percent of these animals are raised in the mountains and piedmont areas, while the remainder are owned by farmers living at the foot of the mountains in semi-intensively cultivated areas of the plains. Although stall-fed animals represent only 7% of the regional cattle herd of 185,000 head, stall-feeding is expanding in the mountainous areas, due principally to increasing opportunities for rural slaughter and export.

3.0 EVOLUTION OF STALL-FEEDING ENTERPRISES

Stall-feeding has been practiced in the Mandara Mountains since the 19th century, although the mountainous zones of the region have been inhabited and cultivated by non-

Moslem agricultural groups for centuries (Marliac, 1969). Inhabitation and cultivation of the mountainous zones intensified during the late eighteenth and nineteenth centuries, when Fulbe warriors swept eastward through Northern Nigeria and Northern Cameroon on horseback and enslaved local agricultural groups in the process (Mohammadou, 1981). To avoid capture, farming groups receded to hilly areas and established intensive mixed farms on terraced steep slopes, enclosed or staked livestock during the pasture scarce growing season, and applied manure to the soil (Boulet, 1975).

Stall-feeding plays an important role in customary social practice in the Mandara Mountains region. Stall-fed bulls are commonly slaughtered by their owners at the post-harvest festival (November-December) or to celebrate the Marai, the festival of the bull (January-February), which has both religious and social significance. Beef from slaughtered cattle is customarily distributed to the extended family or to friends. The tradition of post-harvest slaughter and distribution is upheld by older farmers and producers in isolated areas, suggesting that stall-feeding has deep roots in traditional social practice. As shown in Table 1, producers in isolated Magoumaz sold no beef after disposing of nearly half of the stall-fed cattle raised over a four year period.

Recently this traditional system has become more commercial. Producers report that little beef from slaughtered stock was sold before 1970. By March 1981 a sample of households from five villages in the Mandara Mountains reported that only 25% of the stall-fed cattle slaughtered were consumed or distributed with no sale of beef since 1977. Many of the younger farmers who stall-feed cattle were beginning to raise cattle at least in part for commercial sale. In fact, 28% of the stall-fed cattle in the above sample were sold on the hoof, as shown in Table 1. By 1981 most live cattle were sold in the producer's village, although some farmers trekked their cattle to nearby cattle markets or to Nigeria. Of the 72% of the bulls that were slaughtered by producers, at least some of the beef was reserved for traditional distribution and household consumption in 80% of the cases. In 63% of these cases farmers sold at least one quarter

TABLE 1

DISPOSAL OF STALL-FED CATTLE RAISED IN VILLAGES NEAR MOKOLO[a]

	Magoumaz		Mavoumai		Entire Sample		Estimated Breakdown of Regional Offtake[b]	
	Number of Bulls	Cumulative Percentage	Number of Bulls	Cumulative Percentage	Number of Bulls	Cumulative Percentage	Number	Percent
Sold live	8	7.5	46	42	75	28	1,655	27.6
Sold all beef	12	19	7	48	40	42	882	14.7
Sold three quarters	10	28	40	85	55	63	1,213	20.2
Sold two quarters	3	31	5	89	9	66	199	3.3
Sold one quarter	18	48	2	91	21	74	463	7.7
No sale of beef	52	97	10	100	69	99	1,522	25.4
Beef exchanged for livestock	3	100	0	100	3	100	66	1.1
Total	107	100	110	100	272	100	6,000	100.0

SOURCE: Survey of stall-feeding households, September 1980-March 1981.

[a]The sample includes households from Magoumaz, Mavoumai, Zileng, Ldamstai and Mandaka, which are villages within 12 kilometers of Mokolo. The sample is purposive in that it includes only stall-fed cattle sold or slaughtered from 1977 through March 1981. Bulls that died or were stolen are not included in the sample. The sample was not randomly selected from stall-feeding households. Rather, certain sections of villages were completely enumerated (or close to being enumerated). The sample is also not entirely representative in that the villages were chosen for their accessibility. Stall-feeding households in isolated villages are not included in the sample.

[b]An estimated 6,000 head of stall-fed cattle are slaughtered or sold each year, assuming a regional stall-fed herd of 12,800 head and an average feeding period of 25.7 months. The proportional breakdown of the regional offtake corresponds exactly to the breakdown of the entire sample (column 8).

of the slaughtered bulls to other villagers, including local butchers, or to buyers from neighboring villages. In 48% of these cases, stall-feeding households sold three-quarters or more of the beef from the carcass. Beef sales generate enough revenue to reinvest in another bull, buy clothing, pay taxes, or make other necessary purchases.

Overall sample survey findings show that producers in the five villages were moderately commercially oriented. During 1977-81, 61% of the stall-fed cattle offtake was sold, while 39% of the beef was reserved for household consumption and distribution to the extended family. Assuming that the regional offtake of stall-fed cattle corresponds to the pattern observed for the sample, 60 percent of the total offtake of 6,000 head or 3,600 stall-fed cattle equivalents in 1980 were sold. Forty-six percent of this commercialized offtake was sold on the hoof to butchers and traders. The remaining 54% was sold as quarters of beef, of which roughly half was sold to rural butchers, while the other half was retailed by the producers.

Commercialization is gradually increasing in some isolated villages, such as Magoumaz, while commercialization is increasing quite rapidly in less isolated villages, particularly near the Nigerian border, such as Mavoumai. Greater cattle and beef sales have accompanied the increasing monetization of the economy of the Mandara Mountains region, which is considered a backwater by Cameroonian standards. Furthermore, cattle price inflation in West and Central Africa during the 1970s and early 1980s compelled many stall-feeding farmers to sell at least some beef to acquire cash for reinvestment. Inflation was fueled principally by the rapid growth of the Nigerian economy following the petroleum price hikes of the 1970s. At the same time that demand for beef in West Africa shifted outward, slaughter cattle supply contracted in the wake of the Sahelian drought. The regional cattle herd decreased in size as a result of drought-induced losses, reducing the availability of slaughter stock. Moreover, potentially available slaughter animals were held back as producers sought to reconstitute herds. The resulting slaughter cattle supply contraction put further upward pressure on prices. Periodic

drought in semi-arid regions of Africa and the subsequent reduction in marketed surplus of cattle, after the initial period of distress sales and herd liquidation, will likely continue to make investment in livestock a good inflation hedge in the 1980s and 1990s.

The effect of cattle price inflation on the trend toward greater commercialization of stall-feeding has been especially marked in the Mandara Mountains region, where food deficits are common and alternative sources of income are limited. Simply holding cattle led to considerable appreciation in their value during the 1970s. Retail price data from Yaounde, the capital of Cameroon, show average annual appreciation of four percent in real terms. Without the inflation in real cattle values during the 1970s, it is likely that fewer sales of cattle and beef would have taken place and that fewer farmers would have undertaken stall-feeding for monetary gain.

4.0 INTEGRATION OF STALL-FEEDING INTO THE INTENSIVE FARMING SYSTEM

4.1 The Annual Crop and Livestock Production Cycle

The pattern of rainfall distribution, cropping and livestock raising cycles, and periods of livestock purchase and disposal that characterize the intensive mixed farms of the Mandara Mountains region are illustrated in Figure 2. The seasonal distribution of rainfall governs agricultural and livestock production practices in this semi-arid region, dictating planting, weeding and harvesting dates, which in turn determine the periods of livestock enclosure and free grazing. Cattle are enclosed beginning in April and released for grazing crop residues and standing hay after the harvest (November). During the seven month enclosure period, cattle are stall-fed both dried and stored fodder (April-June) and freshly cut forage (July-October). Water is also hand-carried to stall-fed animals during the hot dry months (April-June). Once the rains begin in July, there is adequate moisture in the freshly cut forage.

During the slack period in the agricultural cycle after the second weeding and before the harvest (mid-August through mid-October), farmers collect, dry and put into storage grasses, sorghum and millet stalks and leaves, sweet potato vines and peanut

FIGURE 2

ANNUAL CYCLE OF RAINFALL, CROP AND LIVESTOCK PRODUCTION IN THE MANDARA MOUNTAINS

Activities	Months											
	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Average Mo. Rainfall (mm.)	0.7	29.5	92.2	143.9	286.8	299.0	158.6	44.0	0.4	0	0	0
Standard Deviation	2.0	24.5	38.8	43.1	86.3	83.7	61.1	41.1	145.5	-	-	-
Crop Production	*clear fields*	*prepare fields*	*planting*	← *weeding* →		← *slack period* →			harvest	← dry season →		
Livestock Enterprises	←	feeding of *stored fodder* →		←	feeding of freshly *cut forage* →				←	grazing →		
						cut & store fodder						
		←	cattle enclosed →						←	cattle released →		
Average Labor Inputs to Stall-Feeding (HR/HH)	41.2	71.8	94.2	100.7	105.6	107.0	116.7	129.3	91.2	23.1	14.8	10.3
Stall-Fed Cattle Acquisition/ Disposal	bull calf acquisition →					← concentration of cattle slaughter/sale →						
									harvest festival			Marai
Regional Supply of Slaughter Cattle	← short supply (high prices/kg) →					← abundant supply (low prices/kg) →						

Sources: Rainfall data--Catholic Mission, Ouro-Tada, 1963-79 in Campbell, David J., Larry Lev and John Holtzman, "Results of a Socio-Economic Survey in the Department of Margui-Wandala and the Arrondissement of Meri in North Cameroon, April-May, 1980," MSU/USAID Mandara Mountain Research Report No. 11, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan, December 1980.

Average monthly labor inputs to stall-feeding--intensive survey of stall-feeding, 1980-81.

hay. This stored fodder is principally fed to livestock during the early rainy season, but may also supplement late dry season (March-April) grazing resources, which are often exhausted or inadequate by March in villages with high ruminant livestock populations and limited dry season pasture. Both the need to store fodder for feeding during the March-June period and the high labor requirements per animal unit during enclosure limit households' livestock holdings. Generally the larger families with more active laborers are able to meet the demanding labor requirements of stall-feeding.

4.2 Interactions Between Cropping and Livestock Enterprises

Figure 3 illustrates many of the linkages between cropping and livestock enterprises on small farms in the Mandara Mountains region. Rainy season labor activities are deliberately emphasized, for it is during the growing season that the crucial labor resource allocation decisions are made. Family labor has a far lower opportunity cost during the dry season, when few income earning opportunities are available within the region.

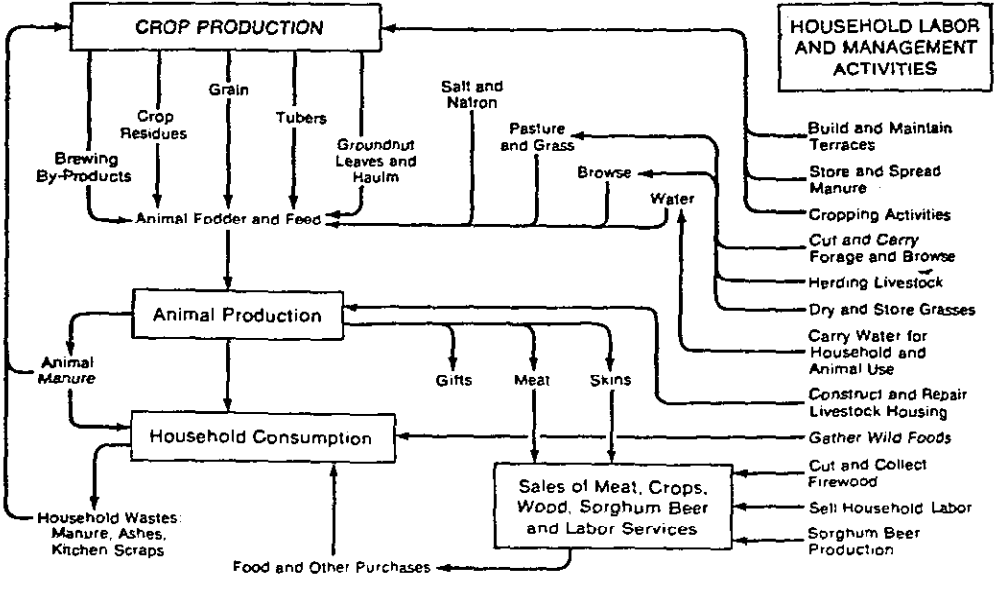
Crop and livestock production are the most important enterprises on mixed farms in the region. Other enterprises which generate income include sorghum beer brewing, collecting firewood; drying and storing grasses; selling agricultural labor services within the village, in neighboring villages and in Moslem settled areas in the plains; and selling non-agricultural labor services in larger towns during the dry season.

4.3 Competition for Labor Between Cropping and Livestock Enterprises

Households' labor is in short supply during the growing season, when intensive cropping and livestock enterprises demand heavy inputs. Both men and women provide agricultural labor, although there is some specialization in tasks. Men clear the fields and cut and carry grasses to livestock more often than women, while women maintain the terraces, weed, carry water for household and livestock use, and prepare feed for livestock more often than men. About one-third of the children in the mountain villages

FIGURE 3

SCHEMATIC REPRESENTATION OF THE INTENSIVE FARMING SYSTEMS OF THE MANDARA MOUNTAINS



go to school, but most primary schools let out by noon each day to allow children to help their families in the fields. Furthermore, children become full-time laborers during the June-August school recess, helping to cut and carry fodder for small ruminants and weed.

4.4 Complementarities Between Cropping and Livestock Enterprises

Although crop and livestock production compete for household labor during peak periods, such as planting and weeding, they also have important complementarities. By-products such as groundnut leaves, sweet potato vines and spent grain from sorghum beer brewing are used as animal fodder. Furthermore, crop residues are grazed by farmers' livestock. Grain and tubers are also fed to livestock in limited quantities, especially when farmers are trying to fatten their cattle and small ruminants for dry season slaughter or sale.

Manure is one of the joint products of livestock production which serves as a direct input into crop production. Livestock manure is highly valued as a fertilizer and rarely burned as a source of heat or cooking fuel, nor is it sold to other households, as in Niger (Thomas-Peterhans, 1982) or in Ethiopia (ILCA, 1982). In mountainous areas adjacent to the plateau, farmers often pay Fulani herders to graze their crop residues by large cattle herds. Payment is usually in grain, legumes or prepared meals.

5.0 INPUTS INTO STALL-FEEDING ENTERPRISES

5.1 Bull Calves

Farmers purchase bull calves from one to four years of age for stall-feeding. At the time of acquisition these bulls weigh an average of 175 kilograms, though they ranged from 135 to 219 kilograms (data from a sample of 18 animals followed from October 1980 to October 1982 by the Centre National de Formation Zootechnique et Veterinaire for a Cameroonian credit agency promoting stall feeding, FONADER, Fonds National de Developpement Rural, Thys, Oumate, Dineur, 1983). The bulls are typically slaughtered some two years later at liveweights which average 320 kilograms, but which range widely

from 180 to 450 kilograms (ibid.). Most farmers pay cash for their bull calves, although some exchange small ruminants to supplement limited cash holdings. The average purchase price was 35,117 FCFA for a sample of 54 households near Mokolo in 1980. Acquisition prices increased at an average annual rate of 9.1% from 1972 to 1980. Two-thirds to three-quarters of the bull calves are acquired for stall-feeding during the dry season (December-May), when farmers acquire cash from the sale of livestock or cash crops, such as sweet potatoes and peanuts. During the dry season they also have time to attend distant cattle markets in the Diamare Plains, such as Gazawa, Meme, and Maroua.

5.2 Labor

Cattle stall-feeding is a labor-intensive enterprise demanding high labor inputs during the growing season. Labor data collected by activity at two-week intervals for a sample of 52 households in two survey villages show that households allocate approximately 900 hours per year per stall-fed bull (Holtzman, 1982). Stall-feeding households own an average of 1.1 bulls (Campbell, Lev, Holtzman, 1980). Labor devoted to herding is excluded from the calculation of total hours, since cattle are herded by children during the dry season, when labor has a low opportunity cost.

Cutting and carrying grass and carrying water to the cattle absorb 60-75% of the labor allocated to stall-feeding. Procuring fresh grasses demands the most labor of any single activity (40-50% of total hours), while hauling of water absorbs 20-30% of total hours. Other important labor activities are stocking of fodder for late dry season feeding and the preparation and hand-feeding of feed while cattle are enclosed. Manure management, stall construction and repair, tick removal, and cutting leaves from trees for feed account for less than five percent of labor inputs. Herding requires significant inputs of child labor, but most of this labor is provided during slack periods and therefore has a low opportunity cost. Nevertheless, households with children have a definite advantage in meeting dry season herding requirements, which frees adult labor for seasonal migration and employment, sorghum beer brewing, collecting firewood,

butchering, cattle trading, food preparation for sale at local markets, and other employment.

Nearly three-quarters of the labor required for stall-feeding cattle is allocated during the growing season, when labor inputs into cropping enterprises are also highest. However, only about 50 percent of labor inputs into stall-feeding are required during peak crop cultivation periods, which occur from May through mid-August and from mid-October through mid-November. During the first two months of the growing season (May and June), most of the labor allocated to stall-feeding is devoted to carrying and giving water to the bulls. From July through the end of the rainy season (October) 70-80 percent of the labor inputs are for cutting, carrying and hand-feeding grasses.

During the two-month growing period that follows the final weeding (early August) and precedes the harvest (mid-October), households allocate more labor to stall-feeding, particularly to cutting, drying and storing forage and agricultural by-products. Total labor inputs for stall-feeding and stocking forage were highest during the months of September and October.

5.3 Feed and Water

The six principal sources of livestock feed for households that stall-feed cattle in the Mandara Mountains are:

1. Hand-cut and carried grasses that grow in and around the village;
2. Agricultural by-products, such as legume leaves, sweet potato vines, sorghum and millet stalks and leaves, and crop stubble;
3. Standing forage that is grazed during the dry season;
4. Dried and stored grasses and agricultural by-products;
5. Sorghum beer brewing by-products; and
6. Natron and salt.

The composition of stall-fed cattle rations varies dramatically by season (Table 2). During the dry season and first month of the rainy season (December-May), the ration

TABLE 2

COMPOSITION OF STALL-FED CATTLE RATIONS
BY SEASON, FONADER SAMPLE, 1980-82

Component of Ration	Dry Season Ration (Percent)	Rainy Season Ration (Percent)
Fresh Forage	0	64
Dried/Stored Forage	44	0
Peanut Leaves/Vines	24	12
Millet/Sorghum Leaves and Stalks	16	13
Potato Leaves/Vines	14	9
Bean Leaves	3	1
Sorghum Brewing By-Products	1	2
	100	100

Source: Thys, E., Oumate Oumar and B. Dineur, Centre de Formation Zootechnique et Veterinaire, "La Recherche Embouche Bovine dans les Monts du Mandara Nord-Cameroun," Rapport Final, Fonds Special d'Actions Rurales (FONADER), Maroua, 1983.

is comprised of dried grasses (44%) and agricultural by-products (56%), which are stored at the household compound. Cattle are also released to graze after the harvest (November). The animals first graze the crop stubble and then any standing forage, which becomes increasingly dry and decreasingly nutritious as the dry season progresses.

During the dry season stall-fed cattle typically gain little if any weight, and some animals actually lose weight. The crop stubble, standing forage and stored hay and agricultural by-products barely provide a maintenance ration during this period of greatest nutritional stress. Thys, Oumate and Dineur (1983) note that the voluntary feed intake of ruminant livestock, particularly dry matter consumption, declines by as much as 30% if water availability is limited. Since water becomes increasingly scarce during the dry season, and labor inputs needed to acquire water for household use increase greatly, stall-fed cattle consumption of dry matter is likely limited by water shortage in the Mandara region. This problem becomes especially acute during the hottest and driest months of March through June, once the cattle are enclosed in April as cropping activities begin.

While stall-fed cattle gain little or no weight during the long dry season, weight gains are concentrated during the rainy season. The FONADER sample averaged 542 grams per day during the rainy season of the first year of fattening and 399 grams per day during the second rainy season (Thys, Oumate, Dineur, 1983). Freshly cut and carried grasses, which contain ample moisture, predominate the ration (64%) during the rainy season. Agricultural by-products (34%) become progressively more important over the course of the growing season. In addition, some producers feed limited quantities of grain, melons, tubers, and sorghum brewing by-products to stall-fed cattle from October to December, particularly if they intend to slaughter or sell the animals after the harvest.

Over the course of two years of stall-feeding, daily dry matter intake per 100 kilograms of liveweight varied significantly from season-to-season for the cattle in the FONADER sample. During the first dry season the cattle consumed 2.38 kg. of dry matter per 100 kg. liveweight. Intake increased to 3.27 kg. during the rainy season, dropped to 1.97 kg. during the second dry season, and rose back up to 2.7 kg. during the final rainy season (Thys, Oumate, Dineur, 1983).

Most cattle feed and water is provided by household labor and not purchased. Yet half of the households in one of the survey villages bought stored fodder for late dry season and early rainy season feeding (April-June). Producers buy stored fodder from other households who are able to cut, dry and store more fodder than needed to meet their own livestock's maintenance requirements. The demand for stored feed generates employment for rural households with modest livestock holdings, during slack rainy season periods. An expansion in the stall-fed cattle herd in the Mandara Mountains would increase the demand for stored fodder and generate additional employment for households that do not stall-feed cattle. In addition to buying dried fodder, about 15 percent of the households in the survey purchased grain for supplemental feeding.

All of the survey households bought natron for their cattle, and two-thirds bought salt. Natron is a hydrated native sodium carbonate, which sometimes contains other important minerals for livestock. Most households are only able to afford minerals toward the end of the rainy season and after the harvest, when they fatten the bulls for sale. Provision of these minerals is irregular during other periods of the year.

5.4 Veterinary Inputs and Livestock Housing

Stall-fed cattle receive little veterinary care in the Mandara Mountains, particularly in the more isolated villages. Isolation of cattle in stalls reduces exposure of stall animals to contagious and infectious diseases and worm infestation (Schillhorn, 1980). Cutting and carrying of grasses during the growing season may introduce parasites into cattle stalls. Nevertheless, mortality of stall-fed cattle is low.

Stall-fed cattle are enclosed in circular huts within the household compound that are about three meters in diameter. The huts are constructed of mud and clay and covered with roofs made from dried sorghum and millet stalks and grasses. The hut is typically repaired and reroofed every second dry season. Since the huts are constructed using locally available materials and household labor, their value is best determined by valuing the household labor (at its dry season opportunity cost) that goes into the gathering of the locally available materials and stall construction.

6.0 OUTPUTS OF STALL-FEEDING ENTERPRISES

6.1 Cattle/Beef

After an average of 25.7 months of stall-feeding, cattle are slaughtered in producer's village or sold to rural butchers or cattle traders. Value-added for the sample of stall-fed cattle produced in five survey villages from 1977 to 1981 averaged 22,036 FCFA, or 966 FCFA per month, expressed in nominal terms. The value of fattened cattle reached an average of 64,600 FCFA or $270 ($1.00 = 240 FCFA) in early 1981, and value-added over the fattening period averaged 27,260 FCFA. The eighteen stall-fed cattle monitored by the Centre National de Formation Zootechnique et Veterinaire were sold for an average of 91,400 FCFA in late 1983, representing average value-added of 57,500 FCFA over two years, given an initial average purchase price of 33,900 FCFA in late 1981 (Thys, Oumate, Dineur, 1983). While stall-fed cattle prices increased at an average annual rate of eight to ten percent during the years 1977 to 1981, an important part of the increased value of stall animals after two years of feeding can be attributed to inflation. Cattle price inflation helped make stall-feeding an attractive investment for those households that could muster the necessary capital and labor.

Stall-fed cattle slaughter and sale are concentrated during the late rainy season and early dry season. Ninety-three percent of all slaughter and sale occur from September through March in five villages near Mokolo. Nearly three-quarters (73%) of the cattle are slaughtered or sold from October through January in these villages. Two-

thirds of the stall-fed cattle are slaughtered and sold during December and January at Magoumaz. Most of this represents slaughter for traditional post-harvest festivals. In contrast, 75% of the stall-fed cattle are sold and slaughtered from October through December at Mavoumai, a village where stall-feeding has become increasingly commercialized in recent years.

6.2 Cattle Manure

The economic value of animal manure has been appreciated by farmers worldwide for centuries, and manures have been applied to soils to maintain soil fertility, improve structure, and increase crop production. Crops with a relatively high nitrogen requirement such as maize, sorghum and small grains, are most likely to respond to manure application (Brady, 1984). Animal manures are also a valuable source of micronutrients such as calcium, magnesium, sulfur, iron, zinc, boron, manganese, copper and molybdenum. Since livestock utilize only about one half of the ingested organic matter in their feed, manures are to a large extent partially degraded plant materials. In addition, soil organisms (namely bacteria) are an important organic component of animal manures which break down constituents in feces and decompose manure in storage.

Manure application is especially valuable in denuded soil areas, on soils where micronutrients are deficient but where specific nutrient deficiency is uncertain, and on loose, incohesive soils. Application of manure holds soil particles together in light sandy soils, reducing erosion and improving water-holding capacity. Manure also supplies humus to soils, thereby improving soil tilth, water-holding capacity, aeration and temperature relations. Benefits from utilization of animal manures are not always apparent in the first few years following application. As elaborated by Brady,

> "Manure, along with crop residues, is a primary means of replenishing soil organic matter. Although a portion of the nutrients and organic matter in manure is broken down and released during the first year or two, some is held in humuslike compounds subject to very slow decomposition. Its effect is long-standing, not only on future nutrient supplies but also on the physical condition of the soil." (Brady, 1984)

While the quality of manure varies widely in Africa, it is generally agreed to have yield-augmenting effects. Citing heterogeneous sources, Jahnke reports that a crude rule of thumb for gauging the effect of manure application is that manure from two livestock units would increase grain yields at low levels (e.g., 600 kg.) by 50% (Jahnke, 1982). Therefore, one "manure effective" livestock unit would augment yield by 150 kg. of grain equivalents per hectare. This can be considered a conservative estimate. Toulmin reports that yields of short-cycle millet in Kala, a village in semi-arid, central Mali (Segou region), varied from as little as 250 kg/ha for a plot with no manuring to over 2,000 kg/ha for a field manured by a cattle herd (Toumlin, 1983). In this case, rates of manure application are higher, as farmers negotiate manuring contracts with herders in which cattle herds spend one or more nights on farmers' plots. Yield plot data from manured and unmanured sorghum fields in four villages of the Mandara Mountains showed that yields were two to eight times higher on the fields receiving more manure near the household compound (Holtzman, 1982).

The manure produced by stall-fed cattle is not sold in the Mandara Mountains, but its economic value can be approximated by estimating incremental cereal production due to manure application to sorghum fields. A method of estimating the economic value of cattle manure application in Africa has been developed by Zalla (Zalla, 1982). Zalla estimates that 3.8 tons of usable manure are produced annually by one adult stall-fed zebu bull. Since bulls are enclosed seven months of the year in the Mandara Mountains, the annual output of usable manure averages at least 2.2 tons per stall-fed head of cattle (Zalla et al., 1981). Drawing upon studies of yield response to manure application done in Mali (Shulman, 1979) and Nigeria (Lombin and Abdullahi, 1977), Zalla estimates that the 2.2 tons of manure augments cereals production on farms in the Mandara Mountains by 285 kilograms per year, valued at 19,707 FCFA in 1980 prices, adjusted for increased labor costs in harvesting the additional grain (Zalla et al., 1981).

7.0 RETURNS TO STALL-FEEDING

Using input-output data collected during the intensive survey of 52 stall-feeding households at Magoumaz and Mavoumai, it is estimated that the return per man-day of labor is 127 FCFA for stall-feeding enterprises (Table 3). Gross enterprise returns are roughly equally divided between manure production and the added value of beef produced during two years of feeding. The principal cost components are the initial investment in a young bull and the opportunity cost of equity capital invested in cattle, livestock housing and working capital.

The daily return to stall-feeding is below the peak season wage paid to seasonal agricultural laborers in the Mandara Mountains, who received 250-300 FCFA per man-day during the planting, weeding and harvesting periods in 1980. Returns to stall-feeding are lower than returns to grain cropping enterprises in villages in the mountainous zone, which ranged from 190 to 330 FCFA per man-day for sorghum production in three survey villages in 1980 (Zalla et al., 1981). Stall-feeding returns are also lower than returns to sweet potato production, which are over 500 FCFA per man-day. Sweet potatoes are an important cash crop for farmers with access to well-watered bottom land, which is in very scarce supply in mountainous areas of the region.

7.1 Possible Upward Adjustment of Returns to Stall-Feeding Enterprises

The disparity in returns to stall-feeding and cropping enterprises is surprising, given the prevalence of stall-feeding in the Mandara Mountains. It is possible that returns to stall-feeding have been underestimated. A sensitivity analysis of producer returns under several return-augmenting contingencies is shown in Table 4.

The enterprise budget for stall-feeding assumes that the cattle are sold on the hoof, while it is quite common for households to slaughter the cattle and retail at least some of the beef themselves. It is reasonable to assume a retail margin of 10-20 percent for an additional 15 hours of household labor, which would increase the return 17-35 percent or 21-44 FCFA per man-day. The retailing margin may be higher than 20%

if producers are able to attain returns that are comparable to returns obtained by rural butchers for slaughtering and retailing stall-fed cattle.

Returns to stall-feeding may also be understated due to an underestimation of additional cereals production resulting from manure application. Repeated application of cattle manure to fields near the household compound builds up soil fertility and cohesiveness over time, particularly in villages such as Magoumaz, where very intensive cultivation and high rates of manure application are common. As a result, the rate of manure application may be considerably higher than the rate assumed in calculating the benefits to manure production. If the additional sorghum production due to manure application is 15-30 percent higher than initially estimated, the return to stall-feeding rises 15-31% or 19-39 FCFA per man-day.

Another factor which has increased returns to stall-feeding over time is the appreciation of cattle values. Livestock appreciated in real terms at an annual rate of four percent from 1969 through 1980 in Cameroon. While this benefit may not continue throughout the 1980s, nonetheless it contributed to the profitability of stall-feeding during the 1970s. Returns to stall-feeding rise 14% or 18 FCFA per man-day if 4 percent annual appreciation is assumed.

By combining several return-augmenting contingencies, producer returns to stall-feeding increase significantly. One plausible scenario would be for producers to obtain a 10% retailing margin, 15% higher incremental cereals production, and annual appreciation in the value of cattle of 4%. In combination these contingencies would increase producers' returns to 187 FCFA per man-day of labor, a 47% increase over the base return. A second, more favorable scenario, whereby producers would obtain a 20% retailing margin, incremental cereals production would be 30% higher and the value of cattle would appreciate 4% per year, would cause producer returns to rise 81% to 230 FCFA per man-day. Returns to stall-feeding resulting from the above scenarios are

TABLE 3

REPRESENTATIVE COSTS AND RETURN OF STALL-FEEDING CATTLE, 1979-1981

Cost and Return Categories	Amount (FCFA)		
	Year		
	0	1	2
Gross Enterprise Returns:			
Cattle Sale[a]			60,396
Estimated value of manure[b]		16,750	16,750
Sub-total		16,750	77,146
Costs:			
Production Costs			
Acquisition Price of Two-Year Old Bull[c]	33,137		
Variable Costs[d]			
Cattle feed:			
Natron and salt		2,200	2,200
Stored fodder		600	600
Sorghum grain		295	295
Misc. (cut grasses, agric. by-products		175	175
Sub-total		3,270	3,270
Wage labour inputs:			
Labourer (who cuts and carries grasses)		110	110
Herder[e]		185	185
Sub-total		295	295
Total Variable Costs		3,565	3,565
Fixed costs			
Housing depreciation[f]		750	750
Housing repairs[g]		-	-
Mortality risk/insurance[h]		700	700
Sub-total		1,450	1,450
Cost of Equity Capital (10%)			
Cattle[i]		3,755	3,755
Housing[j]		375	375
Working Capital[k]		178	178
Sub-total		4,308	4,308
TOTAL COSTS	33,137	9,323	10,605
Net Enterprise Returns to Household Labour and Management	-33,137	7,427	66,541
Discounted Net Enterprise Returns[l]		28,577	
Total Labour Inputs[m]		1,800	
Net Return Per Man-Day of Labour[n]		127	

Table 3 - Notes

a This was the mean sales price for 23 stall-fed bulls from five villages near Mokolo, which were sold on the hoof in 1980-81.

b It is assumed that a stall-fed bull produces 2.2 tons of usable manure per year and that each ton augments sorghum production by 130 kilograms. Sorghum is valued at its average market price over the year (70 FCFA/kg) and the cost of harvesting the increased sorghum production equals 15% of its sale value and is not a benefit to the stall-feeding enterprise.

c This was the mean acquisition price paid in cash for immature bulls by 95 households in five villages near Mokolo in 1978-79.

d The variable cost estimates were obtained from the survey of 52 stall-feeding enterprises conducted at Magoumaz and Mavoumai.

e Six of the 52 households at Magoumaz and Mavoumai paid an average of 3,225 FCFA for entrusting their bulls to herders during at least part of the growing season.

f This assumes an investment cost of 6,000 FCFA, four cycles of stall-feeding of two and one-half years each, and a salvage value of zero.

g The cost of housing repairs are included in labour time since all costs were labour costs.

h This assumes a 6% probability of dying before sale and that meat from the carcass of the dead bull would be sold at 50% of liveweight prices. Calculated as follows:

$$\frac{(\text{acquisition value} + \text{sale value})}{2} \times \text{mortality rate} \times \text{loss on dead animal as a proportion of live animal}$$

i The capital cost of cattle is calculated on the average value of the cattle investment for each year, adjusted for mortality. The opportunity cost of farmers' equity capital is assumed to be 10% in real terms. It is also assumed that the cattle appreciate by equal amounts each year. The calculation of the capital cost for each year is as follows:

$$\frac{(\text{value at beginning of year} + \text{value at year end})}{2} \times \text{survival rate} \times .1$$

j The capital cost of livestock housing is calculated on the average value of the investment in housing over a ten year period assuming zero salvage value and a two and one-half year investment period for each cycle of stall-feeding. It is calculated as follows: $\frac{(\text{investment cost})}{2} \times .1 \times \frac{30}{12}$

The capital cost of housing is divided equally between the two years.

k The opportunity cost of the working capital which is used for the purchase of variable inputs is calculated on the average value of working capital required each year as follows: $\frac{(\text{variable costs})}{2} \times .1$

l A discount factor of 10% is used to calculate net enterprise returns.

m An annual average of 900 man-hours of labour is used in the calculation. This estimate excludes dry season herding labour.

n Assuming an eight hour man-day.

TABLE 4

SENSITIVITY ANALYSIS OF PRODUCER RETURNS TO STALL-FEEDING USING EXISTING TECHNOLOGY

Contingency	Producer Return (FCFA)	Proportional Change Over Base
0. Base budget	127	-
1. Asset appreciation[a]	145	14%
2. Retailing margin[b]		
a) 10% margin	148	17%
b) 20% margin	170	34%
3. Varying incremental cereal production[c]		
a) 15% increase	146	15%
b) 30% increase	166	31%
c) 15% decrease	108	-15%
4. Varying the discount rate		
a) 12% discount rate	118	-7%
b) 15% discount rate	105	-17%

[a]Price indices available for a basket of consumer goods and for beef retailed at Yaounde show that cattle prices increased 4% per year in real terms from 1969 to 1980. It is assumed that this secular appreciation will continue to prevail (in Northern Cameroon).

[b]Additional labor inputs of 15 hours are assumed for slaughtering and retailing.

[c]As in the base budget, sorghum is valued at its average market price over the year (70 FCFA/kg). The cost of harvesting (or of not harvesting) the increased (decreased) sorghum production equals 15% of its sale value and is not a benefit to the stall-feeding enterprise.

competitive with returns to sorghum production (190 FCFA per man-day of labor) in the intensive survey.

7.2 Reasons for the Widespread Practice of Stall-Feeding Despite Relatively Low Returns

Even after making the above adjustments, the returns to stall-feeding do not approach returns to sweet potato production or the peak season agricultural wage rate. In villages having access to both mountainous and plateau land such as Mavoumai, where large, well-watered tracts of land are available for sweet potato cultivation on the plateau, many farmers expressed an interest in acquiring bulls for animal traction. Indeed, farmers are spontaneously acquiring oxen for traction purposes in parts of the Mandara Mountains region where farmers have access to more fertile and well-watered lowland soils. About one-third of the sample of stall-feeding households at Mavoumai stated that they would prefer loans for animal traction to loans for stall-feeding. Yet in more densely populated mountain villages, where the supply of well-watered bottomland for sweet potato production and nearby pasture for grazing is limited, animal traction is not a feasible alternative to stall-feeding.

In isolated villages of the Mandara Mountains with little arable land and few off-farm employment opportunities, investment in livestock, particularly in cattle for stall-feeding, is one available means for productively utilizing surplus household labor. Stall-feeding enterprises generate about 900 man-hours of employment per year, which is equivalent to .7 man years (Byerlee et al., 1977). While slightly more than half of this labor is required during peak agricultural periods and competes directly with crop production, the other half of the labor requirements are met during slack periods.

Returns to off-farm employment outside the village are generally higher than returns to stall-feeding during slack periods in the agricultural cycle. Many of these employment opportunities are found, however, in the large towns of Northern Cameroon (Maroua, Garoua) and Northeastern Nigeria (Mubi, Maiduguri), which are rather far from

the Mandara Mountains. Many other opportunities are available only in rural Nigeria. Male household members incur significant travel, lodging, food and psychic costs in seasonally migrating to distant areas for slack period employment. Some men in the Mandara Mountains, particularly household heads, are unwilling to incur these costs, despite the attractive potential gross returns to seasonal migration.

Investment in stall-fed cattle the Mandara Mountains has proven to be an inflation-proof investment since the 1960s. Livestock is also a form of insurance against grain production shortfalls, which occur frequently in this semi-arid region. Yet livestock acquisition is more than merely capital accumulation or an insurance policy. It enables rural households in the Mandara Mountains to maintain the economic viability of intensive farming systems. Erosion and declining soil fertility are serious problems in many areas of the Mandara Mountains, particularly where terraces have not been constructed or are poorly maintained, and where manure is not systematically collected and applied to the fields. Terrace maintenance and application of livestock manure to the fields are necessary to avert further degradation of farming systems in this resource poor region. Manure application builds up soil fertility and cohesiveness, which is a critical investment in an ongoing durable.

It is also important to note that there are few opportunities for households to generate a surplus, to consume this surplus, or to convert it to other consumer goods, which are in short supply in the Mandara Mountains. While there is limited evidence of investment in improved housing and a handful of diesel-powered grain processing mills in areas of the Mandara Mountains along the Nigerian border, most of the region is characterized by low incomes, grain deficits, a low level of commercialization, and isolation from the rest of Northern Cameroon.

Finally, it is possible that revenues from sale of the stall animals or beef could contribute to modernization of agriculture. While sale proceeds are used for many purposes, including reinvestment in livestock, some of the revenues could be used to

purchase better tools, oxen and animal traction implements, animal drawn carts, improved seed varieties, fertilizers and pesticides, improved storage and storage insecticides. With few alternative sources of funds, farmers can use cash earnings from stall-feeding enterprises to increase agricultural productivity.

8.0 DISCUSSION AND CONCLUSIONS

Stall-feeding of cattle is an economically viable, though not highly profitable, enterprise in intensive farming systems in the Mandara Mountains. The viability of this enterprise stems from the economic value of the joint outputs of cattle manure and live animals for slaughter. The higher quality beef of stall-fed cattle is preferred by both rural and urban consumers to the tough, less flavorful beef of cull cows, which provide two-thirds of the slaughter cattle in urban markets of the Mandara Mountains. Cattle manure, the other joint output of stall-feeding enterprises, is a critical input into the agriculture of a resource poor region. When applied repeatedly over a period of years, cattle manure improves soil structure and cohesion, as well as adds nutrients and organic matter that improve soil fertility. Sorghum and millet yields are significantly higher on well-manured fields than on fields receiving no manure.

Although cattle stall-feeding is economically viable and helps to sustain soil fertility in the Mandara Mountains, it is not easily adopted by all rural households. Stall-feeding demands high labor inputs, particularly during certain peak periods of household labor utilization. However, only 50% of total labor inputs for stall-feeding are required during peak periods. After the second weeding, from mid-August through mid-October, households face a slack period in the cropping cycle and stall-feeding utilizes surplus labor at that time. Nevertheless, it is clear that larger households with more economically active members are better able to meet labor demands for stall-feeding than smaller households.

A second disadvantage of an enterprise such as stall-feeding is that purchase of a young bull represents a significant investment for small farmers in a resource poor region

such as the Mandara Mountains. Acquisition prices in the early 1980s were greater than 30,000 FCFA per head, or well over $100 at prevailing exchange rates--equal to at least half of a rural household's annual per capita income. Not everyone is able to raise this amount of capital. This contrasts markedly with the relatively low initial investment required for feeding small stock, particularly sheep, which are fattened for Moslem festivals throughout West Africa (see Kolff and Wilson, 1985). Yet sheep do not produce anywhere near the quantity of manure that stall-fed cattle do.

A third perceived disadvantage of cattle stall-feeding is that large quantities of cattle manure must be applied to fields to realize significant yield augmenting effects and that cattle manure is an imperfect substitute for chemical fertilizer. Yet chemical fertilizers are not widely available in the isolated Mandara Mountains. Transport costs from coastal ports are high, increasing the real cost of delivered fertilizer. Finally, investing in fertilizer represents certain risks, as fertilizer has little--or negative impact in years of low rainfall and production shortfall. Although cattle manure is an imperfect substitute for fertilizer, it has soil improving characteristics which help to maintain the fertility of low quality soils and the viability of farming in a resource poor region.

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