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AGRICULTURAL PRODUCTION POTENTIAL
IN THE MANDARA MOUNTAINS
IN NORTHERN CAMEROON

By

Tom Zalla, David J. Campbell, John Holtzman
Larry Lev and David Trechter

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Department of Agricultural Economics
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ORIGINAL

AGRICULTURAL PRODUCTION POTENTIAL IN THE MANDARA MOUNTAINS

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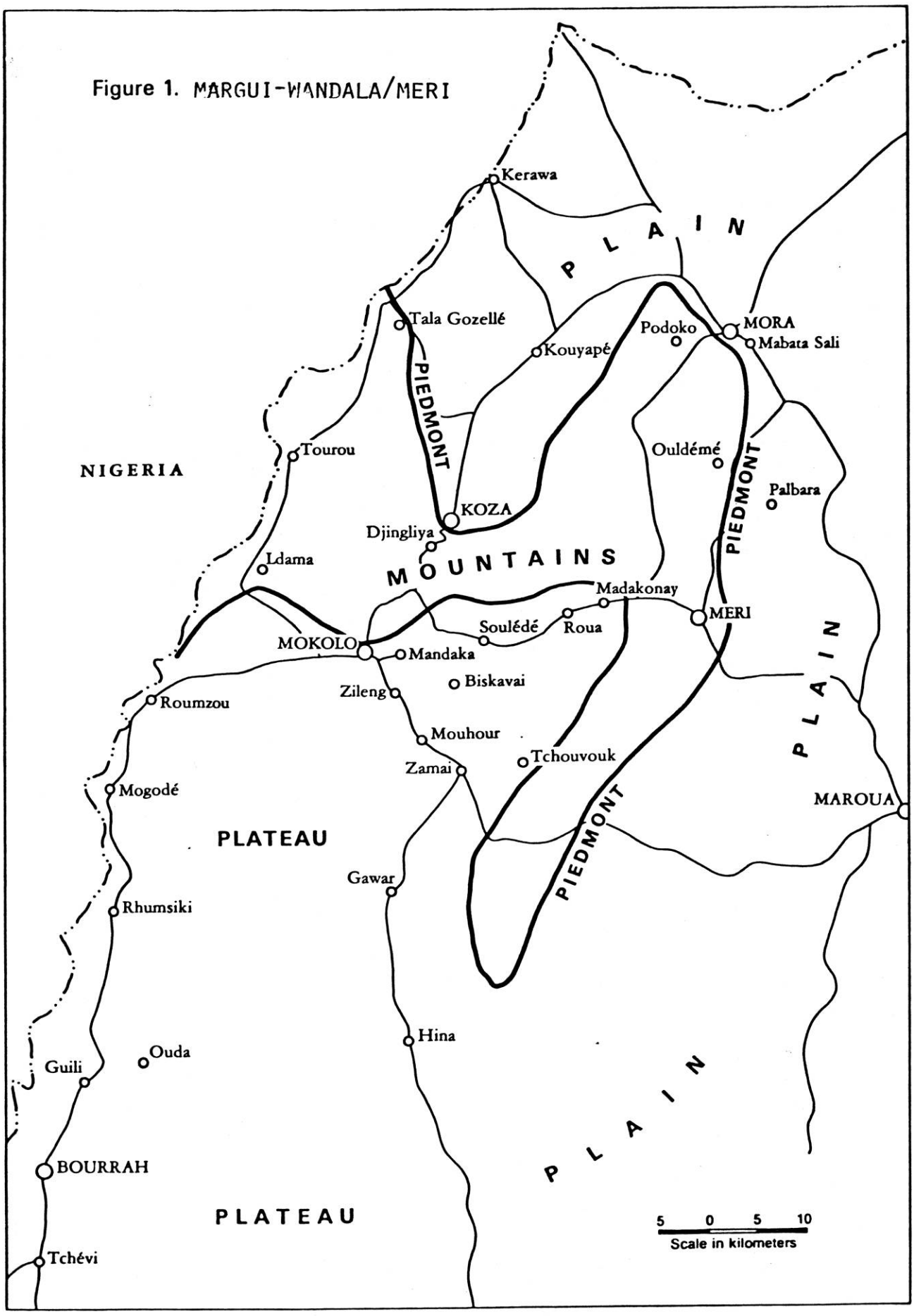
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AGRICULTURAL PRODUCTION POTENTIAL IN THE MANDARA MOUNTAINS

A. Background

The Mandara Mountains are located in the Margui-Wandala Department and the Meri Arrondissement (Diamare Department), of the Northern Province. The population of Margui-Wandala is approximately 500,000, and an additional 50,000 people live in the Meri Arrondissement. One of the most densely populated regions in Cameroon, and one of the three major population concentrations in the country, the area is comprised of farm families (98% of the population) who intensively cultivate sorghum, millet and groundnuts on terraced slopes and on the region's high plateaus. The area has one of the lowest per capita incomes in the nation. It has the country's lowest school enrollment (15.7%) [Ministere de l'Education Nationale, 1979], lowest literacy rate (9.5%), highest infant mortality rate (196 per 1,000 live births), highest proportion of children with both acute malnutrition (1.4%) and mild-acute malnutrition (7.5%) [Government of Cameroon, 1978]. These figures refer to the whole Northern Province, and the Mandara area is the poorest in this Province.

The current high population density in the mountains is partially the result of historical conflicts among ethnic groups. Some ethnic groups have withdrawn into rugged mountains and have sought to isolate themselves from outside influences. In the 1960's and early 1970's the Government of the United Republic of Cameroon (GURC), assisted by various donors, attempted to resettle people from the Mandara mountains to the less populous plains. However, a high percentage of the settlers returned to the mountains [Hoben, 1976]. In the mid-1970's the Government shifted

its development strategy in the Northern Province from resettlement to the amelioration of the stark circumstances of mountain life. This shift is mirrored in its fourth Five-Year Plan (1976-1981). The Northern Province is currently the focus of intensified development activities which respond, in part, to the needs of the Mandara area people.

Following extensive discussions and preparation by the Cameroonian government and other officials working in or having responsibility for the Margui-Wandala/Meri area, a team from Michigan State University visited the Cameroon in September, 1979, to assess the development potential of the region. One conclusion of the team was the need for more information on farming systems, livestock production, marketing, nutrition relationships and land use and land tenure within the mountains.

In January 1980 the Department of Agricultural Economics at MSU was requested by USAID/Yaounde to carry out a series of studies to assess the agricultural development potential of the Mandara area. The first group of MSU researchers arrived in Mokolo, departmental headquarters for Margui-Wandala department, in February, 1980. Since that time, numerous studies have been undertaken and reported (see bibliography). This paper summarizes the findings of the studies completed to date and speculates on the expected findings of those which will be completed later in 1981. The focus of this paper is on identifying potential interventions which can increase agricultural and livestock production, income, and the welfare of rural people over the next five to ten years.

B. Data Sources

Data used in this paper and in many of the reports completed thus far came mostly from primary data sources. In April/May, 1980, MSU

researchers conducted a baseline survey of 288 households from 36 first stage sample units drawn from census enumeration area listings covering the entire area. Sampling and data collection methodology for the extensive survey is described in Campbell, Lev and Holtzman [1980]. Subsequently, five of the first stage sample units selected in the extensive survey were chosen for an intensive input-output study of farming systems typical of the project area. The input-output survey was carried out over the July 1980 - February 1981 period. Two additional areas were chosen for a study of stall-feeding of cattle. Each of these households was visited every two weeks and data recorded on a recall basis. Since the intensive survey got underway well into the production season the period over which interviews took place varied from five to eight months, all ending shortly after the harvest of cereal crops.

Food consumption, anthropometric and other data for the nutrition study were collected from separate interviews of households in three of the five intensive sites. The collection period covered three months around the height of the hungry season. Data on small ruminants are derived both from the extensive and intensive input-output surveys as well as intensive case studies of individual herds in three of the intensive sites. Finally, soil samples were taken from throughout the area and analyzed at MSU.

Some of these primary data have already been summarized and analyzed by Campbell, Lev and Holtzman [1980], Lev [1980], Holtzman [1980] and Trechter [1981]. Other studies relying more on informal interviews and direct observation have been prepared by Campbell [1981], Campbell and Riddell [1981], Frazier and Deguefu [1980], Harley [1980], Holtzman and Weber [1980], Riddell [1980] and Schillhorn [1980]. This report draws

on all these studies, others in the course of completion, trip reports, the data base itself and the authors' own observations.

An early directive from the Minister of Plan limited the potential project site to the mountain areas of Margui-Wandala Department and Meri Arrondissement not covered by SODECOTON, i.e., all areas excluding the plains to the north of Koza, and east of Meri and Hina. But officials in Mokolo have resisted the balkanization of their department and have emphasized the need for the project to include the plains because these areas can expect to receive a growing number of migrants from the more densely populated mountains over the next generation or two.

Officials in Meri have always been on the periphery of involvement in studies and discussions concerning the project since Meri is part of Diamare Department and horizontal administrative links are weak to say the least. While this has not posed problems at the research phase, there will be a need to involve officials in Meri much more actively in the project planning and design phase.

Segmenting the area poses difficult implementation problems no matter what structure might be adopted for carrying out a project. Departmental Délégués see attempts to concentrate resources and programs in the mountains as unfair to the plains area over which they also have jurisdiction. This suggests criteria for allocating regular government or non-project resources between mountains and plains areas is an issue that needs to be addressed squarely before resources begin flowing.

In our survey work in the Mandara Mountains we attempted to produce data for both those who want to include the plains and those who do not.

An initial extensive survey covers the entire Margui-Wandala Department and Meri Arrondissement while the follow-up studies of farming systems, livestock and nutrition concentrate on the mountain and high plateau areas. The marketing and land use studies give some attention to the plains though their central focus is also the non-plains area.

C. Topography and Areas of Greatest Agronomic Potential

Topographically Margui-Wandala/Meri can be divided into mountains, plateau and plains. A very narrow piedmont traces the border between the mountains and the plains, this area exhibits characteristics of both the mountains and plains.

1. The Plains

Many observers feel that the plains have the greatest agricultural production potential because population density is not as high as the mountains and substantial tracts of land are uncultivated and available for grazing livestock. Farmers in these areas report good yields of cotton and cereals rotated with cotton.

Campbell [1981], in reviewing ORSTOM publications, argues that large areas of the plains are not suitable for continuous cultivation. Most of the highly fertile areas are already settled and new lands being settled by recent migrants from the mountains are less productive. In addition, people from the mountains do not have secure tenure over lands which they settle in the plains [Campbell and Riddell, 1981].

While these trends are noteworthy, data on agricultural production gathered in an extensive survey of the entire Margui-Wandala/Meri area [Campbell, Lev and Holtzman, 1980] indicate that production of rainy season cereals per household is about 30% higher in the plains than in the mountains. When dry season cereals are included, household production of cereals in the plains is almost twice as high as in the mountains. Moreover, farmers on the plains can count on a substantial cotton crop in addition.

2. The Mountains

In many ways it is misleading to group all the mountainous areas of Margui-Wandala/Meri. Though overall cereal production per household in the mountains is the lowest of the entire project area, this low average masks large variations within the mountainous zone.

The mixture of hills and valleys interspersed with rocky mountains to the northeast and east of Mokolo extending past Meri seems to be the most marginal of the entire area. In spite of abundant uncultivated land between Mokolo and Meri, production per household and cereal yields per acre are among the lowest in the Mandara mountains. Soils are poor and coarse resulting in very poor soil moisture retention capability. In addition, rainfall to the northeast and east of Mokolo seems to be more erratic. Striga[1] takes a higher toll in poorer soils and hits this area particularly hard. Finally, parts of it are so densely cultivated that felxibility within the farming system has been all but eliminated.

Djingilia represents a second level of potential that covers a large area on the eastern side of the Mandara Massif and the entire Mora Massif

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[1] Striga hemonthica is a parasitic weed that attaches to the roots of sorghum and selected other plants.

to the north of Meri. Here cereal yields are clearly well above average, farmers give considerable attention to maintaining terraces and incorporating household and animal residues, but flexibility within the farming system is also limited and farm sizes appear to be small. Virtually all land is under cultivation, cattle numbers are few and grass for stall-fed animals has to be transported over long distances. Since soil structure is good and soil organic matter is above average the use of chemical fertilizers should generate higher yields and greater amounts of organic matter for use as livestock feed or green manure than most areas. Stall-feeding of cattle is practiced here but the limited availability of feedstuffs limits its potential for expansion.

A third fairly distinct type of mountain farming system exists in the Magoumaz area to the north-west of Mokolo where terracing, soil conservation and stall-feeding of cattle are all most intensively practiced. Average cereal yields are highest here, attaining as much as nine tons per hectare on yield plots placed in well manured sections of fields. Sweet potatoes are a more commonly found enterprise, and uncultivated portions of the valleys provide an accessible source of forage to cut and store for stall-fed animals.

Throughout the Magoumaz area one finds evidence of sophisticated soil conservation measures being maintained by individual farmers: weirs in gullies, level, well maintained terraces and careful distribution of manure. These practices are reflected in high yields for cereal crops. In spite of the steep slopes common in this area, there is little evidence of soil erosion as found elsewhere in the project area. Stream beds are full of grass instead of sand. In short, this area represents an example of what is possible in the mountains from a well integrated system which respects and maintains its environment.

On the west and northwest slopes of the Mandara Massifs, past Tourou on towards Koza, land is somewhat more abundant than in Djinglia and Magoumaz but outmigration to Nigeria is high. As at Magoumaz, terraces are better maintained and soils appear to be more fertile. Eleusine is found occassionally but sorghum and millet are still the dominant cereals by far. Roads in this area are impassable during most of the year and there are problems of access to markets. This area appears to be a cereals deficit area obtaining its supplies from Nigeria which is much more accessible than Mokolo or Koza. This area has potential for an expanded stall-feeding program based on sales to Nigeria and for increasing cereal production for home consumption.

3. The Plateau

To the south of Mokolo and the Mandara massif lies a vast plateau that comprises almost half of the land area of Margui-Wandala department. Even where settlement is most dense there is sufficient land for grazing and fallow. Household production of cereals is higher here than in the rest of Margui-Wandala/Meri [Campbell, Lev and Holtzman, 1980] and peanuts and sweet potatoes are important cash crops.

The fertility of land on the plateau is quite varied. A large tract of land controlled by the chief of Mogode is used for little more than extensive grazing even though soil tests indicate the soils are more fertile than average. To the north and south of this vast tract of sparsely settled land lie large concentrations of settlement and thriving agricultural communities.

On the northern side of the plateau lie Roumzou and Ldama, centers of Irish potato and sweet potato production with relatively good soils in

the valleys and ample rainfall. Many farmers in Roumzou double crop: maize with tobacco and Irish potatoes with cowpeas or tiger nuts. Animals are mostly grazed, though there is some stall-feeding in Ldama where the plateau runs up to the mountains. Household agricultural production is quite high by standards for Margui-Wandala/Meri and locally available varieties of red and white sorghum respond well to applications of manure and incorporation of organic residues. Yield plots placed on some of the better producing fields in this area produced at the rate of 3-4.5 tons per hectare, uncorrected for harvest losses.

On the southern half to third of the plateau lies the most dynamically growing part of the department outside the plains. Land is still relatively plentiful and livestock are abundant. Draft oxen are widely used in this area and cereal production per household is high as it is elsewhere on the plateau, though there is ample evidence of depleted soils. Cereals planted on these soils appear to respond well to applications of manure and organic wastes, with strategically placed yield plots indicating per hectare yields as high as five tons per hectare, excluding field and harvesting losses. Here, as well as in most other parts of Margui-Wandala/Meri, available evidence suggests that yields of locally available cereal varieties can be improved through application of chemical fertilizer and lighter but more extensive application and better management of organic residues. There is also sustained demand for draft oxen in spite of high mortality rates and generally poor veterinary support.

D. Soil Fertility

Several soil samples were taken from throughout the Department. In general, they confirm Campbell's [1981] summary of an ONAREST [1971] study and preliminary observations made by Frazier and Deguefu [1980].

Nitrogen is deficient in all soil samples which had never received manure. The percent N varies only slightly between unmanured plains and mountain soils, ranging between .03 to .05 in all samples. Even apparent virgin soils in the plains fell within this range.

The percent N rises sharply in plots which have been manured, averaging around .24% N in soils manured within the past year to .12-.16% N in those manured one to two years ago. These results were remarkably consistent between terraced and non-terraced fields and between mountains, plateau and plains.

Phosphorus is particularly deficient on the southern plateau while potash seems to be more available there than elsewhere in the region. Available Phosphorus levels of 3-5 kilograms per hectare in the south compare with 8-20 kilos per hectare in unmanured parts of the mountains. Both are very low. As for potash the 70-100 kilograms per hectare typical of soils in the mountains and the plain to the north of Koza compare with 80-250 kilograms on the southern plateau. Concentrations on the higher end of this range came from the vast uncultivated stretch of land to the north of Mogode. Magnesium is also quite high in general.

Soils throughout the non-plains area tend to be more or less neutral in ph. Ranges of 6.4 to 7.0 were common in the upper profile in the southern plateau and 6.9 to 7.2 in the mountains. A few well manured fields in the mountains had a ph higher than this, the highest being 7.7 near Ldama. All these values are within a tolerable range for cereal crops with the higher end of the range occurring on better yielding fields more often than not.

Soluable salts were very low in all samples, a very favorable condition for crop production. As would be expected under these circumstances sodium toxicity is not a problem except in <u>harde</u> soils.

The one significant yet not so surprising finding of the soil analyses is the very high level of organic matter, nitrogen, phosphorus and potassium on fields receiving regular applications of manure or organic household residues. This concurs with experiments in northern Nigeria which show an increase in fertility of soils manured at the rate of 7.5 tons per hectare over an extended period, [Lombin and Abdullahi, 1977]. Another Nigerian experiment [Abdullahi and Lombin, 1978] indicates that manure applied at the rate of 2.5 tons per hectare increases yields of cereals by at least as much as an application of equal amounts of nutrients from inorganic nitrogen and phosporus, and that at higher levels of application, manure is clearly superior to the mineral fertilizers. This is the rate most commonly used in the Mandara mountains though farmers usually cover the same part of their field only once every two or three years.

Well manured fields also seem to be less affected by Striga. This is probably related to the higher fertility of manured fields and the delay this causes in the onset of the tillering stage of the striga. Thus improving soil fertility may have output effects beyond what would be expected on the basis of the nutrients applied alone.

E. Scope for Expansion and Intensification of Cropping Activities

1. Cereals

a. Sorghum

In an average year about 2/3 of all land area is planted in sorghum, 85% of this in rainy season sorghum and the remainder in Musquari, a dry season sorghum. The 1980 crop year was a good one to observe rainy season sorghum. The Mafa areas of the Mountains, which practice a rigid sorghum/millet rotation, were all planted in sorghum.

It is clear throughout the area that rainy season sorghum does much better on the parcel of land surrounding the homestead than elsewhere. This field receives the bulk of household and animal waste and the higher organic matter content of the soil improves fertility, tilth and soil moisture retention capability. However the increases are more dramatic in some parts of the project area than others.

It is difficult to estimate the number of different sorghum varieties in the Mandara Mountains but it must exceed fifty for commonly used ones and perhaps 300 if all varieties and strains are counted. Most areas use a composite variety which includes a mixture of three to ten varieties but is summarily identified with the name of the area where it is most commonly used or from which it originated.

Some of these varieties have good agronomic potential as is indicated by the results of several 3 meter by 4 meter yield plots placed in farmers fields as part of the intensive survey. Table 1 shows average yields of sorghum on well manured plots equivalent to 2,500 to 6,000 kilograms per hectare. Plots with yields as high as 7,000 to 9,000 kilograms were observed. The data in Table 1 represent the best plots on the better fields and, as such, are not generalizable to whole fields under actual farm conditions. However, they do suggest that farm level yields of 1,500-2,000 kilograms per hectare are possible on well manured or well fertilized fields using locally available varieties. Incorportion of manure and organic residues as is practiced in many parts of the area addresses both problems. The principal problem is in getting enough of either to make a difference on a large scale.

Given the response to manure evident throughout the project area, and the response of sorghum to nitrogen and phosphorus elsewhere in Africa

TABLE 1

YIELDS OF LOCALLY AVAILABLE SORGHUM VARIETIES ATTAINED IN 1980 ON FERTILE SOILS IN MARGUI-WANDALA/MERI WITHOUT THE USE OF CHEMICAL FERTILIZER--UNADJUSTED YIELD PLOT[a] ESTIMATES
(Kilograms)

Variety	Village	Equivalent Yield per Hectare[b]		
		Average of Ten Yield Plots	Average of Top Five Yield Plots	Highest Yield Plot
Djigari	Ouda	2490 (603)[c]	2980 (388)	3580
Kilbouri	Ouda	2590 (1310)	3410 (1439)	5000
Sorghum/Millet	Roumzou	2830 (888)	3400 (915)	4580
Tchakalari	Roumzou	3220 (701)	3730 (605)	4580
Matakamri	Ldama	4510 (948)	5250 (598)	6250
Djigari	Ldama	3680[d] (618)	3960 (629)	5060
Tchakalari	Ldama	3640 (458)	3950 (225)	4330
Matakamri	Magoumaz	5964 (1969)	7614 (1063)	8910

[a]Yield plots of three meters by four meters each.

[b]Unadjusted for harvest losses.

[c]The number of parenthesis is the standard deviation of the observed yields.

[d]Only eight observations.

SOURCE: Intensive survey.

[Zalla, Diamond and Mudahar, 1977] it is reasonable to expect a response of 8-10 kilograms of grain per kilogram of nutrient when applied in conjunction with relatively light applications of manure or decomposed organic matter at the rate of 100 kilograms of nutrients per hectare. Given an unsubsidized cost of bagged high analysis fertilizer delivered to Mokolo of around $1000 per ton of nutrient for either urea or triple superphosphate[1] the economic cost of fertilizer for this added output would be $100.00 versus $225-280 for the incremental cereal output at prevailing wholesale prices. This gives a value cost ratio of 2.3 to 2.8. Given other costs associated with use of fertilizer such as the cost of applying it and harvesting the added output, fertilizer specialists normally regard a value/cost ratio of two or better as sufficient incentive to induce farmers to use fertilizer. At lower levels of application the value/cost ratio would be higher, though the increase in production per hectare would be lower.

Cereal crops, and presumably diets, would clearly benefit from the additional manure produced by an expanded stall-feeding program. Data gathered from Nigeria [Lombin and Abdallahi, 1977] and Mali [Shulman, 1979] suggest that production increases of 130 kilograms of grain per ton of manure are quite feasible under farm conditions in Margui-Wandala when manure is applied at rates below five tons per hectare over a continuous period. Thus the manure from an average stall-fed zebu bull would generate

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[1]Assuming early 1981 CIF Douala prices of $280 per metric ton for bagged urea (46%N) from Western Europe or bagged triple super phosphate (46% P_2O_5) from North Africa, inland transportation and handling costs of $180 per ton to Mokolo, and using 65 FCFA per kilo and an exchange rate of 230 FCFA per dollar to value output. SODECOTON is charging farmers 4500 FCFA for a 50 kilogram bag of urea and 5000 for 50 kilos of high analysis NPKS. This comes to about $850-950 per ton of nutrient and presumably represents last years cost or involves an element of subsidy.

additional cereal production of almost 300 kilograms per year. Current farming practices in Magoumaz clearly demonstrate this. There is also potential for better management of other organic waste.

Given the low amount of P_2O_5 in manure, the small supply of manure relative to needs for maintaining soil fertility, and the apparent responsiveness of many local varieties of sorghum to manure, it would appear that fertilizer trials on farmers fields involving various combinations of nitrogen, phorphorus and manure applied to sorghum would have a high payoff in Margui-Wandala/Meri. Increasing soil fertility, cation exchange capacity and soil moisture retention capability in this way will then facilitate more dense intercropping and production of additional organic residues for animal feed or for incorporating into the soil.

b. Millet

We know much less about millet than sorghum because in 1980, the year in which our studies took place, the Mafa planted mostly sorghum. Stands observed outside the mountains suggest either that millet is reserved for poorer soils or that locally available varieties of millet do not compare in yield potential to varieties available in Senegal and Niger. According to the SAFGRAD agronomist, Owen Gwathmey, Senegalese millet varieties tested at IRAF have not demonstrated yield superiority over locally available varieties under conditions prevailing in Northern Cameroon. Field trials of millet varieties from Niger carried out by Gwathmey [1979] yielded a similar conclusion, suggesting that low soil fertility is, indeed, the main problem. High yielding sections of the well manured fields next to the homestead were not as much in evidence as for sorghum, but then little millet was planted in those areas where

such differences were commonly observed for sorghum. Comments by farmers indicate that average millet yields are considerably lower than average sorghum yields under farm conditions.

Though millet may not look particularly promising at this juncture we need to observe it during the year of the millet rotation in the mountains in order to be sure. And even if it does offer less hope for improvement this does not mean that it has no place in the present farming system. In Northern Nigeria Lombin and Abdullahi [1977] showed that average increases in sorghum yields when planted in rotation with peanuts and cotton were almost 40% higher than yields under continuous cropping of sorghum. There is also some evidence that rotating sorghum with millet may be important for controlling the spread of striga. Thus the widely practiced rotation of millet and sorghum appears to have a sound economic base which argues for persistent attention to improving millet production in the context of present farming systems.

c. Maize

Most farmers grow at least some maize in the area immediately adjacent to the compound because soils are more fertile and retain more soil moisture. Most of the maize produced is roasted green at harvest time since it is the first cereal crop to mature and stocks of sorghum and millet are either exhausted or very low during this period. Consequently it provides an important food source, the expansion of which promises to have a favorable impact on diets proportionately greater than the simple number of calories it provides.

Maize varieties available in Margui-Wandala/Meri do not seem to be particularly high yielding. However good maize varieties adapted to highlands are available in Kenya and high-yielding varieties from Northern

Nigeria [Norman, 1976] may also transfer well. There is a need for conducting field trials on these and other promising varieties. Maize is one crop where a vast resevoir of genetic material and experience exists and progress in this area should be rapid once a structure exists for carrying out this kind of applied research in the project area.

2. Legumes

a. Cowpeas

Our extensive survey revealed that over 70% of all households grow at least some cowpeas, though they are seldom grown in pure stands [Campbell, Lev and Holtzman, 1980]. More commonly they are intercropped with millet and sorghum. Surprisingly they do not seem to be intercropped with sorghum among many of the Mafa. A few farmers in the Roumzou area have had good luck with cowpeas following Irish potatoes in the same year. For this, shorter season cowpea varieties from Nigeria must be used.

In general, cowpea yields are quite low, even when planted in pure stands. When intercropped with millet and sorghum cowpeas tend to provide a crop in years that the cereal harvest fails since their needs for moisture are somewhat countercyclical with sorghum and millet. Only about 10% of the cowpea harvest is sold. The remainder provides an important source of protein that complements millet and sorghum in the diets of producing households.

Good land preparation seems to have a positive impact on cowpea yields, as it does on other cereals. For this reason, rotating cowpeas with Irish and sweet potatoes, tiger nut, peanuts, or bambara groundnuts is common. Currently the SAFGRAD agronomist is conducting field trials of promising cowpea varieties in the project area but at this time nothing is sufficiently

promising to warrent extension to farmers. However variation in the yield potential of locally available varieties does exist and could be exploited by an applied research program aimed at cowpeas. Field treatment against pests and diseases is also important and appears to offer promising results.

Storage of cowpeas is a common problem throughout West Africa where storage losses are very high. It is common for cowpeas to trade on a par with sorghum at harvest time while six months later cowpea prices are more than double sorghum prices. In fact, bulk cowpea prices in Mokolo doubled between November, 1980 and February, 1981 while in Roumzou they increased 250%. A three fold increase in cowpea prices between harvest time and planting time is not at all uncommon. This is related both to storage losses and the very strong demand for cowpeas that exists in Northern Nigeria.

Considerable work has been going on in Cameroon on treatment of cowpeas to reduce storage losses. Chemical products which have been demonstrated to reduce storage losses to around 10% over six to nine months are available.[1] These products would find a ready market in Margui-Wandala where farmers are aware of storage chemicals. Though these chemicals will have no higher return in Margui-Wandala than elsewhere, the importance of cowpeas in the rotation throughout the area suggests that the impact of reduced storage losses of cowpeas on diets and incomes in Margui-Wandala/Meri would be substantial.

b. Peanuts

Peanuts are the most important cash crop in the non-cotton producing areas but, unfortunately, crop failures are common. Average returns to

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[1] An FAO storage specialist indicates he has had the best success with a product called Actellic 2% distributed through AGRICHIM in Douala.

labor on peanuts do not appear to be much higher than those for sorghum except in years of good rainfall. Apparently locally available varieties have a growing season that is a bit too long for average rainfall patterns in Margui-Wandala/Meri.

Insects and pests are important problems for peanuts though chemical treatments have proved to be an effective means of controlling pests and improving yields. Such chemicals and fertilizers need to be made more widely available to farmers in the area. Selection of varieties and conducting field trials of fertilizer application rates and crop rotation regimes also offer potential for improving peanut production in the context of this particular project.

3. Tubers

a. Sweet Potatoes

At the present time 10,000-12,000 tons of sweet potatoes are grown in the project area. Production is concentrated on the piedmont and plateau just south of the Mandara massif to the west of Mokolo.

Sweet potatoes consistently yield returns to labor that are over twice the returns to cereals in most areas of Margui-Wandala. They cannot be grown everywhere but most areas have valleys where soils are heavier and soil moisture retention capability more favorable for sweet potatoes. Moreover greater use of organic residues can allow them to be grown in areas where they are now not commonly found.

Sweet potatoes are grown in long mounds and many farmers incorporate organic residues when they are constructed. This aids soil moisture retention capability and soil texture. It also seems to break down sufficiently

fast to avoid depressing yields due to the immobilization of nitrogen in the soil, probably because of the coarse soils and high temperatures. Sorghum and other crops which follow sweet potatoes in a rotation do very well.

About 80% of sweet potato production is marketed. Most sales occur within a short period after harvest. Farmers appear anxious to sell at this time both because of their need for cash and because of the availability of itinerant merchants and middlemen willing to purchase their production. However prices rise sharply during the two month period following harvest. Data gathered for Roumzou and Mokolo indicate an average increase in the wholesale price of tubers of 50% over this period.

Holtzman and Weber [1980] attribute this to farmers' inability to store tubers and suggest efforts concentrate on extending the growing season. However some farmers in Roumzou are storing tubers in small quantities (3-7 sacks) for periods of up to five months, though, apparently the same variety of sweet potato, when planted in soils in Ldama, does not store well at all. Sweet potatoes also store poorly once they have been bruised in transit. Thus the more promising alternative for increasing both average prices and quantities of sweet potatoes sold are to extend the growing season while facilitating on farm storage during the two to three month period following harvest, followed by rapid movement into distribution channels. Increased extension support oriented toward soil management would also be productive.

There is considerable capacity for both local and regional markets to absorb a much higher level of tuber production provided supplies can be spread more evenly over the year and moved to urban centers. During the flush season a sack of sweet potatoes sells in Maroua at a price that is cheaper than sorghum on a calorie basis. Large quantities move through

this market. At the same time tubers are a mass consumed item accounting for an established and growing share of consumption expenditures in Margui-Wandala/Meri. The principal problems associated with the crop are marketing related, though once these are resolved production constraints can be expected to appear.

Sweet potatoes cannot be grown in all parts of the project area but localized areas have access to year-round surface water for irrigation of tuber crops during the dry season. Though one can expect some opposition from herders for those areas with surface water there is little doubt that such land is more valuable in tubers than pasture.

There is also potential for shallow well irrigation of tubers in areas adjacent to year-round surface water sources. Currently only production of Irish potatoes is concentrated in such areas while shallow well irrigation is used only in large river valleys. However farmers with access to a high risk credit fund and extension support could probably be induced to experiment with shallow wells.

There is considerable scope for improving sweet potato production. Most farmers run their sweet potato mounds parallel to the slope of the hill or valley on which the field is located in order to prevent massive erosion of the mounds when water rushes down from poorly terraced hillsides. Yet where a sweet potato field is at the head of a valley and surface runoff is limited, mounds running perpendicular to the slope exhibit greater vigour and less erosion than those running parallel with it.

Proper water basin management or construction of a drainage canal on the top side of the field can control soil erosion of this type and increase yields. Some farmers tie together the top end of some of their sweet potato rows. This also is effective though it does not completely solve the problem.

b. Irish Potatoes

Irish potato production is about 1/4 as high as sweet potatoes, amounting to 2,500-3,000 tons annually, and is increasing. Production is geographically more concentrated and is centered in Roumzou where surface water supplies are good and rainfall better distributed than in most other parts of the project area. Returns to labor are quite good averaging 20% higher than sweet potatoes and 150% higher than sorghum.

A major constraint on expanding potato production is the lack of a reliable supply of seed potatoes. Farmers complain of poor availability and high prices for seed when they need seed potatoes for the rainy season potato crop, the principal potato crop. Since storage conditions during the area's hot dry season are not good, some farmers must grow a dry season crop to provide seed for the next rainy season crop. The relative abundance of dry season surface water supplies for doing this is probably the principal reason Roumzou has become the center of potato production in Margui-Wandala/Meri. However there is scope for expanding potato production in other areas provided sufficient quantities of seed potatoes can be produced during the dry season.

Like sweet potatoes, Irish potatoes have a positive effect on the yield of crops which follow it in rotation. One short season cowpea variety from Nigeria produced high yields when following potatoes during the same crop year in Roumzou. Thus there is scope for increasing double cropping in this areas as potato production expands.

4. Cotton

Cotton seems to yield good returns to labor when it is grown in the plains. Farmers on the plateau who have tried cotton complain of the

amount of work involved and its competition with cereals for labor. In the plains this problem is avoided by planting dry season sorghum and turning cotton and sorghum from competitive enterprises into complementary enterprises. Some farmers with limited farm size, especially in such areas as Manguirda where average farm size is less than 1 1/2 hectares, grow cotton in the plains and rainy season sorghum on the mountains but this seems to be the exception rather than the rule.

Extension support, input supply and marketing of output for cotton are handled by SODECOTON. Cotton fields are organized in blocks and farmers are required to follow specific cultural practices. Expenses are deducted at marketing time and farmers receive the remainder. SODECOTON has established a reputation for agressive extension and well organized input delivery. This is greatly aided by the virtual monopoly they are given over access to inputs in scarce supply. The company also seems to enjoy the right to select the best extension agents from regular departmental staff, a practice that strengthens SODECOTON at the expense of the Departmental extension programs. The Government justifies all this on the grounds that cotton is a high return crop that generates considerable foreign exchange earnings and savings for the country.

Any expansion of cotton production in the North will come under the authority of SODECOTON. Since the SODECOTON structure is already in place and has been demonstrated to be effective, there appears to be little need for any additional efforts in this area by another project.

5. Fruits and Vegetables

Except for mangoes, bananas and guavas, fruit production in Margui-Wandala/Meri is concentrated near Mokolo and Koza. Apart from guava and

mangoes, only very limited quantities of fruit are available in local markets. In spite of high local prices some of what is produced is purchased by traders for transport to Kousseri.

Vegetable production is also geographically concentrated, and except for onions, most of it is consumed within Margui-Wandala/Meri. Centers such as Mokolo and Mora attract quite a variety of vegetables but those in smaller rural markets are limited to a few carrots and traditional vegetables. Pockets of intensive onion production exist, the largest and most visible being just south of Mozogo. Most of this production moves to urban centers such as Mokolo, Mora, Kousseri and Maroua and as far away as Douala, though distribution to small rural markets is quite good. The onion trade seems to be well organized and there is no obvious need for increased support from the Delegation of Agriculture.

Margui-Wandala/Meri is notable for the lack of cabbage and tomatoes in rural markets, two commodities that one sees quite frequently in small rural markets elsewhere in Africa. There is scope for expanding production of fruits and vegetables along river beds or year-round water sources. Suitable sites are not as scarce as is commonly perceived. In the south around Ouda, Bourrah, and Tchevi, in Roumzou, in the area around Mokolo and along river valleys in several parts of the plains there is scope for shallow well irrigation of fruits and vegetables. Current techniques employing shadoofs are quite suitable in most areas and could profitably be employed in areas now relying soley on walk-in wells. Shadoof technology considerably expands the area near riverbeds and permanent water sources which can be irrigated and is suitable for tubers as well as fruits and vegetables.

Apart from suitable land, the lack of vigorous seedlings is another problem constraining fruit production. The only one of the two nurseries

in the department we observed was producing poor quality seedlings and the loss rate even within the nursery must be quite high. The reason appears to be due more to a lack of proper supervision than to a lack of water. Until existing nurseries are better managed it would not seem wise to create additional ones.

E. Livestock

1. Stall-Fed Cattle

According to the extensive survey [Campbell, Lev and Holtzman, 1980] there are about 12,000 cattle currently being stall-fed in the Margui-Wandala/Meri area. Over 90% of these are found in the mountains and the adjacent piedmont areas. In practice, the distinction between stall-fed animals and extensively grazed animals who spend the night in the owners compound is not always clear. In many areas where there are no stall-fed cattle per se, cattle and small ruminants are penned up during the rainy season to prevent damage to crops. During this time they are stall-fed. In areas where stall-feeding is practiced, on the other hand, most stall-fed animals are left out to graze during all but the last dry season before their slaughter. The existence of stall-fed cows and calves in households sampled in the extensive survey suggests that farmers as well do not always make the clear distinctions that have came to apply to the sacred bull which is fed and slaughtered for the Mafa Fête de Marai.

Many different ethnic groups observe a semi-religious harvest festival every two to four years. It is common to slaughter cattle for such occasions. Practices vary from purchasing a one year old bull calf and raising it for two to three years before slaughter to purchasing a full

grown animal four to six weeks before the festival. For some of the festivals only bulls are a suitable sacrifice. For others females may be used.

The most popular of the harvest festivals occurs at the Fête de Marai among the Mafa. This festival usually occurs every two years following the harvest of the sorghum crop at the end of a rigid two year millet-sorghum rotation. This festival occurs on different days in different villages and 20-40 cattle, roughly one per hundred inhabitants, will be slaughtered in each village. Socially determined distribution rights within the clan ensure widespread distribution of available meat. Indeed, farmers complain of not having enough meat for their own household needs once these obligations are met. These festivals are not, therefore, times of absolute gluttonous consumption of meat, though relative to the rest of the year, meat consumption is quite high.

The Mafa seem to have the tradition of the longest period of feeding these "sacred bulls" with periods of three years not uncommon and two years being average. Farmers usually purchase 1 1/2-2 1/2 year old animals, the average of those studied by Holtzman [1981] being 24 months. Farmers confine the bulls during the rainy season in an enclosure separate from other cattle, but allow them to graze with small ruminants and other cattle during the dry season--with the exception of the dry season in which the festival occurs. During the last dry season the bulls are kept in their stalls and fattened up for the slaughter.

With the passage of time more and more farmers have been selling part of the carcass of these sacred bulls. Others have been stall-feeding cattle for local slaughter and consumption outside the context of the traditional harvest festivals. Among the 10% of households in the extensive survey that had a stall-fed bovine, nine, or 32%, sold all or part of the carcass of the last one slaughtered or sold. The remainder of the animals and meat was consumed at home or by friends and relatives. Overall one quarter of the meat produced from stall-fed cattle was sold; half of this in local markets. The remainder was purchased by neighbors or sold to traders purchasing live animals, in about equal quantities. With an estimated 5000 such animals slaughtered each year the amount of stall-fed beef entering commerical channels is substantial indeed.

It was an awareness of the growing commerical orientation of the stall-feeding enterprise that induced the World Bank to finance a pilot credit program for the purchase and feeding for two years of stall-fed cattle. These animals were expected to find a ready market in Mokolo and other larger towns in Margui-Wandala/Meri where consumers value higher quality beef. By the time our research began, this program had been in operation long enough to permit a preliminary analysis of the feasibility of expanding it to a larger scale.

On the basis of the extensive survey one mountain household in four has one or more stall-fed cattle at any point in time, with the vast majority having only a single bull [Campbell, Lev and Holtzman, 1980]. On the basis of preliminary and very tentative results of the input-output study it appears that labor inputs per stall-fed bovine averaged across all ages range between 900 and 950 hours per year, excluding the

labor of small children in herding.[1] Of this, 65-80% is spent gathering grass or getting water [Holtzman, 1981]. Some of the labor spent gathering grass is expended during a slack period between the last weeding and the beginning of cereals harvest while labor for fetching water is more important during the latter part of the dry season and during land preparation time. Removing manure, feeding and stocking grass are largely slack period activities. Overall we estimate that 40% of the 1025 or so hours per year demanded by the stall-feeding enterprise are worked during relatively slack periods.

In areas where forage is relatively more scarce as many as 70% of farmers with stall-fed cattle purchase forage at some time or another. Overall it appears that 10% of the total forage ration in such areas may be purchased. Thus stall-fed cattle provide income for other households as well as for households with stall-fed cattle, especially toward the end of the dry season when local pastures are depleted and the need for hay for supplemental feeding is greater.

Manure is an important output of the stall-feeding enterprise. Zalla [1981] estimates that an adult stall-fed bull produces the equivalent of 3.8 tons of usable manure a year. Holtzman [1981] found that the

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[1] The labor of small children no doubt has a zero opportunity cost during the dry season. Moreover single bulls are grouped with other cattle so what labor is expended in herding cannot all be attributed to a single stall-feeding enterprise. The actual labor hours recorded by Holtzman were 1000-1050. However these have been reduced by 10% to compensate for anomalies in the data. The range of 900-950 hours per year per stall-fed animal compares with 1000 hours per adult cattle unit found by Zalla [1981] among farmers stall-feeding zebu cattle in Northern Tanzania. In Northern Tanzania animals are 100% stall-fed but much less time is expended gathering water.

average age at acquisition is around 24 months and the average feeding period for animals already sold or slaughtered was 25 months. Given that the period of total confinement averages seven months per year, the annual output of usable manure per stall-fed bovine averages about 2.2 tons.[1] This can be expected to add at least 285 kilograms of cereals per year to the production of an average household in Margui-Wandala/Meri or 600 kilograms of cereals over the life of an average stall-fed bull.[2] When valued at average annual market prices for sorghum the value to the household of the manure produced by a stall-feeding enterprise is greater than the market value of the meat.

Table 2 summarizes preliminary tabulations of costs and returns for the stall-feeding enterprise. The return to family labor and equity capital is around 50,000 FCFA. This yields a return to family labor of 144 FCFA per day after allowing for a 15% real rate of return on invested equity capital. This return appears low in relation to an average wage

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[1] Assuming an average animal weighs 170 kilos at two years and 280 kilos when sold. A fully mature bull is estimated to weigh 310 kilograms. Ruminants tend todefecate when disturbed. The process of standing and lying down when confined causes proportionately more of one days manure production to be excreted in the dwelling where the animal is confined than occurs on the range. Overall we estimate that 80% of the manure produced over the year is deposited in the dwelling where the animal is kept.

[2] Available studies from Mali [Shulman, 1979], and Nigeria [Lombin and Abdullahi, 1977] indicate that one ton of manure can be expected to increase cereal production by about 200 kilograms per year on experiment stations under conditions of adequate moisture when applied at a rate of five tons per hectare or less. This is the usual rate of application in Margui-Wandala/Meri. The realizable increase given farm level conditions, weather uncertainties and poor manure handling techniques would be lower. However average production increases as the period over which manure is used increases. We use here a figure of 130 kilograms per ton of manure.

TABLE 2

ESTIMATED COSTS AND RETURNS OF A ONE BULL STALL-FEEDING ENTERPRISE IN MARGUI-WANDALA 1980-81

Income/Cost Category	FCFA	
Gross Enterprise Output		
Increased beef production	31,500[a]	
Manure	35,500[b]	
Sub-Total		67,200
Variable Expenses		
Cash inputs (purchased grass, grain supplements, salt etc.)	11,500[c]	
Gross Margin		55,700
Fixed Expenses		
Housing depreciation[d]	1,500	
Housing repairs[e]	---	
Mortality risk/insurance[f]	3,700	
Sub-Total	5,200	
Net Enterprise Income		50,500
Charge for Equity Capital (15%)		
Cattle[g]	13,100	
Housing[h]	950	
Working capital[i]	1,800	
Sub-Total	15,850	
Net Enterprise Earnings/Returns to Family Labor		34,650
Total Hours of Labor Worked[j]	1920	
Return Per Day of Labor[k]		144
Increase in return per day of Labor arising from		
Asset appreciation[l]		19
Retailing margin[m]		13
15% increase in cereal production per ton of manure		22
Loan of 45,000 FCFA at 11 3/4%		11

SOURCE: Estimates derived from the intensive input-output and cattle marketing studies and a literature review.

[a]Assuming an average acquisition price of 33,500 FCFA as found by Holtzman for farmers paying cash for their animals and an average sale price of 65,000 FCFA for stall-fed bulls as observed in Soulede and Mokolo markets. Similar results are obtained if we use average monthly value added for only those animals which were sold, excluding those for which sale values had to be imputed.

[b]Assuming an average stall-fed bull produces 2.2 tons of usuable manure per year, each ton of manure increases sorghum production by 130 kilograms, sorghum is valued at its average market price over the year (70 FCFA per kilo) and the cost of harvesting the increased sorghum production amounts to 15% of its sale value and is not a benefit to the cattle enterprise.

[c]Includes only 1/2 of the cost of rice bran supplied by FONADER since Holtzman [1981] reports that much of it was rotten and could not be fed to cattle.

[d]Assuming an investment cost of 6000 FCFA, four cycles of stall-feeding of three months each, and a salvage value of zero.

[e]Included in labor time since all costs were labor costs.

[f]Assuming a 15% probability of dying before sale with the sale of meat from the dead carcass valued at 50% of liveweight prices. Computed as follows

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

[g]Computed on the average value of investment with the cattle investment adjusted for mortality. The opportunity cost of farmers' equity capital is assumed to be 15% in real terms. Computed as follows:

$$\left(\frac{\text{acquisition value + sale value}}{2} \times \text{survival rate} \times .15 \times \frac{25}{12}\right)$$

[h]Computed on the average value of the investment in housing over a ten year period assuming zero salvage value and a 30 month investment period for each cycle of stall-feeding. Computed as follows:

$$\left(\frac{\text{investment cost}}{2} \times .15 \times \frac{30}{12}\right)$$

[i]Working capital covers purchase of variable cash inputs. Computed as follows:

$$\left(\frac{\text{variable cash expenses}}{2} \times .15 \times \frac{25}{12}\right)$$

[j]Assuming 920 hours of labor per year for 25 months, excluding herding labor of children under 10 years of age. This is 10% below the number recorded by Holtzman [1981], and corrects for apparant anomalies in selected labor categories.

[k]Assuming an eight hour day.

[l]Assuming livestock continue their secular appreciation of the past ten years. In real terms this has amounted to 4% per year since 1969 according to price indicies available from the Direction de la Statistique et de la Comptabilité Nationale.

[m]Assuming a margin of 5% and increased labor input of 15 hours.

during the agricultural season of around 250 FCFA. It is true that not every one could find employment at the average wage, but during the peak season wages of 300-400 FCFA per day are not uncommon.

There are a number of explanations of why farmers continue to produce stall-fed beef and take the loans offered for this purpose by FONADER. The first is that our estimates of the real returns to labor may be too low. For example, many farmers slaughter the bull themselves and probably realize a retail rather than a wholesale price for the meat of the animal. This could amount to 5% of the value. In areas such as Magoumaz where terracing and manure handling techniques are quite sophisticated and manure has been applied for a number of years the return to manure in cereal production is no doubt above that used in Table 2 [Lombin and Abdullahi, 1977]. Though the exact response of sorghum production to applications of manure can only be estimated from data elsewhere, a 15% greater response than 130 kilograms of sorghum per ton of manure assumed in the calculation would not be out of the question. There is also the possibility that farmers expect the roughly 4% per year real appreciation in livestock values of the past several years to continue. These factors combined might add another 50-55 FCFA to the return per man day.

Another reason for stall-feeding is that it provides over 1000 hours per year of employment. This equals about .8 man years per stall-fed bull using labor data typical of other parts of Africa [Byerlee et al., 1977]. Once farm sizes fall to such a size that they can no longer fully employ household members during the agricultural season many farmers would prefer to work on their own farms at below opportunity cost wages rather than travel long distances in search of employment. Moreover, the 40% or so of the labor used at other than peak periods provides employment

at times when employment elsewhere may be very difficult to find.

A third explanation of observed farmer behavior with respect to stall-feeding lies in the role of cattle in coping with food shortages. They represent an appretiating asset that can be liquidated to acquire grain when all else fails. Indeed, farmers emphasize the usefulness of livestock for this purpose [Campbell, Lev and Holtzman, 1980]. Finally, stall-fed cattle play an important prestige role in the mountains where not raising and slaughtering a bull for an occasional harvest festival is a source of shame.

The FONADER loan program makes stall-feeding more attractive to farmers than would otherwise be the case. Reducing farmer equity by advancing a loan of 40,000 FCFA at 11 3/4% as does the FONADER loan program, raises the return per day of family labor by 11 FCFA per day, after allowing for a 15% real rate of return on remaining farmer equity. In combination with the previously mentioned reasons, the good response of farmers to the FONADER loan program thus far may not be so irrational as it appears at first glance.

Urban center prices have an important influence on the market for stall-fed beef. Holtzman [1981] notes that prices in Mokolo are officially controlled at levels well below those prevailing in nearby rural markets. Monthly average retail prices in Soulédé averaged over 80% higher than at Mokolo and those at Tourou over 90% higher over the October, 1980-February, 1981 period [Holtzman, 1981]. Average monthly differences between these two markets and Mokolo over the entire year appear to be on the order of 50%.

About 1600 cattle from outside of Margui-Wandala are slaughtered each year in Mokolo town alone. Additional animals are slaughtered in Mora and Koza where prices are also controlled. If Mokolo town prices

were allowed to rise to levels prevailing in nearby rural areas, a good bit of this demand would be supplied by stall-fed cattle from the mountains. Currently many town residents buy their meat in rural areas rather than Mokolo since the quality of meat is higher. During the harvest and post-harvest period effective demand for meat is particularly high.

With elimination of price controls on beef in urban centers in Margui-Wandala available urban, rural and Nigerian markets should have little difficulty in absorbing a 50% increase in stall-fed beef output--an additional 2500 cattle per year--at current prices. Given an average feeding period of 25 months this would require an additional 5000 animals to be stall-fed each year, providing equivalent full time annual employment for close to 4000 adults.

2. Range Fed Cattle

Range fed cattle refer to those cattle which obtain their forage ration by grazing throughout the year. There were about 177,000 such cattle in Margui-Wandala/Meri in 1980. Some of these cattle are in herds that migrate to areas away from the principal residence or village of the owner. Others are in herds that graze in the day but return to the principal residence of their owner or caretaker at night. We do not know the breakdown between the two kinds of herds but one commonly observes them grazing next to each other at certain times of the year. Probably somewhere around 2/3 of the animals return to their owners at night.

Though our study did not focus on extensive cattle production, Holtzman [1981] did collect some data on herd structure from a non-random sample of Fulani cattle herders residing in the mountains. In general his data reflect a herd recovering from a rather servere shock about two years ago with heifers over one year accounting for only 13% of the herd.

Herders do complain of the lack of watering points on the plateau and, indeed, it may be possible to expand total offtake by expanding the number of dry season watering points and the area grazed. However we must not lose sight of the importance of controlling the number of watering points as a means of controlling grazing. Without giving specific attention to herd management factors and offtake rates over the longer term it is not at all clear that investing in watering points to increase the area grazed would be an economic proposition. We need first to establish the relationship between the current herd structure and long run environmental versus managment factors. Only then can be begin to identify cause and effect relationships which can be influenced by policy.

In a number of areas a potential for conflict over land use exists where the movement of farmers into previously uncultivated lands threatens the access of herders to water sources, and pasture, to which they have long had access. Campbell and Riddell [1981] cite the case of conflict between herders and farmers near Mohow, where the extension of cultivation reduced the access of herders to a reliable source of water. They point out the necessity of considering questions of land use in contemplating increased crop production in reverine areas.

3. Small Ruminants

a. Herd Size and Composition

The extensive survey estimated the 1980 population of small ruminants in Margui-Wandala/Meri at 690,000 of which 385,000 were goats and 305,000 were sheep. These figures are 10-15% above equivalent livestock service estimates but confirm the general order of magnitude of the size of the small ruminant population. Overall, 88% of all households have at least one small ruminant with the average being 6.7 per household.

Table 3 gives a rough indication of the herd structure for sheep and goats derived from a small intensive study of three villages in Margui-Wandala Department. Presumably the structure of small ruminant herds in Meri is similar.

TABLE 3

AGE-SEX STRUCTURE OF THE SMALL RUMINANT HERD IN THREE VILLAGES OF MARGUI/WANDALA DEPARTMENT, 1980-81

Age	Sheep		Goats	
	Male	Female	Male	Female
Under one year	18	16	20	17
Over one year, of which	11	55	15	49
Castrated	1	0	5	0
Mature females[a]	0	41	0	35
Totals[b]	28	72	35	65
Number of Observations	267		463	

[a]Given birth once or more.

[b]May not add to column totals due to rounding errors

SOURCE: Intensive survey.

Among both sheep and goats no males under one year of age had been castrated, a practice which is clearly more frequently applied to goats than sheep since castration of goats improves the quality of the meat. The higher number of males under one year confirms the very slight tendency for males to outnumber females at birth but more importantly, shows that one year survival probabilities are the same for both sexes. After one year the proportion of males declines sharply since most are slaughtered at an early age. This practice provides meat for household consumption and increases the chances of survival for the remaining females

both because of reduced pressure on available fodder resources and less crowded housing.

The ratio of males over one year to females over one year is 1:5 and high by African standards [Dahl and Hjort, 1976]. This suggests that the primary determinant of kidding and lambing intervals is nutritional rather than structural. It also suggests that meat production has a high priority relative to reproduction.

b. Fertility and Reproduction

Most small ruminants in Margui-Wandala experience their first parturition shortly after their first birthday. For goats first parturition occurred at an average age of 13.6 months and for sheep 14.2 months. This is within the normal range reported by Dhal and Hjort [1976] who review an extensive literature on African pastoral herds. It also suggests that feeding constraints do not appreciably delay sexual maturity in relation to other parts of Africa.

The incidence of multiple births among small ruminants in Margui-Wandala is on the low side of that reported for actual studies of small ruminants in Africa outside of East Africa. Of all live births 21% of females goats and 5 1/2% of ewes had multiple births. Triple births occurred in 2% of the 163 female goats studied but there were no cases among the 111 ewes.

The kidding and lambing intervals are more difficult to estimate but we can set some limits. Using the time elapsed since the last parturition as a basis we get a nine month interval for both sheep and goats. This estimate is biased by the concentration of births in the period immediately preceding the survey and suggests that mortality and other offtake among

lambs and kids under one year is an unrealistically high 55% and 44%, respectively, based on the herd structure data which should be reasonably accurate. A second estimate based on a small number of case studies suggests kidding and lambing intervals of 13 and 16 months respectively. This estimate implies zero mortality for both sheep and goats under one year of age based on the herd structure data in Table 3. The midpoint of these two extremes gives an estimated kidding interval of 11 months and a lambing interval of 12-13 months. This is within the range found in other parts of Africa as reported by Dhal and Hjort [1976] and suggests rather moderate nutrition related constraints on oestrus, conception and reproduction.

c. Mortality

Using the average kidding and lambing intervals suggested in the previous section in conjunction with herd structure data and data on the disposition of the last offspring we estimate under one year mortality at 30-35% for goats and 25-30% for sheep.[1] An additional 2-3% of animals under one year are slaughtered for household consumption. If true, these

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[1] Farmers reported that 22% of the last kids and 19% of the last lambs born to goats and sheep had died by the time of the interview. Since many of these animals are not yet one year of age they still may die. Others are already over one year of age. These percentages, though practically the only way we can guesstimate mortality from cross section data, are usually underestimates of total under one year mortality. Since most small ruminan deaths occur during the first six months of life, the following formula gives a reasonably good estimate of annual mortality provided births are evenly spread over the year:

$$\text{Percent of last offspring which have died} \times \frac{12}{\text{lambing interval in months}} \times 1.35$$

The factor 1.35 reflects an assumption that 50% of all under one year mortality occurs before three months of age, and 70% of it by the time the animals are six months of age. If births are clustered near the time of the interview, as was the case in Margui-Wandala, a further upward adjustment would be necessary.

mortality rates of 25-30% are common for newborn kids and lambs. Moreover they confirm the age at first parturition and kidding and lambing interval data in suggesting that nutrition related reproduction and mortality losses in Margui-Wandala/Meri are moderate by African standards.

This is not to say that such losses are low. Moreover, there most certainly is a link between poor nutritional status and death from parasites. Well fed animals are quite capable of withstanding attacks of parasites while continuing to grow. The problem arises when parasite infestation occurs on top of limited feed intake such as is common during the late dry season. Anticipation of this by providing treatment for parasites before feeding stress occurs should reduce this kind of mortality.

Crowded housing conditions also appear to be a factor influencing small-ruminant mortality though this needs to be confirmed by longitudinal studies. Goats are especially susceptable to pneumonia when confined closely for long periods of time as occurs during the cultivating season. Housing is one area well within the present means of the farmer to exercise some control and about which information is already available.

Obviously any attempt to reduce mortality in the ways described above would have to be combined with increased emphasis on marketing and slaughter in order to stay within the carrying capacity of local pasture and fodder resources. Relating such actions to extension programs explaining the relationship between nutrition and mortality, and encouraging farmers to cut and store fodder to carry animals over the dry season would then provide an effective labor constraint on herd size.

4. Animal Traction

According to edited results of the extensive survey about 9% of all

households in Margui-Wandala/Meri use animal traction. Of those farmers using oxen, 95% plow with their oxen, none plant, over 15% weed, and somewhat less than 15% use their oxen for transport and uprooting peanuts. A surprisingly large proportion, 65%, rent out their animals for similar work, though the small number of observations with oxen (25) suggests all these estimates are unreliable.

Our findings with respect to animal traction are paradoxical. On the one hand many farmers who adopt animal traction do not continue its use after they lose or sell their oxen. On the other hand, other farmers appear quite anxious to acquire oxen and to replace those which die, in spite of very high mortality rates. One thing that is clear is that raising oxen to maturity and capitalizing on the increased value of the full grown animal is an important component of the total return to animal traction as viewed by farmers.

A slightly higher percentage of farmers had donkeys (11%) than oxen but only a quarter of these used their donkeys for plowing. About 6% used them for weeding, though again these estimates are very unreliable. The principal use of donkeys was for transport (92%) though over 1/3 of the owners rented out their animals for plowing and transport in about the same percentages as for their own use. We have no indication of the profitability of using donkeys for draft power.

Draft animals are not only used in the cotton growing plains. The southern end of the southern plateau and surprisingly, the rolling hills to the east of Mokolo contain concentrations of draft animals. In these areas land is sufficiently available to permit an expansion of the area under cultivation, though the quality of the land may not always be particularly good.

Throughout the project area expansion and profitability of animal traction is constrained by an apparent high mortality rate. Farmers report very little veterinary support but it is not clear whether the high death rate is due to improper feeding or other factors. Available evidence points to disease and infection and the need for closer veterinary supervision of draft animals. Given the low number of veterinary agents it may be desirable to encourage animal traction only in selected areas where both veterinary and extension agents are available.

The low proportion of farmers using animal traction for planting and weeding suggests the potential for substantial increases in production and economic returns if seeders and training in weeding with animal traction were available. Currently there is little experience with animal traction outside of SODECOTON and a training program for the Department's extension agents would be required before much could be done. However experience elsewhere indicates that the potential economic returns to planting and weeding with animal traction are quite high when added to an existing plowing operation, though the learning phase can be quite long [Barrett, et al, 1981].

G. Relative Returns to Land and Labor

The tremendous ethnic and ecological diversity that exists within Margui-Wandala/Meri cannot be captured in a study as limited as ours. The six sites chosen for intensive input-output studies are, nonetheless, more or less representative of farming systems prevailing in large areas of the two Departments involved in the study. Table 4 summarizes average cultivated area, gross income from various sources and gross crop income per worker and per hectare of cultivated land for the six villages. Table 5

details labor requirements and returns per day of labor for the different enterprises studied. Finally, Table 6 shows differences in livestock holdings between the villages.

Ouda in the south, not too far from Guili, represents an important sorghum producing area on the southern plateau, with a relatively diverse agricultural base and abundant land. Livestock are most numerous of the non-plains areas though almost all are extensively grazed. Oxen are in demand for animal traction in order to expand the area under cultivation (Table 6). Returns to labor in sorghum and peanuts are well above average (Table 5) but overall gross returns to land are on the lower end of the range for the six villages studied (Table 4). Thus household incomes are relatively high partly because of the larger area cultivated and partly because of income from livestock. Livestock accounts for about one quarter of income with non-agricultural activities accounting for another fifth or so.

Ldama represents a large area on the northern edge of the southern plateau and the piedmont area to the south of the Mandara Massif. Sweet potatoes are more important than elsewhere and, like Ouda, farm sizes are relatively large (Table 4). Livestock are important but cattle are not as plentiful as on the southern end of the plateau. Some cattle are stall-fed.

Returns to labor for all three enterprises studied in Ldama are surprisingly low, partly, no doubt, reflecting the abundance of land. On the basis of 1980 results, however, Ldama falls in the mid range of household incomes with 30% of the total coming from livestock but only 10% coming from non-agricultural sources (Table 4). Average gross returns per hectare of cropland are not much below those of Ouda in spite of the lower return to labor used for sorghum and peanuts (Table 5). This is due

TABLE 4

CULTIVATED AREA, GROSS INCOME BY SOURCE AND PROPORTION OF CROP INCOME FROM SORGHUM FOR SIX INTENSIVELY STUDIED SITES IN MARGUI-WANDALA/MERI, 1980

Village	Total Cultivated Area (Hectares)[a] Per		Proportion of Area where Sorghum is Main Crop[b]	Gross Value of Household crop Production (000 FCFA)	Proportion of Value Arising from Sorghum	Gross Crop Income (000 FCFA) Per		Estimated Gross Household Income From Non-Crop Sources (000 FCFA)[c]		Total Gross Household Income (000 FCFA)[d]
	Household	Worker				Worker	Hectare	Livestock	Other	
Ouda	2.79	.82	.59	125	.36	36.7	44.8	47	43	215
Roumzou	2.67	.71	.75	180	.56	47.9	67.4	51	20	251
Ldama	2.77	.61	.82	104	.59	22.9	37.5	52	17	173
Magoumaz	1.23	.36	.89	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Madakonay	1.34	.53	.75	56	.46	22.1	41.8	9	8	73
Manguirda of which	.99	.44	.82	75	.54	32.6	74.5	16	33	121
Cotton producing	1.45	.64	.68	105	N.A.	46.3	72.4	N.A.	N.A.	N.A.
Non-Cotton producing	.81	.36	.87	61	N.A.	27.1	75.3	N.A.	N.A.	N.A.

SOURCE: Intensive survey estimates.

[a]Based on 5-23 randomly selected observations in each village.

[b]Based on all households included in the input-output studies (N=20-23) except for Marguirda. In Manguirda there were six cotton producing and 15 non-cotton producing households.

[c]Sample results from July 1, 1980 to February 28, 1981 increased by 33% to get estimated annual totals.

[d]Total of gross value of crop production and gross income from non-crop sources.

TABLE 5

ESTIMATED LABOR REQUIREMENTS AND RETURN PER DAY OF LABOR FOR SELECTED CROPPING ENTERPRISES IN FIVE VILLAGES OF MARGUI-WANDALA/MERI, 1980

Village	Main Crop in Studied Fields	Number of Fields Studied	Average Field Size (Hectares)	Equivalent Man Days of Labor Utilized Per Hectare[a]	Approximate Net Return (FCFA)[b]	
					Per Day[c]	Per Hectare
Ouda	Sorghum	15	.586	75	500	37,600
	Peanuts	20	.368	99	575	56,800
Roumzou	Sorghum	9	.622	85	710	60,700
	Sweet potatoes	13	.039	234	1,500	351,100
	Irish potatoes	11	.012	350	1,800	630,400
Ldama	Sorghum	19	1.014	189	190	38,000
	Peanuts	9	.093	366	100	36,300
	Sweet potatoes	8	.124	246	500	118,700
Madakonay	Sorghum	24	.632	131	190	26,800
	Peanuts	12	.257	166	240	39,900
Manguirda	Sorghum	19	.294	190	330	66,100
	Peanuts	18	.081	309	115	35,900
	Cotton	10	.643	181	300	53,500

[a]For all crops.

[b]Estimated return from all crops in the field. The cost of inputs is not yet completely tabulated. These figures represent adjustments to gross returns based on an estimate of the proportion of total returns which are non-labor costs. For sorghum non-labor inputs are estimated to amount to 5% of gross returns. For peanuts a figure of 20% was used but in actual fact peanut yields have been highly variable in recent years and seed cost can run as high as 50% of the eventual output. For cotton we used 30%, for Irish potatoes 20% and for all other outputs, 10%.

[c]For an eight hour day.

TABLE 6

AVERAGE LIVESTOCK HOLDINGS IN SIX VILLAGES OF MARGUI-WANDALA/MERI BY TYPE OF LIVESTOCK

Village	Average Number Per Household			
	Oxen	Other Cattle	Goats	Sheep
Ouda[a]	.8	3.2	6.4	7.0
Roumzou[a]	0	1.7	3.7	5.9
Ldama[a]	0.1	1.7	8.3	3.7
Magoumaz[b]	0	.6	8.3	1.1
Madakonay[a]	0.2	0.1	5.4	1.9
Manguirda[a]	0.1	0.1	2.7	2.2

[a]Based on average of all households included in intensive sites (N = 20-23).

[b]Based on average of eight randomly selected households.

to a larger labor input per hectare and the greater importance of sweet potatoes in Ldama.

Roumzou is a special case. It is a well watered, relatively fertile area where potatoes and sweet potatoes combine with above average yields on sorghum to generate the highest household income and highest returns per hectare in cultivated land of all the areas studied. Livestock, still mostly extensively grazed, are as important as in Ldama though income from livestock, excluding the value of manure, accounts for only 20% of the higher total income. Crop production accounts for about 70% of total income, the highest of all the high income areas studied. Clearly, this area's wealth is based on its agricultural resources and its wide range of agricultural production possibilities.

Magoumaz, Madakonay and Manguirda are much more mountainous areas with fewer livestock. However, Magoumaz, due to the importance attached to soil conservation and maintenance of soil fertility, has succeeded in obtaining returns to labor on sorghum which are clearly higher than in the other two areas, though we do not yet have the data analyzed to show this. This arises primarily from the fact that only households with stall-fed cattle were sampled in Magoumaz. Both higher income from livestock and the higher yields for cropping enterprises, especially sorghum, are either directly or indirectly attributable to the stall-fed cattle enterprise.

Madakonay and the non-cotton producing households of Manguirda, typical of a vast area to the east of Mokolo, have relatively low returns to labor allocated to cereal enterprises and have only about half of the area under cultivation as do the wealthier villages on the southern plateau (Tables 4 and 5). In spite of this, their greater attention to intercropping and cultivation of other non-cereal crops maintains gross

crop income per hectare above the levels of Ouda and Ldama even though rainfall is less dependable and soils appear less fertile. Total household incomes are the lowest of the six areas studied, due primarily to the much smaller average farm size (Table 4).

Some households in Manguirda are able to expand the area under cultivation and improve average sorghum yields by obtaining a cotton field in the nearby plains. Though grown on fields quite distant from the household, cotton generates superior returns to labor for both the cotton crop as well as for the sorghum crop which follows it. Incomes for these farmers are among the highest in Manguirda. Unfortunately such land is limited in quantity and cotton production does not offer much hope for those farmers not already possessing a cotton field. Most of these rely on wage employment in the cotton fields of others in the plains in order to supplement their meager agricultural incomes. This accounts for the higher level of income from other sources indicated in Table 4.

H. Agricultural Infrastructure

1. Extension

a. Agriculture

Harley [1980] examined the agricultural extension service in Margui-Wandala from the point of view of the agents. His findings are telling. Only abut half of the agents have received formal training in agriculture and extension methods. The period of training ranges from a few weeks to nine months with the upper end of this range uncommon. The remaining agents received a few weeks in apprenticeship with an experienced monitor.

Of the agents who received some formal training 60% have received no additional training since their initial session which, on the average, occurred 11 1/2 years ago. Another 20% received only one week of additional training.

Logistical support for extension agents is also weak. Agents provide for their own transport from meager salaries and are handicapped by a lack of educational materials and inputs to pass on to farmers. Supervision and guidance appears to be weak and this is not helped by the lack of transport for supervisors and chiefs of post. There is no effective system of extension management and indeed, it probably doesn't make a lot of sense to be concerned about this until more information that is useful for farmers is identified, agents are trained in its application, and the necessary inputs are made available. Not surprisingly, the extensive survey reflected a low rate of penetration of extension outside of the cotton producing areas covered by SODECOTON [Campbell, Lev and Holtzman, 1980].

In spite of all these problems Harley reports that agents are generally enthusiastic about their work and eager for additional training. Still lacking is a structure for identifying, testing and extending information and technologies with a demonstrated payoff to farmers, and providing the inputs to enable farmers to adopt them.

b. Animal Health and Extension

It is generally agreed that vaccination programs cover the area's extensively grazed cattle population quite well while diagnosis and treatment of animals receives relatively little attention outside of Mokolo.

Schillhorn [1980] notes that vaccination coverage of stall-fed cattle is not particularly good and small ruminants receive little attention. He

attributes this to the lack of mobility of the veterinary staff, poorly trained veterinary agents and a preoccupation with vaccination programs for cattle and control of animal movements. Availability of medicines is also a problem though some herders are able to obtain supplies smuggled in from Nigeria. Animal husbandry is neglected; but one of the reasons for this is the fact that fodder production and feeding are the responsibilities of separate ministries.

With respect to extension Schillhorn [1980] noted the need for more veterinary staff initiative in advising farmers. A recently established annual livestock show is an attempt in this direction but no leaflets or other forms of instruction are available for distribution to farmers. Moreover, Cameroonian radio programs rarely discuss matters of interest to livestock owners. Schillhorn also notes the lack of an effective extension program aimed at farmers participating in the bull fattening scheme, though an effective program in this area would require joint participation by the agriculture and livestock services.

c. Potential for Improvement

The problem with extension services in Margui-Wandala/Meri goes beyond poorly trained agents, inadequate transport and an insufficient and undependable supply of inputs. Much more could be done with existing resources if extension services were more effectively managed and oriented toward learning from farmers and technicians alike, and then developing programs to diffuse this information to other peasants. Without this, more agents and more vehicles are not likely to affect the current rate of discovery and diffusion of output increasing innovations relating to agriculture and livestock. With it, productivity of the currently available manpower

could be increased immensely with little increase in operating expenses for the extension service. Once an improved management and operating system is in place, then increasing the number of agents and their effective area of coverage will hold some promise of providing a positive return to the increased investment.

2. Research

Currently very little agricultural research is being carried on in the Mandara mountains, though SAFGRAD has a couple of varietal testing sites in the nearby plains. The SAFGRAD researcher is based at the IRA station in Maroua and has responsibility for the entire Northern Region. Only a small portion of his time is spent in the Department. His efforts are concentrated on testing promising plant material from all over Africa, only some of which takes place on farmers fields.

As the previous discussion on crops pointed out, farmers themselves have a great deal of information on what works and why. Some local cereal varieties are as high yielding as any likely to come from other parts of the world. What is needed is work on the rotation, soil management and soil fertility factors that allow this yield potential to be expressed. Similarly, several cropping practices appear to be associated with remarkable differences in yields of local varieties of other crops as well, sweet potatoes and cowpeas being two important examples. Trials are needed on the degree of substitutability of chemical fertilizer for manure and the potential for composted green matter to supplement available manure supplies. Crop rotation and storage technologies for tubers are other areas where the existing knowledge of selected farmers can provide promising leads that can then be field tested for wider applicability and eventual diffusion.

This is not basic research. It is applied research and could be very easily integrated with normal extension activities in the department. Agents could solicit observations from farmers, make a preliminary interpretation, pass interesting findings to an agronomist and farming systems economist at Departmental headquarters who could then follow-up with more detailed observations. Once a promising cropping or soil management practice is identified the agronomist could then design a simple field trial to be carried out on farmers fields by the extension agents and farmers. In this way farmers and extension agents become active participants in the research and testing process, increasing considerably the likelihood of developing recommendations that are consistent with existing farming systems and farmer preferences. At the same time, promising exotic plant materials or practices identified by researchers at Maroua and elsewhere could be fed into such a system for on-farm testing.

Such research and field testing provides, in turn, an excellent focus for in-service training of extension agents. Not only will agents need to be taught about important factors that need to be controlled in carrying out the applied research, but they will observe first hand the results. Summaries of the research results could then be incorporated into each year's training program; and the following year's applied research agenda could be established at this time as well.

A similar approach may work for livestock, though we found few instances where farmers were ahead of researchers. The major need in the livestock area is for more pointed applied research on animal health and the effect of selected feeding and housing practices. These three areas are central to the stall-feeding program for cattle and for

reducing mortality of small ruminants. But a lot more knowledge building will be necessary before a package of practices that will reduce mortality and increase meat production per animal can be confidently recommended to farmers.

This process of knowledge building does not require a major outside research effort. True, it will need the support of technical agriculture scientists, laboratories, veterinarians and animal health specialists from research stations and schools in the Northern Region. But most of this need only be supportive of an ongoing applied research program carried out by one agronomist, one livestock specialist and one farming systems economist working with existing agricultural and livestock service extension agents. Blood and manure samples taken from animals which die, trials of alternative feeding and housing systems, and selected prophylactic and treatment measures could form the basis of a very useful applied research program relating to livestock.

The applied research referred to here has to be no more ambitious than utilizing agriculture and livestock service manpower already assigned to the department more effectively. Once the process began to prove itself, and agents themselves became better trained as a result of their involvement in the applied research program, then consideration could be given to increasing the number of agents. What is needed is not a massive beginning, just a beginning.

3. Input Supply

Except rarely, fertilizer and crop storage chemicals are not available from the local agricultural post or in local markets. Fertilizer smuggled in from Nigeria can be found in the market near Tchévi and agricultural chemicals from the same source, throughout markets near the

border. However, smuggling of agricultural inputs is resisted by Nigerian authorities since these inputs are heavily subsidized in Nigeria.

Since Cameroonian fertilizer is not available in local markets farmers desiring fertilizer and other inputs must form groups and apply to FONADER in Garoua for a loan for their purchase. FONADER then orders the inputs on behalf of the farmers and tranships what is availble. Sometimes, when local supplies are not available, as in the case of fertilizer, FONADER sends cash for farmers to make their own purchases in the black market.

Peanut seed also seems to be a problem in Margui-Wandala/Meri. Until good quality peanut seed is available from other sources the full agronomic potential of this important cash crop in the area will go unrealized.

The problem with respect to inputs is that the mechanism for acquiring them is cumbersome and prone to corruption. Commercial supplies will only become available when some authority or governmental unit takes responsibility for acquiring and distributing inputs to smaller towns and market centers in the project area.

Input supply also needs to be separated from credit. Evidence suggests that some farmers are prepared to pay cash for chemical storage products and some for fertilizer. This does not rule out the use of credit for the purchase of inputs, including oxen and animal traction equipment. However credit is a separate issue that needs to be dealt with at the national rather than the local level if FONADER is to be the administering agency.

4. Credit

Currently agricultural credit in the project area is supplied by FONADER. Apart from the stall-feeding program which has a separate operating

system, applications for short and medium term credit must come from farmer groups and are placed through the Chief of the Agricultural post who then forwards them on to the FONADER office in Garoua. Farmers are required to pay a loan application fee which, since they have only the word of the extension agent as to the amount, has sometimes been higher than the amount sent to FONADER. Agents are not separately compensated for their assistance in helping farmers obtain and repay loans but their role as middle man and the failure of FONADER to deal directly with farmers sets up a situation for unscrupulous agents to exploit.

We did not look into the repayment record for medium term credit to farmers nor the operating structure of the program in detail. However it is clear that a larger credit program would need to tighten up its operating and accounting procedures and facilitate direct farmer-credit agency contact before it would have a reasonable likelihood of success. The FONADER stall-feeding loan program provides an example of a separate yet integrated structure on which it might be possible to build an expanded program.

5. Soil Conservation

The relatively sophisticated terraces and a long tradition of farming steep mountain slopes does not imply that farmers in the Mandara mountains have developed good soil conservation techniques and are maintaining them. Whatever was the case in former years, the evidence today, with one or two notable exceptions, is that soil erosion is an increasingly severe problem in both the plains as well as the mountains that will require collective rather than individual action to arrest.

Terraces are seldom constructed anew in current times. Maintenance of existing terraces is done by both men and women as they prepare the

land for planting. Obviously the more strenuous task of moving large rocks usually falls on men.

Farmers appear aware of the relationship between soil erosion and the state and slope of their terraces. Yet those with whom we spoke about excessive slope on the terraces felt that the terraces were good enough the way they were. On the other hand many expressed a willingness to improve their terraces if in doing so they could earn a wage equal to 100 FCFA per day during the slack season.

Campbell [1981] expresses concern over the abandonment of terraces on the upper slopes of the mountains and the aging of the area's remaining population as young people migrate in search of employment and better opportunities elsewhere. Less attention is being given to maintenance of terraces. This increases surface runoff and overwhelmes farmers on the lower slopes who are unable to control the volume of runoff which results. ONAREST [1971] makes a similar observation.

It is not clear that poor maintenance and construction of terraces is just a recent phenomenon. The deep sandy loam soils found in many valleys in the mountains suggests that this process has been ongoing for some time. What is happening to agricultural production per unit of land and labor over time is a matter of speculation. One thing is for certain, however; in Magoumaz, where terraces are well maintained and designed to hold as much water on the mountain slopes as possible while controlling the flow of runoff, average sorghum yields are clearly the highest in the department. Certainly this area's heavy emphasis on stall-feeding and careful utilization of the resulting manure is an additional explanatory factor.

The problem of erosion in the more rolling parts of the plateau or on the plains should not be underestimated either. Farmers leaving the mountains for these areas do not seem to be taking their intensive cultivation practices with them. The result is visible erosion and rapidly depleted soils. Campbell [1981] expresses concern that the problem will progress to a point of no return before farmers recognize the need for more careful soil conservation measures. He urges consideration of measures which would make it economically worthwhile for farmers to give more attention to soil conservation measures in the present. Planted grasses for stall-fed cattle, reforestation of abandoned terraces in the mountains and construction of wiers and bunds to reduce gully and overland flow in the plateau and plains are a few of the measures he suggests. A public works program paying nominal wages might be another.

Though it is possible to conceive of many possible interventions in soil conservation there is little doubt that returns to such investments will be low in economic terms and, if fully costed, probably cannot compete with the short run returns offered from other investments. However, one cannot overlook the fact that much of the output from more rapidly maturing investments is consumed rather than invested. The output of soil conservation measures, on the other hand, is usually more investment in the form of growing forests, more productive soils and reduced operating costs for future investments in other areas. Any choice between projects based on a simple comparison of internal rates of return would imply indifference between investment and consumption over time, hardly a valid assumption for an area as poor as the Mandara Mountains or a country like the Cameroon. Moreover, the return to soil conservation measures will be higher than might be suggested at first glance if the employment and income such

investments would generate reduce the need for other kinds of assistance in the area.

Soil conservation is never easy to implement even when the need is recognized and the economic payoff is evident. It requires community organization and participation and, if such measures are to be permanent, community implementation and control. It is often difficult to control the flow of benefits from such projects since most of the cost would come in the form of wages of one sort or another for an output that is not easily quantifiable on land that usually will belong to an individual. Still, at the very least it would appear desirable to begin to accumulate some experience on what conservation techniques and implementation structures work best in the Mandara Mountains.

I. Nutrition

The study of human nutritional status carried out by Trechter [1981] found that insufficient production of calories and lack of education with respect to public health and the needs of weaning children are the principle causes of malnutrition and below normal consumption of calories. Though households generally eat two meals per day during the hunger season, the period during which the study took place, it is not uncommon to find villages where large groups of households consume only one meal per day or even skip eating for a day at this time of the year.

In terms of the nutrient adequacy ratio for calories (NARc)[1], the village with lowest household income of the three villages studied by Trechter, Madakonay, had an average NARc of .8 on the basis of four

[1] The ratio of calories consumed to calories required. Trechter [1981] computed this on a household rather than an individual basis.

consecutive days of recorded food consumption. The highest NARc, 1.14, occurred in Ouda, a village with a high proportion of Moslems. Since the first half of the study period coincided with Ramadan this figure is no doubt considerably above a more normal NARc for this time of the year. Ldama, with an NARc of 1.00, fell in between the two.

Not surprisingly, the NARc's in general suggest that food supplies are inadequate to marginal during the hungry season of the year. With average values of 100 or below it is clear that many households fairly consistently fall well below this level. Unless these are also those households with below average genetic requirements--a possibility for at least some of them--this situation suggests considerable room for expanding local consumption of cereals and legumes. The challenge is to increase production in those households experiencing nutritional defficiencies.

Not surprising perhaps, Trechter found that consumption was generally higher on market days. Home production accounted for 70-90% of calories consumed in the two wealthier villages but only 43% in the poorest village. The latter had to rely heavily on wage income and gifts to acquire household food supplies during the hunger season. He did not find that consumption of wine was as high and widespread as had been thought but notes that wine drinking may be more of a dry season pastime when grain supplies are still relatively plentiful and people have more time on their hands.

In looking at anthropometric measures of children under five Trechter found that villages that are better fed at this time of the year do not necessarily have lower incidences of child malnutrition. He identifies infant weaning practices as the source of this difference and fairly clearly demonstrates that improving nutritional status is a much more complex issue than simply increasing food production, in spite of the intuitive

appeal of, and need for, the latter. Water supplies, cleanliness, other public health considerations, womens earning power and flexibility of the farming system appear to be equally important in Margui-Wandala/Meri. The nature of these relationships is being analysized with a multivariate analysis of available data.

In terms of the relationship between nutritional status and the farming system most of our observations are still preliminary. It is clear that the more flexible and diverse systems provide better diets but this may be more a function of absolute availability of resources than the nature of the farming system itself. Stall-feeding of cattle appears to have a positive impact on diets through the manure it supplies to the cereal enterprise within the farming system. Like cereals, a large proportion of peanut and cowpea production is consumed so any improvement here would affect diets both through direct consumption of legumes and through the increased feedstuffs that residues from these crops provide for the stall-feeding enterprise.

Cereals serve as a means of generating dry season income for women in the form of sales of beer and prepared foods. Presumably this translates more directly into food purchases, provides diversity in the diet and generates a more or less steady stream of cash with which to maintain this diversity over time, though data on this are still being analyzed.

Livestock are another important component of the farming system that directly influence diets. Many farmers report the sale of such assets as a principal means of acquiring grain during food shortages. Slaughter of young male animals and emergency slaughter of animals of all ages provide an intermittent supply of meat for consumption by household members and neighbors. And since some meat is dried and stored in Margui-Wandala/Meri, dead and slaughtered animals may not generate the feast or

famine kind of syndrome with respect to meat consumption one might otherwise expect. Finally, there is the obvious impact on diets one would expect from income generated from sales of live animals.

Trechter and Campbell [forthcoming] analyze the behavior of families under nutritional stress and note three strategies employed by them that were not used by their relatively well fed neighbors. Reducing food intake at each meal, not eating for an entire day, and migration of family members in search of employment. They argue that these three practices, when occurring in concert, represent a breakdown in the village's ability to cope with food shortages by internal means. They suggest that these three behaviors be monitored as a basis for determining when outside intervention, especially in the form of cereal sales by the "Office Cerealier", is required. Though the authors recognize that limited effective demand for cereals would greatly compromise the effectiveness of an intervention by the "Office", other mechanisms could be used to respond to areas experiencing severe food shortages at a particular point in time. The behaviors identified by Trechter and Campbell will be useful for identifying such areas when intervention of one sort or another becomes feasible.

J. Summary and Recommended Interventions

1. Summary

The proposed project area is divided into three broad ecological zones: the plains, the mountains and the plateau. The plains are the principal cotton growing areas of the department where SODECOTON is promoting cotton, cereals and animal traction. SODECOTON appears to have no problem acquiring inputs and staff for its operations and there seems little purpose in duplicating the work of SODECOTON in the plains.

The mountains and the plateau are the neglected parts of the department. The plateau offers wide potential for increasing both the area under cultivation as well as the intensity of agricultural production. Farming systems in major parts of the mountains also have considerable flexibility and potential, but those in important portions, such as the area to the east of Mokolo toward Meri and Zamai, seem to be locked in a low-level equilibrium. At present there are no tested interventions which can be extended to increase crop and livestock production in the mountains.

Soil fertility throughout the area is low but, as the soil tests indicate, improves considerably with continuous application of manure and other organic and household residues. Soil organic matter is the principal soil fertility variable which can be influenced by farmers. Rainfall, especially the uneven distribution over time and space, is an overall constraint on farming systems in Margui-Wandala/Meri.

In terms of the scope for expansion and intensification, sorghum, sweet potatoes, Irish potatoes and fruit production offer the greatest potential for increasing crop production while stall-fed cattle are the most promising of the livestock enterprises in the mountains. Animal traction offers additional potential as a joint livestock-crop activity on the plateau and the flatter parts of the mountain areas.

Rainy season sorghum accounts for about 55% of crop acreage in an average year. Yields of rainy season sorghum varieties grown on the mountains and on the high plateau average between 500-700 kilograms per hectare. Some of these varieties, already grown over more than half the mountain, yield as much as 3-8 tons per hectare when planted on well manured plots. This indicates that soil fertility rather than the yield potential of local varieties is the principal constraint on increasing

sorghum production. Research from northern Nigeria, visual inspection, and soil analysis all suggest that manure, both alone and in conjunction with chemical sources of phosphorus and nitrogen, should be able to increase production of such sorghum varieties by 8-10 kilograms per kilogram of nutrient applied. The lower end of this range is more likely for commercial fertilizers by themselves. With this kind of response, application of NP compound fertilizers on sorghum would be economical, even at the very high farm level cost of fertilizer delivered to Northern Cameroon.

We are much more confident of the returns to joint application of manure and chemical fertilizers than the return to the latter alone. The low clay and organic matter content of most of the area's soils, coupled with the intense rainfall during the rainy season, may result in nutrients, especially nitrogen, being leached from the soils before they can be absorbed by plants. The very low sodium and soluable salt readings in the soil samples suggests this and indicates that any approach to making fertilizer more available should be cautious and accompanied by applied research to confirm its economic potential.

Should commercial fertilizers by themselves prove promising for cereals, maize should rapidly gain importance in the farming system, especially if short season high yielding varieties from Nigeria and elsewhere become available. Maize is attractive because its early maturity provides a harvest which can break the hunger season and, in some areas, allow double cropping with short season crops, such as tobacco.

Tubers, both sweet potatoes and Irish potatoes, offer excellent potential for expansion. This potential is even greater if marketing can become more effectively managed during the harvest and immediate post-harvest period. The technology to store sweet potatoes at the farm level

is available, at least in some areas. Needs for cash, coupled with the availability of transportation and itinerant traders willing to purchase their output, seem to be the principal factors pushing farmers into dumping their tubers onto the market at harvest time. Still, net returns to labor in tuber production are over twice as high as cereals. An improved tuber market at Mokolo coupled with some form of group action by producers to encourage more competition among traders or to arrange long distance marketing, loans for crops in storage and contracts with producers for production of seed potatoes promise to greatly expand both available markets and production of these two very profitable crops.

Fruit production has potential for expansion but the very small current base means it will take considerable time before its absolute magnitude is important. Nurseries need to be better managed so as to increase their output of viable seedlings. Farmers should be encouraged to plant one or two trees in promising areas. Currently, the supply of seedlings is the limiting factor. Marketing will pose few constraints for many years to come, based on high current prices and good demand in Kousseri. On the production side, surprisingly large areas appear suitable for fruit production using manual, shallow well irrigation technology.

Stall-feeding of livestock has the potential to absorb a large volume of labor resources. There is strong local demand for meat from stall-fed animals in the rural areas of Margui-Wandala/Meri as well as in Nigeria. Stall-feeding also produces organic fertilizers and provides off-season employment. Available feeding materials appear adequate to support an expanded effort though the supply of inputs and veterinary services needs to be better organized than at present and more attention must be given to preservation and storage of grasses during the latter part of the rainy season.

Currently, retail meat prices in Mokolo and other urban centers in Margui-Wandala are officially controlled at levels which are about 25% below official control prices in the city of Maroua, and 40% below free market prices in the rural markets of Gazawa, Soulede and Tourou. Raising the level of retail price controls for beef in urban centers in the Department would open a major and as yet relatively untapped market for the higher quality, higher priced stall-fed beef.

With such a change in price policy, we estimate that 2,000-2,500 additional stall-fed cattle could be marketed in Margui-Wandala annually without depressing rural meat prices. This would require that an additional 5,000 animals be placed in stalls and would provide an additional 4,000 person years of employment each year in that part of the project area most desperately in need of additional employment and income. Important constraints at present are access to capital for the purchase of cattle, and the supply of inputs, especially rainy season labor for gathering feed.

Animal traction could also be expanded considerably outside the mountain areas, if extension services could be improved and the supply of animal health services and other inputs were more assured. There is also a need to provide training to extension agents and farmers on the use of animal power for planting and weeding so that weeding constraints on expanding the area under cultivation can be broken. Currently the institutions for performing these services either do not exist, or function at very low levels of efficiency and output.

On the institutional side, it must be admitted that extension is very weak, proven research results are not available for dissemination, the supply of inputs is virtually non-existent and credit programs are cumbersome and prone to exploitation. However, farmers hold a substantial body of

knowledge about what practices work and why. Some of the areas where farmers are keeping up with or are ahead of researchers are crop rotation systems, land preparation techniques, utilization of organic wastes, soil conservation techniques, and identification of superior varieties. What is missing is a structure for gathering this information, field testing on a wider scale promising findings from both within and outside the area, training extension agents in their application and managing extension resources for diffusion to farmers.

Finally, problems of maintaining and improving long term soil fertility through soil conservation need to be addressed. Those who doubt the effectiveness of such measures need only go to Magoumaz during the production season to observe the tremendous difference that good soil conservation and soil management can make. However, at this point we have only a very poor idea of the cost and potential implementation mechanisms for such a program. For some measures we also need to get a better idea of the returns. This can only be done through a fairly lengthy experimental testing, implementation and monitoring phase. It would be a mistake to embark on an ambitious program before more is known. But it would be a bigger mistake not to embark.

2. Proposed Development Strategy

The problems that face the Mandara Mountains have accumulated over decades and will take a long time to solve. As best as we can determine from available data it appears that the mountains are becoming more rather than less dependent on outside assistance. The region is not self-sufficient in cereals, even in a normal year, and there is evidence that per capita production of cereals is declining. Outmigration, malnutrition

and soil erosion are almost certainly increasing and the area's ability to sustain itself is in question.

People have lived in the Mandara Mountains for a long time and obviously will continue to live there in the future. It is equally obvious that future population growth, given present growth rates, cannot be absorbed by the area's resource base without an accompaning decline in the standard of living of most of the inhabitants. Migration will continue to be an important option for the area. Thus a two pronged development strategy is called for: (1) interventions in roads, communications and education to facilitate outmigration and integration into the Northern economy and (2) intervention to achieve self-sufficiency in the production of cereals and other foodstuffs in order to provide adequate diets and incomes for those who choose to remain. Hradsky [1980] and other donor Projects planned for North Cameroon address the first component of this strategy. The remainder of this paper deals with the second.

Our findings suggest a cautious approach to promoting agricultural development in the Mandara Mountains--one that leaves adequate time to identify and test proposed interventions prior to their diffusion to farmers at the same time that it provides for implementation. It would be irresponsible to argue for a large project in the absence of proven technological packages for farmers. We recommend the government of Cameroon prepare a four year project to a) carry out applied farming systems research in the Mandara Mountains and b) strengthen the implementation capacity of the agricultural and livestock extension services to help identify, field test and diffuse promising agronomic and livestock practices and technological packages to farmers. This should be seen as the first phase of long term development intervention in the Mandara area.

The purpose of the project would be to increase food production in the Mandara Mountains and the food deficit areas of Margui-Wandala Department and Meri Arrondissement. Modest opportunities exist for commercialization of agriculture and increasing cash incomes from crops shipped outside the area but these pale before the potential for increasing production of cereals, tubers, meat and other foodstuffs for local consumption. This is also an excellent opportunity to strengthen ongoing government services which will, no doubt, have a claim on scarce development resources for some time to come. To the extent that the project helps these services make better decisions and provide more relevant advice or more useful inputs to farmers, it will be a success.

3. Proposed Areas of Intervention

a. Cropping Systems

1) Sorghum

Local sorghum varieties planted in well manured fields give impressive yields in many parts of the mountain and represent a sound foundation on which to base a strategy of increasing food self-sufficiency. Preliminary evidence suggests that these yields can be achieved on a wider scale through combined applications of chemical fertilizers and light doses of manure and other organic waste. It appears that such increases in yield will be economic and of sufficient magnitude to induce farmers to adopt them. Thus a case can be made for aggressive experimentation with fertilizer and organic residues coupled with a modest distribution network to make fertilizer and other inputs commercially available to farmers at unsubsidized prices. Anything more than this should await the demonstration of economically viable experimental results or demonstrated effective demand by farmers.

2) Tubers

Several practices appear to improve tuber yields and warrent applied research. Horizontal placement of sweet potato mounds and incorporating organic plant residues in them at land preparation time appear to have the most dramatic effect. Applied research should confirm these effects and determine whether similar responses are obtainable from chemical fertilizer used either alone or in conjunction with organic residues. Furthermore, identifying the soil management factors associated with increased yields of sorghum and other crops rotated with tubers may suggest cultural practices which can improve yields of sorghum and other crops on a wider basis than at present. There is also a need to explore ways of spreading the production and harvest of tubers more evenly over the year so as to avoid the depressing effect of market gluts on producer prices.

b. Livestock Systems

Stall feeding of cattle has considerable potential for expansion in the mountains. We estimate that 5,000 additional cattle can be stall fed at any one time without depressing current rural meat prices if urban retail meat prices are raised. This would increase the annual production of stall fed animals by 2,000-2,500. Since availability of capital and inputs are important constraints on stall feeding at present, this will require that additional funds be made available for cattle loans and more attention be given to the supply of feedstuffs and veterinary services. More comprehensive vaccination and prophylaxis programs for stall fed cattle and draft oxen should have especially high priority. The additional cattle loans can be used to introduce stall feeding in high-density areas where presently it is not commonly practiced, though any such effort should be preceded by applied research to confirm its economic feasibility in the context of prevailing farming systems.

Applied research also needs to be carried out to identify the causes of high mortality among oxen, stall-fed cattle and small ruminants. At the present time animal housing seems to be an important factor and applied research needs to be directed toward alternative housing arrangements and designs to determine their ability to reduce this mortality. Attention should also be given to preservation of fodder and to dry season feeding regimes.

c. Storage, Marketing Systems and Pricing Policies

1) Pricing Policy

Increasing official retail meat prices in urban centers in Margui-Wandala Department should be given high priority. Higher prices will stimulate stall-feeding of cattle and bring meat prices for the urban consumers more closely in line with other markets in the North. It would also be helpful to ease controls on livestock exports to Nigeria both as a means of increasing prices to producers and to facilitate trade with a large and expanding center for consumption in the North. Present regulations effectively exclude stall-feeding farmers from the Nigerian market.

2) Input Supply

There is a need to experiment with alternative mechanisms for supplying agricultural and veterinary inputs to farmers in Margui-Wandala/Meri. Fertilizer, chemicals, feeds, medicines and vaccines all need to be made more readily available to farmers. We propose establishing a public buying and distributing agency in the department in order to supply inputs to farmers through selected merchants. The merchants would have to be given credit to finance their inventories. The operating costs of the public/private distribution system would be fully reflected in prices

charged to farmers and would cover the cost of purchasing and holding stocks of all inputs, from medicines and fertilizer to spare parts for animal traction equipment. We are aware of the problems associated with centralized para-public middlemen and emphasize the need for on-going applied research aimed at evolving a commercial distribution mechanism that can be self-supporting.

3) Tuber Storage and Marketing

Tuber storage and marketing is another area needing applied research. Successful storage technologies need to be identified and diffused to farmers not currently employing them. The feasibility of using loans against crops in storage as a means of distributing the sale of tubers more evenly over the year should be examined more carefully before actual implementation. Group action by producers also offers potential for expanding markets and increasing incomes for tuber producers. In all these areas field testing and implementation need to be tied together so that accumulated experience can lead to modifications in approach or content, thereby improving performance.

d. Rural Development Fund

Some of the interventions already mentioned, as well as a number of others, will require investment in prototypes to confirm their technical and economic feasibility. Some of these investments will be high risk and may not yield a pay off. The project will need a rural development fund to cover research and development expenses related to such prototype interventions.

1) Soil Conservation

Many of the soil conservation techniques which offer promise, such as construction of wiers, leveling of terraces, reforestation, water basin

management and others discussed in FAO (1976) are of this type. Some of these, especially those relating to water basin management in areas surrounding the newly constructed dams, may be on quite a large scale and will need flexible supplementary funding, depending on the implementation structure being tested. All soil conservation interventions tested during the first four year phase should be financed from the rural development fund. This will provide the flexibility to experiment with nominally paid community labor as well as volunteer labor. The fund should cover field costs for applied research directed toward measuring the effect of such interventions on yields.

2) Small Scale Industries and Agricultural Investments

Selected small scale industries such as blacksmiths and flour mills and other investments such as shallow well irrigation, animal traction and storage facilities for tubers should draw on the rural development fund for research and development related to their more experimental dimensions. Once the technical and economic viability of a technology or industry is confirmed the credit fund can provide capital to farmers and others wishing to invest in it.

e. Improving and Strengthening Rural Institutions

1) Research and Extension

The aforementioned list of promising applied research that needs to be done in Margui-Wandala/Meri is only a partial one; peasants themselves are an excellent source of knowledge on where to begin and what works. We are recommending an integrated applied research and extension program for Margui-Wandala/Meri that involves farmers and extension agents in identifying problems, proposing ways of dealing with them and then

conducting field trials to confirm their effectiveness prior to more widespread diffusion. A participatory approach of this kind would get farmers, extension agents and researchers working together on a set of problems of direct relevance to farmers.

Such an applied research program cannot work in a vacuum. It needs support from on-site technicians, and from local research stations and laboratories to provide technical backup and promising materials for the farm trials. It needs a strengthened extension service. In Margui-Wandala/Meri this means in-service training and extension management more than anything, though some logistical support will also be necessary. It also means a source of capital for setting up experiments, bearing risks and financing prototype investments until their feasibility is firmly established. It presupposes work to improve the supply of inputs and credit so that proven technological packages and innovations can be more easily extended to farmers, and the pay-off to applied research finally realized. Finally, it implies a commitment to long term development. Without this, it makes little sense to proceed.

2) Credit

The project proposes to establish a revolving credit fund to be administered by FONADER in much the same way as is currently done with the stall-feeding loan program. FONADER should establish an office in Mokolo and make loans directly to farmers, merchants, cooperatives and to extension agents at commercial rates. The structure of this program needs to be worked out in conjunction with FONADER. It should be run on sound business principles so as to ensure maintenance of the fund. The fund would provide credit for the following:

a) The purchase of motorcycles and bicycles by extension agents.

b) Credit to merchants for carrying stocks of inputs for sale to farmers.

c) The purchase and stall-feeding of 5,000 additional cattle.

d) Small scale industries, flour mills, shallow well irrigation, farm level storage bins, loans against crops in storage, grain banks and other rural investments when demonstrated to be economically viable through applied research.

FONADER would be expected to maintain its current loan fund for stall-fed cattle as constituted by the IBRD project. Feed supplements, medicines and vaccines would be provided through the marketing component, and training of veterinary and agricultural extension staff through the research and extension component.

3) Implementation

The necessary commitment to long term development presumed by the project we are recommending suggests that permanent rather than temporary institutions serve as the basis for the applied research program and development interventions which emanate from it. The extension service needs to be upgraded, the supply of inputs assured, and community participation needs to be elicited. Since regular government structures have responsibility for some of these functions it is logical that they be strengthened rather than supplanted by newly created parallel institutions. One way this can be done is by concentrating on developing and implementing management systems for existing institutions.

We therefore endorse the Barclay and Eilerts [1980] recommendation that a decentralized planning model be adopted for implementing the project. Budgetary control and responsibility for planning and implementation would rest with a Department level coordinating committee consisting of the chief administrative officer of each of the line ministries involved in project

implementation, as is currently the case with the Water Resources Project. A project coordinator with some expertise in area planning and economics should oversee day to day management. The Prefect would chair the coordinating committee and be the ultimate person accountable for the use of project funds.

This kind of decentralized management system strikes us as being quite sensible. It provides flexibility in addressing management problems which inevitably arise in the course of implementation. It increases the likelihood that persons charged with implementation will be receptive to advice, and willing to execute programs and changes as decided by the coordinating committee. Finally, it creates both an incentive and the means for strengthening the technical and implementation capacity of each of the line ministries involved in the project, while encouraging them to work together.

4. Specific Project Components

a. Technical Assistance

We recommend a four member technical assistance team for the pilot applied research/extension project with the following specifications: an expatriate project coordinator with an extension background, one agronomist, one livestock specialist and one farming systems economist for four years each. Short term consultants in agricultural marketing, agricultural engineering, soils and soil conservation would also be required.

All technical assistants should be assigned to an Applied Research and Training Center and would work under the project coordinating committee in close liaison with the chief of the respective technical service. The extension advisor would work with a Cameroonian Project coordinator in ensuring the supply of inputs and coordinating the in-service training

programs. He would work with the Chiefs of the technical services in designing the content of the in-service training programs and implementing and fine tuning extension management systems for each.

The agronomist and livestock specialists would work with the farming systems economist, the chiefs of service and extension agents in defining and carrying out the applied research and in-service training programs. They would consult regularly with researchers and other technicians working elsewhere in the North on related problems. They would assist the chiefs of service in overseeing and improving the extension management systems. They would also help define the content of extension programs and evaluate their impact.

b. Counterparts

Three permanent university level Cameroonians, one agronomist, one livestock specialist and one agricultural economist should be assigned as counterparts to the technical assistants. Like the expatriates, the Cameroonians would be more effective if assigned to the applied research and training center under the authority of the project coordinating committee. They would share the same responsibilities as the expatriate technical assistants and would work closely with the chiefs of the technical services and extension agents in carrying out the applied research, training and extension programs.

c. Research and Training

There will be a need to create a center in Mokolo for training extension and veterinary agents and for preliminary screening of field trials. This facility would include office space for the technical assistants and their Cameroonian counterparts as well as a store for inputs. It would probably also have to include offices for credit agents assigned to work with the project.

Under this component the project will have to provide per diem or other allowances to cover expenses of agents coming to Mokolo for their annual training program.

d. Logistical Support

Each of the Chiefs of Agriculture and Veterinary Posts should have a motorcycle and each agent at least a bicycle. The Departmental Delégué of Agriculture, the Director of Elevage, the Cameroonian project coordinator and each of the four technicians should have their own all-terrain vehicle. Motorbikes and bicycles would be purchased by extension agents from the project's revolving credit fund and agents would then receive a monthly allowance for maintenance and depreciation for on the job use. There would also need to be a fund to cover overnight expenses for researchers and technicians away in Maroua, Garoua or other areas on research or other project business. Additional agricultural and veterinary posts can be added in a later phase of the project once the current structure is being utilized to full advantage.

e. Rural Development Fund

The project will need to provide a fund to cover costs associated with identifying, purchasing and testing selected prototype investments relating to the rural sector. Once such prototypes are shown to be technically and economically feasible, farmers wishing to invest in them would have access to the project's credit fund.

f. Revolving Credit Program

The revolving credit fund should provide credit for purchase of vehicles by extension and veterinary agents, agricultural inputs by merchants, cattle for stall feeding, selected agricultural inputs and a wide range of small scale industry and agricultural investments. Only investments which are economically viable and which create a cash flow sufficient to permit repayment of the credit from the proceeds of the investment itself should be eligible for credit from the fund. Loans should be made at commercial interest rates and delinquent accounts dealt with promptly.

APPENDIX

Summary Budget of Components for a First Phase Four Year Applied Research and Extension Project

Expenditure Category

A. Technical Assistance

1. Extension Specialist (4 py)
2. Agronomist/Soil Scientist (4 py)
3. Livestock Specialist (4 py)
4. Farming Systems Economist (4 py)
5. Short Term Consultants (12 pm)

B. Counterparts

1. Project Coordinator (4 py)
2. Agronomist/Soil Scientist (4 py)
3. Livestock Specialist (4 py)
4. Agricultural Economist (4 py)

C. Research and Training

1. Building with Six Offices and Conference Room
2. Operating Expenses
3. Per Diem and Travel for Researchers and Visiting Lecturers

D. Logistical Support to Extension

1. All Terrain Vehicles (7)
2. Vehicle Operation (28 vy)
3. Maintenance Allowance for Bicycles and Motor Bikes
4. Travel Allowances and/or Per Diem for Extension Agents and Supervisors

E. Input Supply

1. Ten Ton Truck
2. Three Ton Truck
3. Driver, Storekeeper and Laborers

F. Rural Development Fund

1. Soil Conservation
   a. Unskilled Village Labor (16,000 man months)
   b. Materials
2. Untested Rural Investments

G. Revolving Credit Program

1. Vehicles (30 bicycles and 25 motor bikes)
2. Merchant Credit and Input Supply
   - 100 tons of fertilizer (maximum annual)
   - 5 tons of crop storage chemicals (maximum annual)
   - veterinary medicines (annual)
   - 250 tons of feed grains (maximum annual)
   - spare parts for animal traction equipment, flour mills etc.

3. Stall Feeding Loans (5,000 for purchase of cattle, feed grains, insurance and medical supplies)
4. Small Scale Industry and Agricultural Investment Loans
   - 200 flour mills
   - 200 loans for animal traction equipment
   - storage facilities for tubers
   - unforeseen possibilities
5. Crop Loans
   - 2,000 tons of Irish potatoes in storage
   - 4,000 tons of sweet potatoes in storage

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