

ANALYSIS OF SUPPLY AND DEMAND OF MILLET
AND SORGHUM IN UPPER-VOLTA

Thesis for the Degree of M. S.
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H. PAMATEBA DIENDERE

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ABSTRACT

ANALYSIS OF SUPPLY AND DEMAND OF MILLET AND SORGHUM IN UPPER-VOLTA

By

H. Pamateba Diendere

Upper Volta desires to be self-sufficient in cereal production; but, since independence it has relied upon imports and food aid to meet its food grain requirements of mostly millet and sorghum.

This study's main objective is to analyze the millet and sorghum sector of Upper Volta, and to identify and estimate elasticities of the most important variables affecting its supply and demand.

To achieve this study's objective, an econometric model was specified and estimated. Then the equations were combined and solved simultaneously to make forecasts of millet and sorghum production and demand under different alternatives.

The analysis finds that: (1) annual increases in millet and sorghum production within the range of data did not keep pace with population growth; (2) increases in millet and sorghum production are hampered by a low level use of fertilizer, poor rainfall, and lack of suitable land; (3) millet and sorghum supply and demand are only slightly responsive to prices: the own price elasticities of supply and demand are very low; and (4) self-sufficiency in millet and sorghum by 1988 would require a 5 percent increase in yields.

ANALYSIS OF SUPPLY AND DEMAND OF
MILLET AND SORGHUM IN UPPER-VOLTA

By

H. Pamateba Diendere

A THESIS

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To my wife Francoise
in appreciation for her love

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CHAPTER I

INTRODUCTION

1.1 Importance of the Study

Upper Volta desires to be self-sufficient in the production of cereals. But ever since the favorable harvest of 1969/70, the imbalance between the rate of growth of agricultural production and Upper Volta's population growth rate has forced the country to rely increasingly upon imports and food aid to meet its food grain requirements of mostly millet and sorghum. This import requirement is in contrast to Upper Volta's objective of becoming self-sufficient in staple foods. For some policy makers, the main difficulties to overcome in order to reach self-sufficiency in food crops production are: low soil fertility, unimproved or inappropriate technology, ineffective extension services, wide spread use of low yielding varieties by farmers, and inappropriate incentives created by government policies.

To aid in the formulation and implementation of appropriate policies, programs and projects designed to obtain food self-sufficiency in Upper Volta, this paper proposes to answer several questions related to production. The questions to be answered include: 1) What regions are the country's best millet and sorghum producers? 2) What factors explain why some areas are self-sufficient in food? 3) What proportion of all cereals produced in Upper Volta is millet and sorghum? 4) What factors limit increased productivity in cereals? It can be argued that at

planting time, most farmers compare the advantage and costs of producing cash versus food crops to make planting decisions. This study asks: to what degree is this statement true for Voltan farmers whose production is more oriented toward home consumption and who are faced year after year with the risk of drought and low producer prices imposed by the government? In other words, it asks what variables do Voltan farmers respond to in making their planting decisions? Also of interest is the nature of farmers' responses to changes in prices. What are factors to be taken into consideration in the evaluation of millet and sorghum prices and how do these influence the production and marketing activities of farmers? Is self-sufficiency in staple food a realistic target? If so, when can it be achieved?

1.2 Objectives of the Study

In the above section, many important questions were raised about Voltan agriculture. These questions are complex and in some cases the answers require data not available. As a result, some questions may remain unanswered empirically. Otherwise, this study intends to answer all questions raised except where the data do not permit. The following are the objectives of this study:

1. To analyze the actual situation prevailing in the millet and sorghum industry.
2. To determine what relevant variables affect supply and demand, and to use these discovered variables and their interrelationships for policy analysis, formulation and implementation.
3. To estimate the supply demand elasticities of the respective variables identified in the previous objective.

4. To predict future supply and demand conditions under different alternative scenarios including:

- a. alternative growth rate of GNP;
- b. alternative technological package;
- c. alternative prices.

1.3 Plan of the Study

The study is quantitative as well as qualitative in nature. The reason for this is that some of the questions raised, although important, could not be verified on a quantitative basis, due to lack of data. In such cases, all available information has been pooled together in an attempt to give some answers based from qualitative analysis. The remainder of this study is divided into six parts. Chapter two provides a background information about Upper Volta and the role of agriculture in the national economy. Chapter three reviews the present food supply (production) and marketing situation during the period 1961-1981. It gives a description of the main factors that determine millet and sorghum production, and the effects of official marketing and pricing policies on the grain subsector. In chapter four, a discussion of the sources and limitations of the data used in the study is presented in addition to providing an analytical framework for the evaluation of the empirical results presented in the following chapter. It emphasizes the need to improve the statistical data relating to Voltan agriculture to help make coherent cereal policies for the country. Chapter five is divided into two parts. The first part identifies variables needed to estimate demand, price, yield and acreage for millet and sorghum. The second part of chapter five presents the estimated

results and simulations as well as and the estimated elasticity measures of interest in millet and sorghum production equations. Chapter six projects cereal supplies and requirements for the period 1982 to 1990, using the equations described in chapter five. These forecasts are based on a number of assumptions that are discussed throughout the chapter. The two last chapters, chapter seven and eight, conclude the study with a summary and policy statements and some guidelines for future research. They identify some relevant questions whose correct answers would provide more information needed in diagnosing the problems of the agriculture subsector.

The data used in this study are presented in Appendix 1.

CHAPTER II

THE AGRICULTURAL SECTOR OF UPPER VOLTA

This chapter presents a brief review of background information about Upper Volta and the role of agriculture in the Voltan economy.

2.1 Physical Characteristics of Upper Volta

2.1.1 Location and Climate

Upper Volta is a small country located in the West Sahelian part of Africa. It is a landlocked country that lies above the equator between the latitude of 10° and 15° North and longitude 6° W and 2° East. It is bounded by Mali to the North and West, by Niger to the East and by four coastal countries, Ivory Coast, Ghana, Togo, and Benin to the South.

Upper Volta occupies a surface area of $274,000 \text{ km}^2$ ($106,560 \text{ mi}^2$) and is divided into three major zones of vegetation each depicting a specific pattern of rainfall: 1) the Sahelian zone; 2) the Sudano-Guinean zone; and 3) the Sudano-Sahelian zone. The Sahelian zone, which covers the northern part of the country, receives less than 600 mm of rainfall per year. The Sudano-Guinean zone in the Centre, the largest climatic zone, receives between 600 and 900 mm rainfall. The Sudano-Sahelian zone, the most productive zone receives over 1000 mm each year. More than 80% of the Voltaic farmers live in these last two agroclimatic zones. Together these two regions represent 89 percent of the 8,915,000 ha considered to be arable.

There are two distinct seasons in the vegetation zones of Upper Volta, a short rainy season from June to October and a long dry season from November to May. Duration of the rainy season varies from one zone to another. However, its average duration for the whole country is about 3.5 months.

2.1.2 Population

The official 1982 Upper Volta population estimate is 6.8 million people and is increasing at a rate of 2.6 percent annually. However, not all of Upper Volta's population live in the country. According to a World Bank estimate, as many as .7 million persons live and work in the neighboring Coastal countries of Ghana, Ivory Coast, Togo and Benin. Upper Volta's immigration rate, the highest among all Sahelian countries, is estimated by the World Bank¹ to be 1.7% during the period 1960-1980.

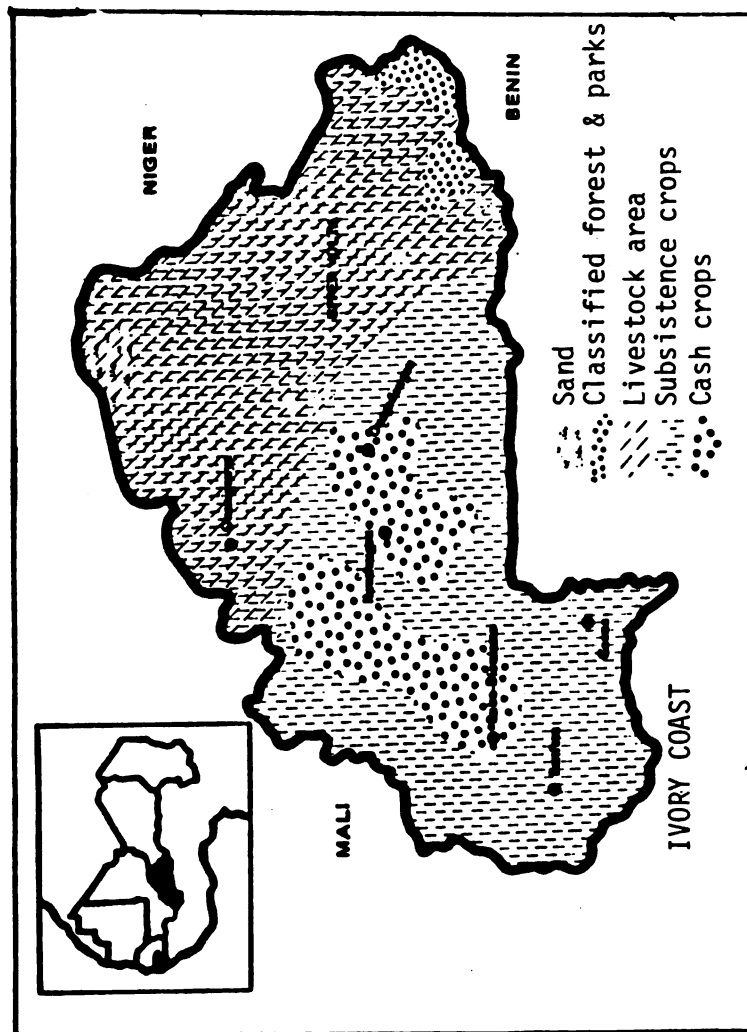
The population living in Upper Volta is located mostly in rural areas with only 8 percent living in urban areas. Population density varies widely from region to region. The Mossi Plateau is the most populated zone. Its density averages 40 persons/km² against 12/km² for the rest of the country. The total average density is 23 persons/km².

2.2 Socio-Economic Characteristics

2.2.1 The Government Policy Formulation

Upper Volta is divided into 10 main administrative regions in which are located 11 regional development offices (ORD's). The ORDs are

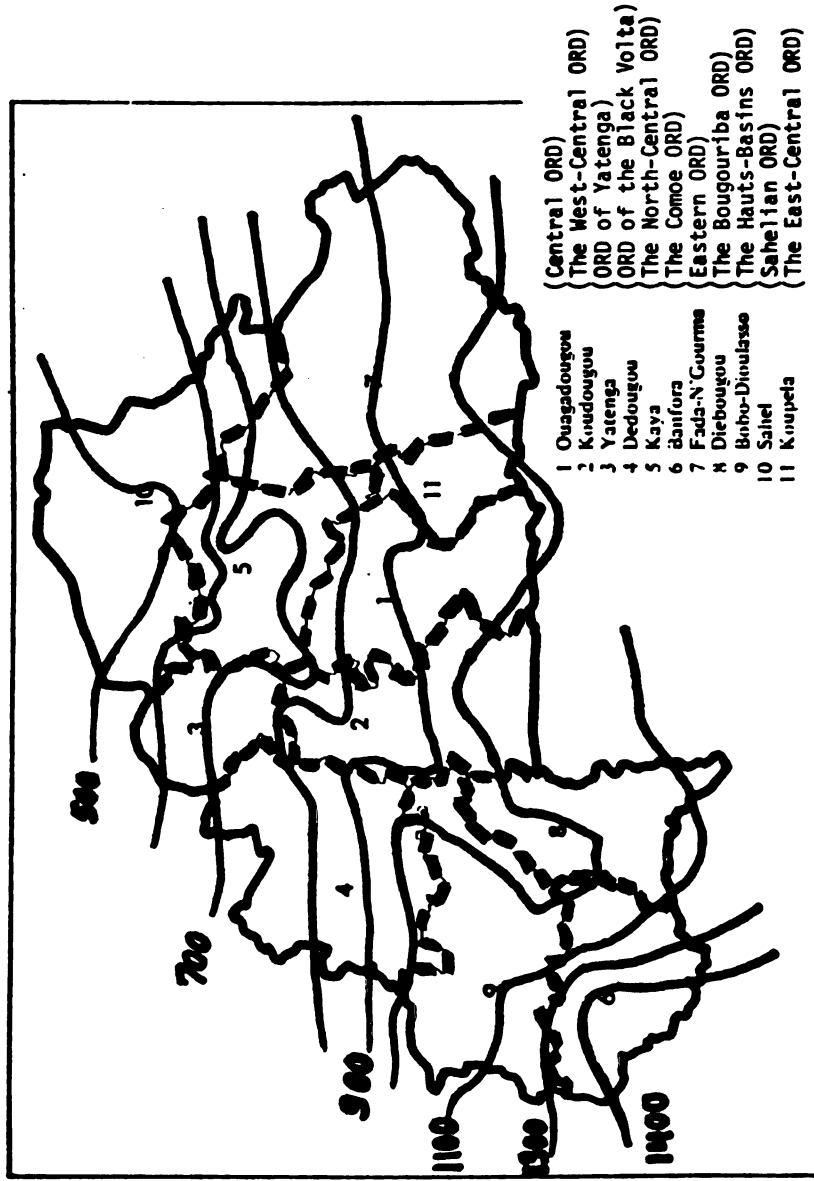
¹World Bank: Upper Volta agricultural issues study; WB report 3296 UV Oct. 1982.



Source: Adapted from IFDC: "Etude sur les engrais en Afrique de l'Ouest" Vol. 4 UPPER VOLTA, 1976.

Figure 2.1

Actual Land Use in Upper Volta



Source: Adapted from IFDC: "Etude sur les engrais en Afrique de l'Ouest" Vol. 4 UPPER VOLTA, 1976.

Figure 2.2

Rainfall in Upper Volta

responsible for all development programs in the regions and report their activities to the General Secretary of the Ministry of Rural Development.

The government's policy toward agriculture is centralized at the Ministry of Rural Development which is implemented at the ORDs and other levels. To date, the main policy objectives of the government toward agriculture have been: 1) to integrate rainfed agriculture with live-stock production; 2) to increase the development of swampland and irrigated agriculture; 3) to relocate the population from infertile soils of the overpopulated Central Plateau to the west and southwest to the new and fertile lands of the Volta Valley; 4) to achieve self-sufficiency in food crops by increasing cereal production; and 5) to encourage agricultural diversification to increase export opportunities.

2.2.2 Income Distribution

Income is unequally distributed in the country in particular between farm and nonfarm workers. Income in agriculture is generally low. It has been estimated that revenue of those working in the agricultural sector is 10 percent lower than that of nonagricultural workers. According to the FAO the average per capita revenue grew at a rate of 4 percent annually between 1960 and 1975 from 8,463 CFA to 15,551 CFA respectively (US \$34 and US \$73)¹. Within the same period, the nonagricultural per capita income increased at a rate of 7.5 percent, increasing from 29,174 CFA in 1960 to 76,090 CFA in 1970 (US \$31 and US \$355 equivalent respectively) while per capita average agricultural revenue grew only at a rate of .4 percent, or ten times lower than the national average.

¹See Appendix 2 for exchange and information.

2.2.3 Land Tenure and Use

There are no established official land tenure rights. But there are customary rules of land tenure expressed through families and lineage. The rights on a piece of land are established by cultivating the same land year after year, after receiving the land from traditional authorities such as the Tengsoba (chief of lands) in the Mossi tribe. The land can be passed from father to son, and, in a lesser degree, from son to grandson. The household chief has all rights to lands which are cultivated by his household members. He can decide to lease it or donate its control to friends or family. A lifetime right to the land may be allocated to the user but he cannot sell or trade it. In fact, there is no market for land in Upper Volta except in some towns for irrigated lands. In these cases, administrative rules of land tenure allowing private ownership prevail. In many situations, this is not done without conflicts since the sets of rules governing the land control are directed toward essentially the same public.

One can characterize Voltaic agriculture as land scarce. Not only is the total arable land area (33% of total area) small relative to the population, but about 5% of this area is not occupied as well because of endemic diseases and lack of drinking water. This raises the pressure on land, mainly in the Central region, a region densely populated which forces people to settle and cultivate on marginal lands. This fact helps explain the low productivity of agriculture and the high immigration rate which characterize the country.

2.3 Role of Agriculture in the National Economy

2.3.1 Contribution to the Gross National Product

Despite all the structural problems (insufficient rainfall, inefficient marketing systems), the agricultural sector contributes up to 40 percent of the gross domestic product (see Table 2.1). According to the World Bank, the largest share, that is, 25% of the total agricultural contribution is supplied by crop cultivation and the remainder (15%) by livestock. Table 2.1 shows that from 1965 to 1979, the relative contribution of the entire sector has consistently declined as a proportion of GDP, from 59 percent in 1965 to 38 percent in 1979. During the same period, both the GNP and the GDP steadily increased but with a relatively low per annual growth rate (4% in real terms). This might be an indication of economic growth provided by other sectors in the economy whose contribution is growing at a much faster rate.

2.3.2 Agriculture in Exports

Table 2.1 shows that the agricultural sector has contributed a large share to the total export revenue. About 33 to 50 percent of all export revenues come from the sale of livestock. This is not surprising because, after all, Upper Volta is primarily an agricultural country with more than 90 percent of the population engaged in farming.

But in 1960, agricultural exports contributed 15 percent of the total export revenue. In 1977, agricultural exports were 60 percent of total exports, in percentage terms, four times its 1960 level.

Accounting for growth in agricultural exports have been the steady growth since 1960 of cotton and groundnuts. In 1960, cotton's share of total export revenue was 2 percent. In 1977, cotton earned 41 percent

TABLE 2.1 Agriculture's Importance in the Economy
of Upper Volta, 1960-1979

Year	GNP ^a (million CFA)	GDP ^b (million CFA)	Contri- bution of Agri- culture to GDP (%)
1965	71,800	61,700	59
1966	74,300	64,700	60
1967	77,300	70,000	53
1968	79,500	72,000	50
1969	86,700	78,400	51
1970	89,400	79,300	48
1971	99,200	87,300	47
1972	103,600	89,800	46
1973	103,500	88,500	43
1974	122,100	104,500	45
1975	134,600	114,600	43
1976	146,900	122,400	39
1977	178,600	147,300	40
1978	199,400	165,200	38
1979	222,900	184,800	38

^aGNP in current market prices.

^bGDP in current factor costs.

Source: World Bank: Upper Volta, Agricultural Issues Study, Report #3296 UV, October 1982, table 1.1, p. 198.

TABLE 2.2 Agriculture's Contribution to Export Earnings, 1969-1979 (millions of current CFA)*

	Total Exports Value (CFA)	Value of Agri- culture Exports (CFA)	Contribu- tion of Agricul- ture in Exports (%)
1960	1056	160	15
1961	812	105	13
1962	1654	312	19
1963	2769	362	13
1964	3087	497	16
1965	3432	782	23
1966	3869	888	23
1967	4429	1514	34
1968	5290	2063	39
1969	5329	2637	49
1970	5055	2894	57
1971	4408	2123	48
1972	5141	2169	42
1973	5598	2497	45
1974	8702	4519	52
1975	9368	5014	54
1976	12690	10004	79
1977	13614	8208	60
1978	9524	4750	50
1979	16240	9356	58

*Values are FOB in current prices.

Source: World Bank: Upper Volta: Agricultural Issues Study, Report No. 3296, table 1.6 p. 203.

of all export revenues. Cereals are mainly consumed domestically and represent a small portion of agricultural exports. They are the smallest component of all agricultural export revenues.

2.3.3 Agriculture in Imports

Upper Volta has been an importer of some few food items, mainly cereals and flour. The share of food grain imports including food aid, to total imports increased from 2 percent in 1960 to 12 percent in 1978. It represents the main component of all agricultural imports. The data indicate that substantial imports of grains started in 1975 following the drought period.

TABLE 2.3 Share of Agriculture in Imports
(values in millions CFA)

Year	Total Imports	Cereal Imports	All Agriculture Imports	Portion of Agriculture Imports in Total Imports
1960	2715	-	-	-
1961	6992	153	557	8
1962	8551	339	742	9
1963	9382	333	748	8
1964	9484	394	903	9
1965	9169	456	916	10
1966	9293	669	1067	11
1967	8970	600	1024	11
1968	10119	458	1100	11
1969	12450	834	1412	11
1970	12963	693	1259	10
1971	13890	712	828	6
1972	15312	677	1635	11
1973	21690	1260	2034	9
1974	34664	4383	5638	16
1975	32386	2239	3308	10
1976	34423	2115	2369	7
1977	51357	3989	4404	9
1978	51083	6057	6897	14
1979	63916	6285	7810	15

Source: WB, Upper Volta, Agricultural Issues Study, Report No. 3296 UV October 1982, pg. 204. CILSS/Club du Sahel, Developpement des Cultures pluviales en Haute Volta, Sept. 1982, pg. 60.

CHAPTER III

PRODUCTION AND MARKETING

This chapter presents a brief review of the millet and sorghum industry in Upper Volta. A detailed discussion of the nature of millet and sorghum production, marketing, storage, and evaluation of some of the government policies in the cereals subsector are the main parts of this review.

3.1 Production

3.1.1 Evolution of the Voltan's Self-Sufficiency Level in Staple Food

Table 3.1 provides three indicators of the Voltan level of self-sufficiency in cereals. The first in column 6, is the rate of self-sufficiency in millet and sorghum. It is the ratio of production to net availability of millet and sorghum for consumption expressed in percent terms. This ratio varies substantially from year to year. The highest level was in 1965 (98.6%) and the lowest in 1974 (90.8%) during the last year of the drought period (1972-74). The data show that the ratio during the 1960's averaged over 97.5 percent; whereas, in the last ten years, including the drought period, it averaged 94.6 percent which represents a decline of 3% over the previous decade.

The second indicator, the rate of self-sufficiency in all cereals shown in column 5 of Table 3.1 indicates that over the past 20 years, the average rate of self-sufficiency in all cereals has been less than

TABLE 3.1 Evolution of the Volcan Level of Self-Sufficiency in Staple Food

	1	2	3	4	5	6	7
	Cereal Pro- duction (1000 T)	Millet and Sorghum Pro- duction (1000 T)	Cereal Available for Con- sumption (1000 T)	Millet and Sorghum Available for Con- sumption (1000 T)	Rate of Self-Suf- ficiency in Cereals col 1 col 3 (%)	Rate of Self Sufficiency in Millet /Sorghum col 2 col 4 (%)	Produc- tion of Cereals Per Capita (kg)
1961/62	701	606	755	628	92.8	96.5	162.3
63	876	769	928	781	94.4	98.5	198.8
64	901	776	933	791	96.6	98.1	200.5
65	1187	1038	1226	1053	96.8	98.6	258.9
66	1012	880	1067	902	94.8	97.6	216.4
67	1036	890	1089	920	95.1	96.7	217.2
68	1057	904	1095	924	96.5	97.8	217.3
69	1061	898	1103	920	96.2	97.6	213.8
70	1011	929	1067	960	94.8	96.8	199.8
71	1018	941	1066	971	95.5	96.9	197.2
decade avg.	986	863	1033	885	95.5	97.5	208.2
72	1051	973	1112	1013	94.5	96.0	199.6
73	991	912	1031	951	96.1	95.9	184.5
74	812	734	905	808	89.7	90.8	148.2
75	1160	1075	1205	1103	96.3	97.5	207.6
76	1088	1000	1136	1028	95.8	97.3	190.8
77	1196	1123	1276	1175	93.7	95.6	205.7
78	1025	960	1106	1023	92.7	93.8	172.8
79	1147	1025	1253	1106	91.5	92.7	189.6
80	1178	1041	1292	1125	91.2	92.5	191.0
81	1108	989	1194	1060	92.8	93.3	184.6
decade avg.	1076	983	1151	1039	93.5	94.6	187.5

Source: From Appendix 1 and Appendix 2 and also from FAO Production Yearbook and Tradebook series.

that of millet and sorghum (96 vs. 94.5). The rate of self-sufficiency is also declining and suggests increasing dependence of the country on the outside world for food. To some extent, this is probably due to expansion in the demand for rice.

The evolution of per capita cereal output is also given in Table 3.1. The trend shows that production during the pre-drought period of 1961-1971 averaged over 208 kg per capita; whereas, in the period following this decade (which includes the drought period) it averaged only 186 kg, a decline of 22 percent. This sharp decrease in production may be attributed to stagnation of millet and sorghum yields and/or reduction of the work force in the Central Plateau. The work force reduction has occurred because increasing numbers of younger workers have migrated to neighboring coastal countries to seek more rewarding jobs. The proportion of adult males in the work force had already declined in the mid 1960's due to internal migration toward cities. The increasing participation of animal traction as well as women and old men in the labor force has retarded productivity growth.¹

3.1.2 Actual Supply and Demand Levels of Millet and Sorghum

Millet and sorghum production destined primarily for domestic consumption, has varied from 890,000 T in 1980 to 1,250,000 T in 1983. Millet and sorghum are grown throughout the entire country and are the principal grain in the diet of most rural inhabitants. Their production

¹Analyse de la situation agro-patorale dans l'ORD de l'Est. ORD/SDP KAYA, 1980.

It is worth noting that training on how to use animal traction packages is directed to younger workers but seldom to women and old men. As a result, the latter lack of the skills and experience to make the equipment productive.

varies greatly with rainfall patterns. There appears to be a pattern of drought every two to three years and when this occurs, not only is there no surplus for export, but rather millet and sorghum may have to be imported through emergency aid programs.

Figures 3.1 and 3.2 illustrate the relationship between acreage cultivated, yields, and total productions of millet and sorghum. Factors inhibiting millet and sorghum production are many. Among the principal hampering factors are: 1) the level of the purchase price; 2) the lack of credit and "encadrement" for millet/sorghum compared to that which exists for cotton; 3) the subsistence nature of grain farming; and 4) the limited use of fertilizer and fungicides, higher yielding varieties, and other production inputs which increase output per hectare. These factors combined with the greater increase in prices for crops other than millet/sorghum in recent years, have resulted in a downward trend both in the area planted and in total production of millet and sorghum.

On the demand side, the dominant feature is that millet and sorghum are the staple foods for a greater portion of the population and as such, domestic demand is inelastic and not very responsive to changes in prices. The World Bank estimates that out of an average annual per capita cereal consumption of 152 kg, millet/sorghum consumption accounts for 131 kg. This means that the effect of substitutes in consumption, led by rice and maize, is not expected to be important.

Demand for millet/sorghum has increased as a result of recent developments in the production of bread which uses millet flour and in the widespread production of dolo (local beer) which uses red sorghum.

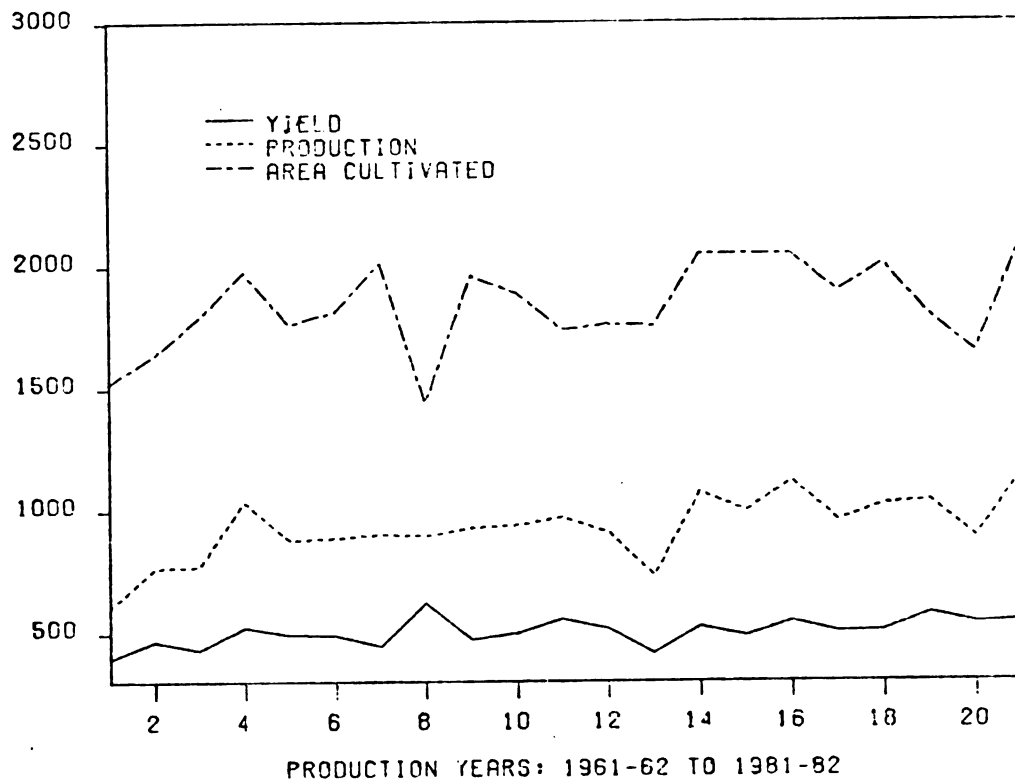


Figure 3.1

Yield Area and Production of Millet and Sorghum

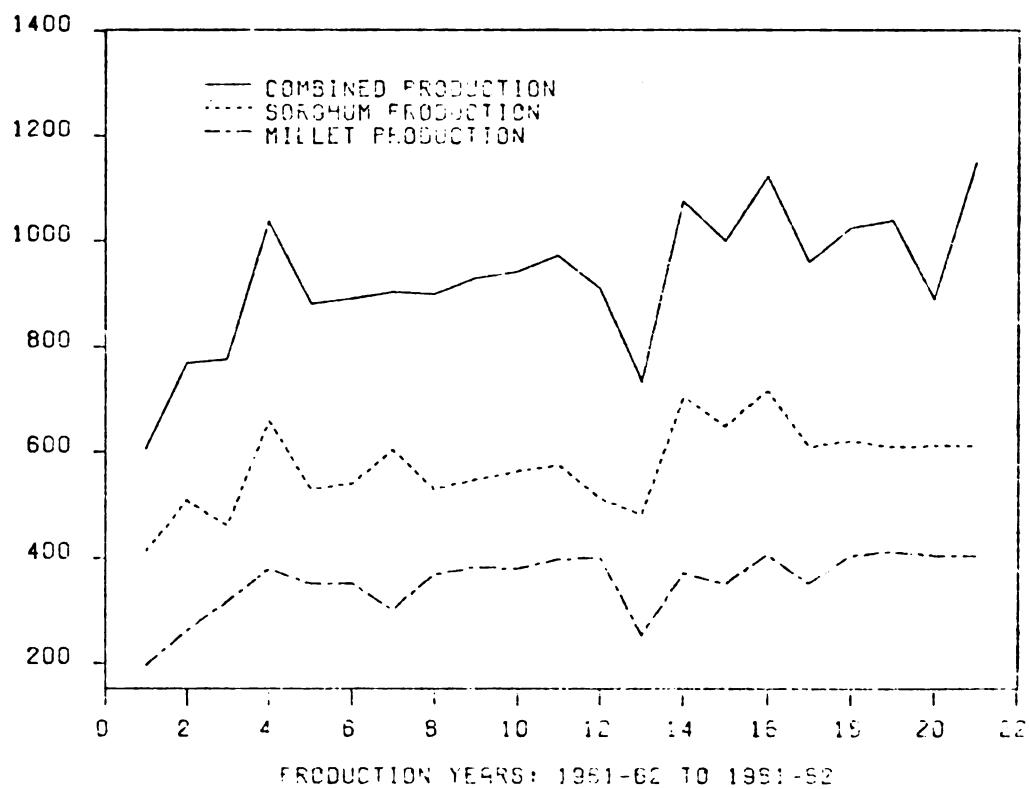


Figure 3.2
Millet and Sorghum Productions

An increasing population (see Figure 3.3) also tends to increase the demand for millet and sorghum. The population was 6.8 million people in 1982 and is expanding at a rate of 2.4 percent per annum. This means that the millet/sorghum consuming population will increase by approximately 29 percent corresponding to 23,169 additional tons needed per year over the next ten years.

On the other hand, further changes in the eating habits of the population are also taking place as incomes rise and may lower the demand for millet/sorghum as more and more Voltaic, principally those living in urban areas, are eating rice.

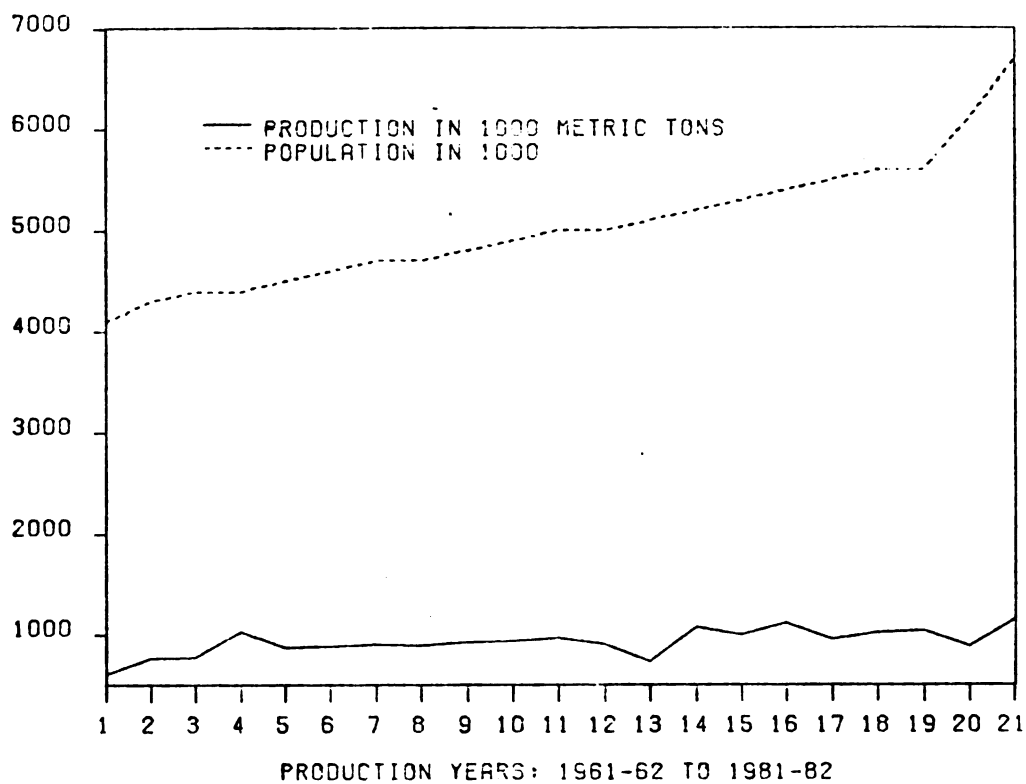
3.1.3 The Main Determinants of Millet/Sorghum Production

Production depends on the yield per hectare and the total hectares planted. The decision of the farmer on how many hectares to plant and his willingness to increase yields, thus the importance of millet/sorghum production are primarily functions of the farmer's consideration of millet/sorghum production as compared to other cash crops.

For many farmers, millet and sorghum are the only crops which yield food for households from one season to another. Furthermore these crops provide a fair amount of cash enabling them to pay head taxes and other similar financial obligations. The purpose of this section is to analyze briefly the main determinants of millet/sorghum production in Upper Volta and to explain the stagnation or decline in production since the 70s.

3.1.3.1 Acreage

Availability of land differs by region. Land is scarce in the Mossi Plateau as compared to the Eastern and Western parts of the



Source: World Bank, recent population unconfirmed.

Figure 3.3
Population, and Millet-Sorghum Production

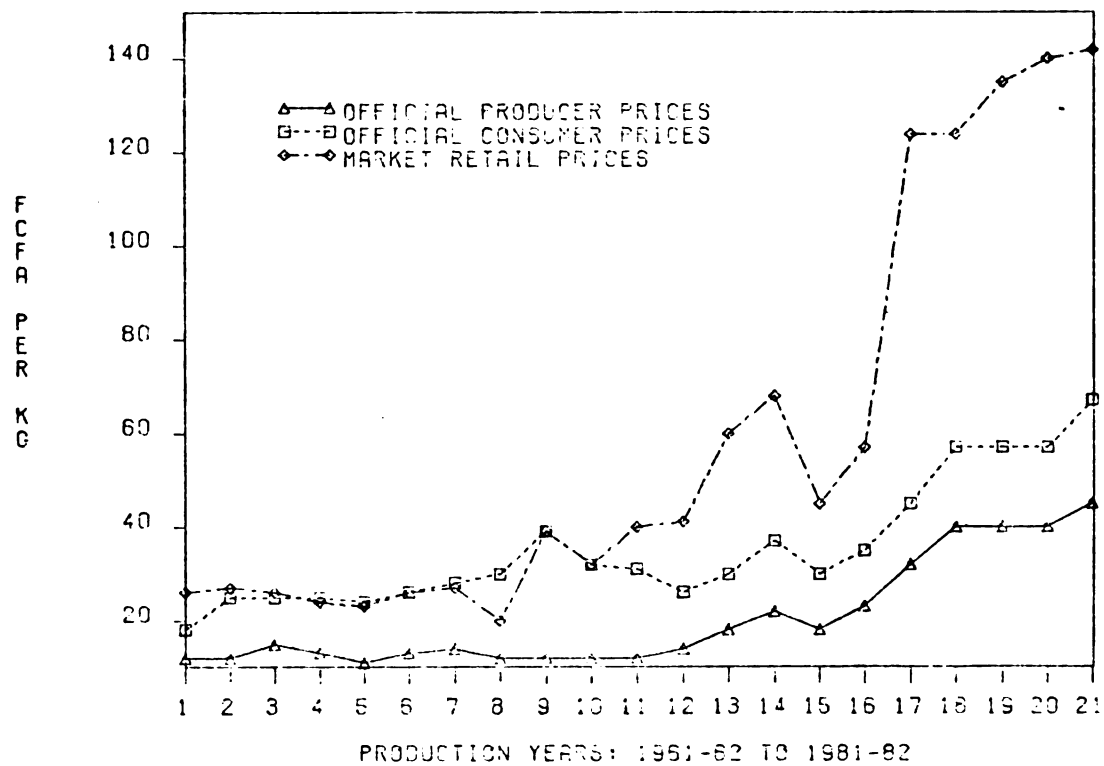


Figure 3.4

Official Producer, Consumer Prices and Market Retail Prices

country. In the Central Plateau, the scarcity of arable land is attributable to a higher population density. Almost 60% of the total Voltan population live in this region. As a result, the soils are cultivated permanently and are very poor in fertility. Farmers are forced to cultivate on marginal lands and to reduce the duration of fallow. Such practices reduce yields. In addition, the ratio of animals reared to land available is too high. Therefore, the soil is damaged by stamping. Furthermore, the vegetal wreckages¹ are used for animal food. This represents a loss for the soil.

Regional variability exists in the size of the farming unit as well as the proportion of area allocated to millet/sorghum production. According to the Direction of Agricultural Services (DSA), the estimated average farm size is 5.26 ha. However, the size ranges between 3 to 4 ha in the Central Plateau and between 5 to 7 in the Western and Southern regions.

In 1978, millet/sorghum occupied 91% of the total cultivated land in the Central Region while it represented only 75% of the total arable land in the West. However, because Western soils are favorable for sorghum production--rich soils providing higher yields--this region is also a good producer of cereals (see Tables 3.2 and 3.3). Thus, the decision of the farmer to allocate more or less land to millet/sorghum production is based on the size of the family, the relevant question being how much land will be sufficient to produce enough grain to meet the family's food requirement during the year.

¹The vegetal wreckages refer to the remaining of the plants after harvest.

TABLE 3.2 Regional Characteristics of Cereals Production and Demand (Campaign 1978)

Regions	Population (1000 ibts)	Popu- lation Density (ibts /km ²)	Cultivated Area (1000 ha)	Cereals Area (1000 ha)	Cereal Production (1000 tons)	Cereal Demand (1000 tons)
Center ^a	3417	33.0	1313	1195	521	580
West ^b	1552	14.5	680	515	400	264
East	436	6.0	210	183	106	74
Sahe1	260	7.0	140	130	31	44
Total	5665	18.0	2343	2023	1058	962

Source: Data compiled by the author from IFDC Vol. 4, Table 3, pg. 4, and Table 10 pg. 10; from FAO (1976) Table 5 pg. 20; from CILSS/OECD (1982) Table 5 pg. 25; and from ORD de l'EST: "Rapport annuel 1978-79": Table 9 p. 111. Cereals consumption per capita figure is given by FAO (1976) to be 170 kg per annum.

^a The Central Region (Center) comprehends the ORD of Ouaga, Yatenga, Kaya, Koudougou, Koupela. However, the population here (i.e. 3417) does not include the population of the cities of Ouagadougou and Koudougou.

^b The West comprehends the ORD of Bobo, Dedougou, Banfora, and Diebougou, (see Figure 2.2).

TABLE 3.3 Relative Importance of Millet/Sorghum in Cereal Production (1978-1979-1980 Average)

Regions	Area (1000 ha)		Production (1000T)		Yield (kg/ha)
	Total Cereals	M&S ^a	M&S as % Total Cereals	Total Cereals	M&S as % Total Cereals
1. WEST	577010	475902	82	455830	77
Black Volta	237440	215077	90	175078	89
Hauts Bassins	121880	87182	71	125840	72
Comoe	81830	51163	62	75320	48
Bougouriba	135860	122480	90	79600	87
2. EAST	167608	156276	93	94350	90
3. CENTRAL	1095350	1042156	95	487260	94
4. SAHEL	140000	138500	99	43000	99
				42935	99
				310	

Source: Compiled by the author from CILSS/OECD (1980) and from World Bank (1982) opt. cit. p.202.

^aM&S = millet and sorghum.

Farmers' allocation of land to millet/sorghum production is also affected by the availability of family labor, rainfall, plant disease, insect attack and more importantly, by the quality of the soils. There are no reliable estimates of the quantities of labor input used in the production of millet and sorghum. According to a World Bank document, traditional cultivation of sorghum requires 70 man days per ha in the center, 85 and 75 man days per ha in the southwest and east, respectively.

In general, labor is not a limiting factor at the beginning of the season because seeding is not a very complicated job. As a result, large areas are quickly planted. However, total labor available is greatly reduced during weeding time and particularly during the first weeding. During that period, women labor is focused in their groundnut and okra fields. As a result, the weeding task in the millet and sorghum fields is not done which depresses yields.

3.1.3.2 Yields

There are many factors that determine yields: social, economic, and biotechnical. Biotechnical factors include soil, climate, date of planting, insect attacks, plant diseases, etc.

The economic incentives affecting millet and sorghum yields are the official purchase price of millet/sorghum, i.e., its relative profitability as compared to other food and cash crops. Also important is the relationship between the farmer's household and the village community, his choice of production technology, and the nature and the availability of hired labor. All these factors play important roles in the farmer's yield.

The average yield of millet/sorghum is estimated to be between 400 and 450 kg/ha (Euro Consult 1980). This appears quite low when compared to the 900 kg/ha yields of the research stations. Figures 3.1 and 3.2 and the time series data on yields on Appendix 1 indicate a declining trend for millet/sorghum yields with no change in total area planted (see Figure 3.5) reflecting the decreasing availability of arable land and the poor fertility of soils. The "Sous Commission de la Production Vegetale" (1980) reports that the low yields per hectare of millet/sorghum are mainly due to the unavailability of varieties which are well adapted to the different soils and climates. But this is not the central issue. As long as the research centres and experiment stations are isolated from farmers' reach, and as long as the price of fertilizer, spray materials and traction equipment remain high, the resource allocations of farmers will remain the same with no improvement in millet/sorghum production. Thus economic, social and institutional factors are as important as the biotechnical factors in determining yields.

Market difficulties, lack of adequate storage policies, and lack of coordination at the government level for establishing long term and durable cereal expansion policies are other elements that affect yields.

3.1.4 Supply of Agricultural Inputs

3.1.4.1 Fertilizer

In Upper Volta, there are two kinds of fertilizers that can be applied to cereals: chemical fertilizers and natural rock phosphate. Chemical fertilizers are imported. Consequently, they are available only in the two major towns, Ouagadougou and Bobo-Dioulasso. The

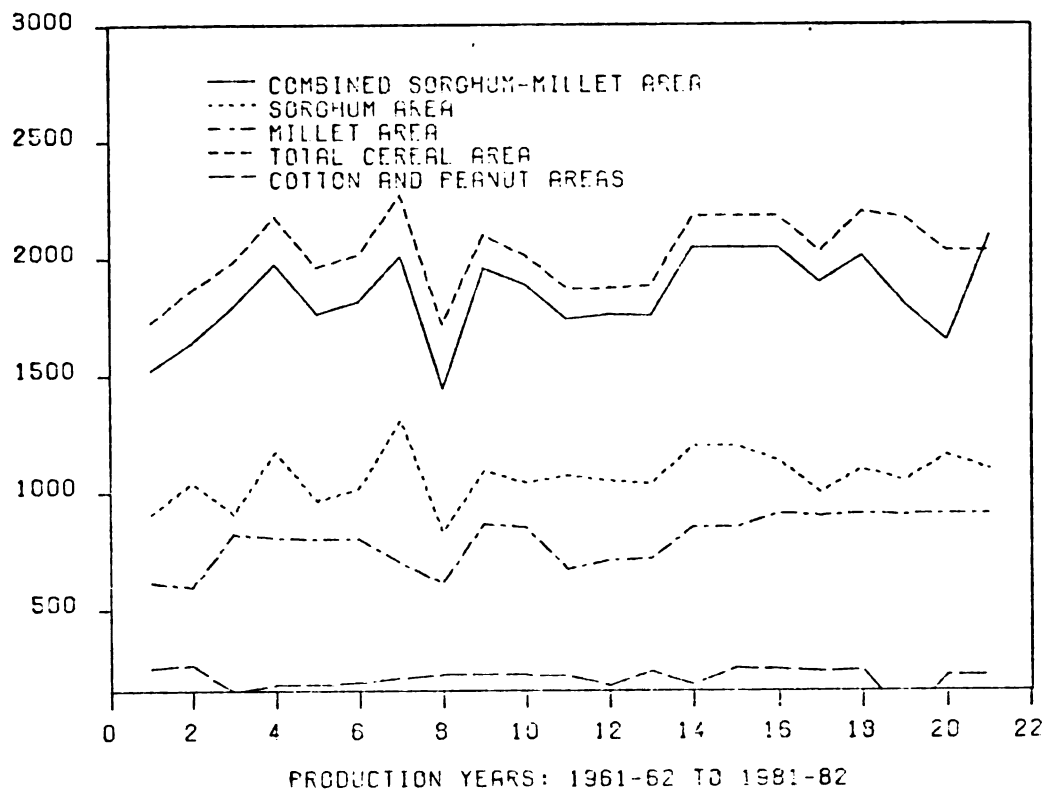


Figure 3.5
Areas Cultivated

natural rock phosphates are produced at Kodjari in the eastern part of the country.

Until 1978, Sofitex (government service responsible for cotton production and marketing) was the sole importer and distributor of chemical fertilizers in the country. Fertilizers are brought into each cotton zone at the Sous Prefecture level and then, to the village level by the ORD's extension agents. In 1978, Sosuhv (the government society responsible for sugar production) joined Sofitex in fertilizers importation, therefore increasing its use and availability in the country. The World Bank (1982) estimates that total imports of fertilizers grew from 500 to 16,000 T between 1965 and 1978. While chemical fertilizers give the farmer the opportunity to increase yields by increasing the fertility of the soils, SDP/ORD (1980) argues that the use of chemical fertilizer alone is not beneficial and is even disastrous in the long term. The use of manufactured fertilizer for millet/sorghum production should be coupled with manure. They found that a combined use of fertilizer, manure, animal traction and erosion control can double the yields for sorghum.

However, use of fertilizer on millet and sorghum fields is quite uncommon. Only 5% (mainly cotton fields) of the total cultivated lands receive chemical fertilizers at a low level usage (6 kg/ha for food crops). The high price of fertilizers, about 35,000 CFA per metric ton, puts it out of reach for most cereal farmers.

3.1.4.2 Pesticides

Pesticides (endrine) are provided by Sofitex and also by the Service Nationale des Semences. Farmers are familiar with this product.

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100.

In fact, they use it in their houses to kill insects as well. Like in the case of fertilizer, the use of pesticides on millet/sorghum fields is not widespread. They are mainly used in cotton fields. Their cost is high and there is a limited quantity of spraying material available, but their contribution to increased yields is well documented. However, the lack of extension agents to show farmers how to use pesticides and the low level of education of the farmers and the extension agent are constraints to increased production through insecticide use.

3.1.4.3 Seeds

The ORD's agents are responsible for the distribution of millet and sorghum seeds to farmers.

Improved seeds are provided to ORD's by the Service National Semencier based at Ouagadougou which is responsible for the production and marketing of some selected seeds. The remaining seed needs are placed under the responsibility of each ORD to produce them. But the ORDs', faced with financial difficulties and lack of qualified personnel, have been unable to provide guaranteed high quality improved seeds to farmers. In addition, farmers could not get the product on time due to ORD's bad management. Furthermore, although the price of improved seed is not too high in absolute terms, it was quite high in relative terms since the product is sold to farmers in bags of five kg, making it unaffordable by the average farmer.

Considering the risk involved and without proof that the new variety is better than the local ones, farmers are reluctant to adopt new improved seeds. According to the World Bank (1982), from 1975 to 1979, the annual average production of certified seeds amounted to 210/metric tons with only 12% reserved to millet and sorghum.

12

3.1.5 Sources of Credit

The purpose of this section is to describe how and where millet and sorghum farmers get most of their credit. Credit sources can be divided into two groups: institutional and individual money lenders.

3.1.5.1 Institutional Money Lenders

3.1.5.1.1 Public Institutions

Farmers receive most of their credit from the different ORDs' and from the Rural Development Fund (FDR). Both ORDs and FDR receive their funds from the National Development Bank (BND). This was a joint venture where the ORDs serve as intermediaries between the Bank and the pre-cooperative or village groups of young men and women. Under the joint venture, most of the credit offered to farmers was for short term input purchases. The ORD's were given the role to select potential farmers eligible for loans, to process the money or inputs to farmers, to give the necessary technical support, and to collect the repayments for the Bank. At the ORD level, this job carried out in the field by the extension workers in addition to their usual tasks. The FDR has a role similar to that of the Bank but with emphasis on animal traction equipment and low lands development.

The BND/ORD joint venture ended in 1978. Various problems contributed to the collapse: a lack of qualified personnel to handle the loan operation at the ORD level, use of inappropriate criteria of eligibility for credit, confusion of roles between the extension worker and the credit agent, use of reimbursement by some ORDs to finance their own operating expenses, and embezzlements. In 1980, the BND was replaced by the CNCA. The ORD continues to play the same role as before. However, in

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each ORD, a CNCA - financed controller was attached to strengthen the ORD's personnel but nothing was introduced to increase the volume of credit destined to farmers.

3.1.5.1.2 Interest Rates

During the BND/ORD joint venture, the share of agricultural credit amounted only to 5 to 10% of the total credit granted as compared to 30 to 35% for the industrial sector. In 1975, this share was estimated to be approximately 5% for the agricultural sector and 95% for the industrial sector.

During the joint-venture, the interest rate charged by the BND to the ORDs for both short and medium term credit was 5.5%. A maximum of 12 and 24 month repayment period for short and medium term credit respectively were allowed to the ORD for the full repayment of the loan. Any ORD with total debts amounting to 20% or more is no longer eligible for a loan.

Interest rates charged individual farmers are higher and more complex. In the case of equipment (or medium term credit), if the farmer pays 50% of the total credit amount, the credit is granted to him at 11 percent interest rate on the remaining amount to be paid within 12 months. With 35% cash payment, the interest rate is 8% charged on the remaining amount to be paid in 24 months. During the agricultural campaign 1981-1982, the first operational year of the CNCA, the interest rates charged to individual farmers averaged 13% for both medium and short term. This is an increase of 62 percent over the eight percent levied during the BND/ORD joint venture.

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While the CNCA represents an improvement in the agricultural credit system, its higher interest rate charges limit the demand for credit at the farm level.

3.1.5.1.3 Private Institutions

Generally speaking, there are no private lending institutions, but there are external donors such as government organizations including IDA, USAID, FED, Conseil de l'Entente and also by some nongovernmental organizations such as Oxfam, Club 4C etc. These donors, through the ORDs' intervene in specific projects that do not often benefit the poorer farmers. Their credit is mainly oriented toward animal traction equipment, to creation of cereal banks, infrastructure, and financial supports to some larger businesses.

Between 1972 and 1980, the total external financing for agricultural development amounted to 51,714 millions CFA or approximately 6,464 millions CFA on average per year (WB 82). However, more than 70% went to infrastructure and financial assistance.

3.1.5.2 Individual Money Lenders

Individual money lending is a common practice among millet/sorghum farmers. It involves small amounts of money but plays an important role in agriculture. According to Tapsoba,¹ an average farmer in the Eastern region borrows 1,500 CFA per year.

Private grain traders are also a source of credit for millet/sorghum producers. However, their credits are used only indirectly for production

¹Tapsoba E.K. (1981), An Economic and Institutional Analysis of Formal and Informal Credit in Eastern Upper Volta: Empirical Evidence and Policy Implications. Ph.D. Dissertation, Michigan State University, 1981.

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purposes. Most of their transactions occur during the "hungry season," August-September. At that time, the granaries are empty. Private traders operating through selected farmers provide cash to the needy households. The repayment is most often made in kind (grains of millet/sorghum) at the disadvantage of the borrower. Interest rates charged by private traders are very high. They can vary between 20 to 100 percent.¹

The second group of individual credit lenders are the farmers themselves. Within the village, credits are exchanged between individual farmers. These credits are in kind or in cash. Tapsoba reports that in the Eastern ORD, only 34% of all individual money lending transactions provided by farmers are in kind. Over 90% of borrowing in kind is in the form of millet and sorghum. In kind borrowing of millet and sorghum is for consumption purposes as well as for planting purposes.

Cash borrowings, much more important than in kind borrowing, is mainly used to meet social obligations such as funerals, weddings, family expenditures, or other social events. They are seldom used for production purposes. Neither the terms of repayment nor the interest rates are known. Although in kind borrowings are often due at harvest time.

In summary, Voltan farmers can get credit from three main sources: the ORDs, the private grain traders, and from other farmers. Credit provided by the ORDs are the most important of the three. These credits concern both medium-term credit for animals and equipment for animal traction and short term credit as well.

¹Societe Africaine d'Etude et de Developpement (SAED); "le Credit agricole"; bulletin No. 23, 1976.

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The short term credits are given to groups of producers or cooperatives, but seldom to individuals directly. Short term credits are used to purchase inputs like seeds, fertilizer and insecticides.

Upper Volta has no means to mobilize local financial resources for investment in agriculture (Vincent Barret et al. 1980). The bulk of the credit to farmers is provided by outside sources using the ORDs as intermediaries. At the ORD level, the lack of qualified personnel to manage the different loan programs, the difficult and confusing criteria for selection of farmers who will benefit from credit and the addition of credit collection and distribution functions to the already fully occupied extension agent, all make the system perform less adequately. Interest rates are high for farmers. Rates of collection are low. Embezzlements are frequent.

Credit transactions made by private grain traders as well as credits exchanged between farmers are also important in volume. Unfortunately, they are not oriented toward production. A large part of these transactions occur during the "hungry season" for consumption purpose.

3.1.6 Government Extension and Research on Millet and Sorghum

There are three types of agricultural research in Upper Volta: crop improvement, agronomy and farm management. None of them is working well. The reason for this situation lies on three major arguments:

1) there is no clear national research policy; 2) there is lack of adaptive research; and 3) there is lack of coordination.

1) Lack of Research Orientation

Upper Volta has no established policy in agricultural research. There are however, many agencies involved in field or station work, each

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doing what it wants to do. There are no national guidelines to follow in conducting their research. Financially independent, they plan and execute their own programs with varying degrees of concern for the recommendations made to them.

2) Lack of Research Adaptability

Research in millet/sorghum in Upper Volta is not well adapted. Crop research represents 80% of the total agricultural research fund. The objective is mainly to select seed varieties which are high yielding and resistant to drought and disease. Since researchers were free to do whatever they want, their research is not focused on real problems faced by farmers. As a result, their recommendations are most often inconsistent with the farmers' actual conditions.

3) Lack of Research Coordination

There are 20 agencies and 5 major institutes that are engaged in crop production research in Upper Volta. Some evidence indicates many overlapping research projects in which some agencies are doing the same research in the same regions at the same time. As a result, some regions such as the southwestern and central regions are heavily emphasized while others like the eastern and northern regions are almost forgotten. Furthermore, research has long focused on cash crops, mainly cotton, and has neglected millet/sorghum.

3.1.6.1 Government Organizations and the Nature of Research in Millet/Sorghum

Since 1981, research organizations are placed under the Institut Voltaïque de Recherche Agronomique et Zootechnique in the Ministry of Higher Education. This institute replaces the former Institut de la

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Recherche Agronomique (IRA) which was under the Ministry of Rural Development.

IRA still controls most of the resources and personnel, making the new arrangement less effective. As a result, agricultural research is extremely dependent upon foreign institutions. There are five of them with only two (IRAT and ICRISAT) working on millet/sorghum.

3.1.6.1.1 IRAT

IRAT is a long-established institute in Voltan agricultural research history. Its activities are broad and cover both fertilizers and cereal variety selection as well as new agricultural practices intended to improve farming conditions. Its work on millet has included the testing of a new short-cycle and disease-resistant variety at Linoghin and Saria (experimental stations located in the AVVs' zones).

With respect to sorghum, the institute is working on short-cycle and high-yielding Senegalese varieties. Per hectare yields are expected to reach 7,500 kg. The 5,174, another long-cycle, high-yielding and good-tasting variety, has been successfully tested. If promoted adequately, its adoption by farmers can improve Voltan agricultural production performance.

3.1.6.1.2 ICRISAT

This institute is based at Kamboinse, near the capital city. Basically, it is doing the same kind of research as IRAT. It tries to select resistant and high-yielding varieties of millet/sorghum and tries to find ways to cultivate them extensively without extensive soil damage.

In summary, agricultural research in Upper Volta indicates a strong tendency towards production oriented research. Selections of high-yielding

varieties resistant to drought and disease is the main objective in the research for millet/sorghum. So farmers are not convinced that these new varieties are really superior to the local ones.

It is time for researchers to go one step further and include marketing research. This will help to improve supply and demand analysis, projections, for better policy formulations.

3.2 Marketing of Millet and Sorghum

In principle, farmers produce millet and sorghum for their own consumption. Sales occur only when there is an excess of production over own consumption. It is very difficult to determine the quantity which is marketed and that which is consumed at home. In 1974, the marketable surplus for all cereals was estimated to be 30,000 metric tons out of a total production of 1,004,300 tons.¹ Out of the 22,400 T that was marketed, millet and sorghum amounted to 15,786 T, or about 71%. The CILSS estimates that on the average nearly 15% of the total production is marketed each year through official and private channels while about 80% is home-consumed. The remaining 5% are seeds and losses.

3.2.1 Marketing Channels

In Upper Volta, millet and sorghum are marketed either privately or in the public market. Knowledge is limited on the importance and the performance of the private channel. The public circuit is dominated by private traders who collect large volumes that allow them to manipulate prices. This prevents Ofnacer (the state cereal board) from realizing

¹Figures are from: "Sous Commission de la Production Vegetale: definition d'une politique cerealiere" p. 3, n.d.

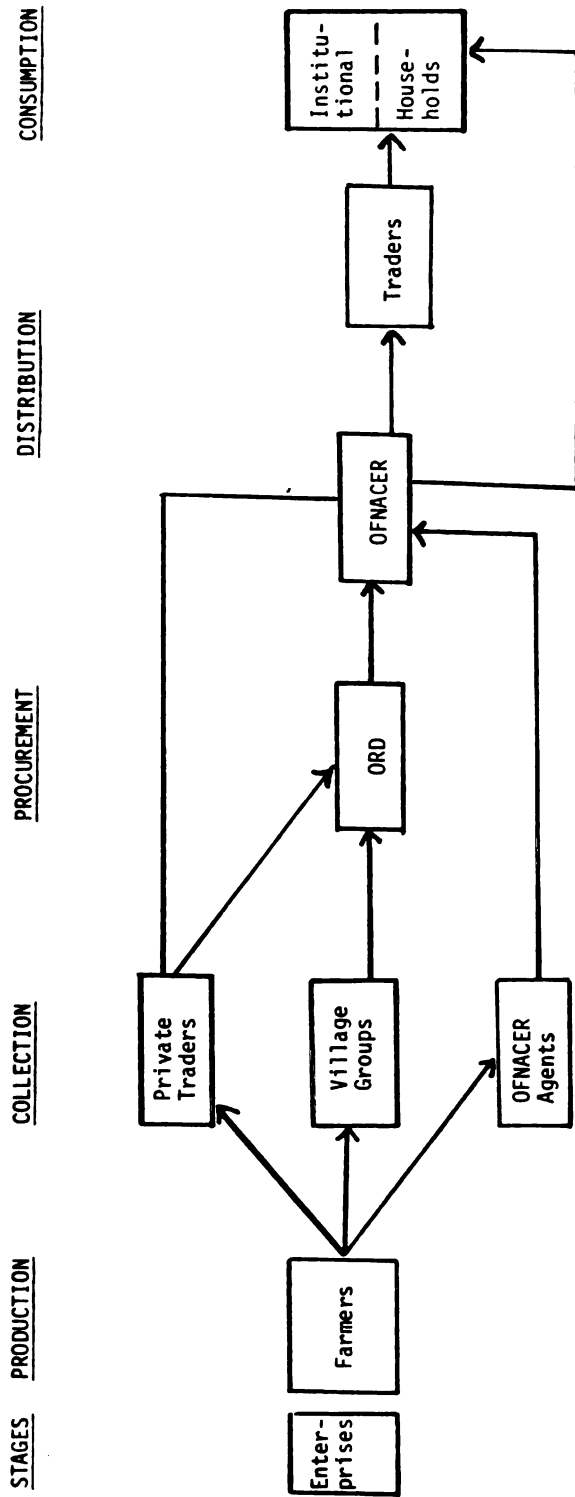
some of its basic objectives which are: 1) to provide farmers a stable and acceptable price for their product; 2) establish a stock in order to reduce seasonal price fluctuations and regional deficits; 3) establish a security stock for eventual drought period; and 4) to transfer cereals from regions where there is overproduction to regions experiencing shortages. Figure 3.6 shows marketing channels for millet and sorghum in both public and private sectors.

3.2.1.1 The Public Marketing Circuit

Ofnacer created in 1971 has a general monopoly on the collection and marketing of millet and sorghum. How Ofnacer gets the grain from producers is explained in Figure 3.6. Authorized dealers and groups of young men are responsible for the collection of millet and sorghum grains at the village level. Grain collected by the groups goes to the ORDs which provide the money for that purpose. In 1979, there were 3,584 registered village groups in more than 7,000 villages. Today, with the widespread creation of village cereal banks, a substantial part of the grain collected stays at the village level in these banks.

Ofnacer agents also intervene in the grain collection at the village level. But to date, their effectiveness has not been demonstrated. In 1978/79, out of 15,300 metric tons of millet and sorghum collected, 7,000 tons was bought directly by Ofnacer's agents, 4,100 tons by village groups, 2,900 tons by unlicensed traders, and 1,300 tons by licensed traders as indicated in Table 3.4 below.

Grain collected by the licensed traders, those who are legally entitled to engage in the grain trade, can be sent to either the ORDs or directly to Ofnacer. Grain purchases by ORDs through the different



Source: Adapted from John W. Kohering: Upper Volta: Grain Marketing Development.
Project No. 686-0243, p. 90. USAID OUAGADOUGOU. Upper Volta, n.d.

Figure 3.6

Flow Chart of Legal Grain Marketing Channel in Upper Volta

TABLE 3.4 Ofnacer Grain Purchases, 1978/79

| Regions | Ofnacer
Agents | Village
Groups | Li-
censed
Traders | Unli-
censed
Traders | Total (Mt) |
|----------------|-------------------|-------------------|--------------------------|----------------------------|------------|
| Fada N'Gourma | 913 | - | - | 301 | 1214 |
| Koupela | 1387 | 87 | - | 23 | 1497 |
| Kaya | 1 | 21 | - | - | 22 |
| Ouagadougou | 1831 | 1513 | 305 | 609 | 4258 |
| Koudougou | 361 | - | 150 | 66 | 577 |
| Ouahigouya | 72 | 128 | 61 | 3 | 264 |
| Dedougou | 2265 | - | 365 | 640 | 3270 |
| Bobo-Dioulasso | 128 | 2217 | 357 | 1175 | 3877 |
| Dori | <u>113</u> | <u>126</u> | <u>15</u> | <u>52</u> | <u>306</u> |
| Total | 7071 | 4092 | 1253 | 2869 | 15285 |

Source: John W. Kohering: opt. cit. p. 88.

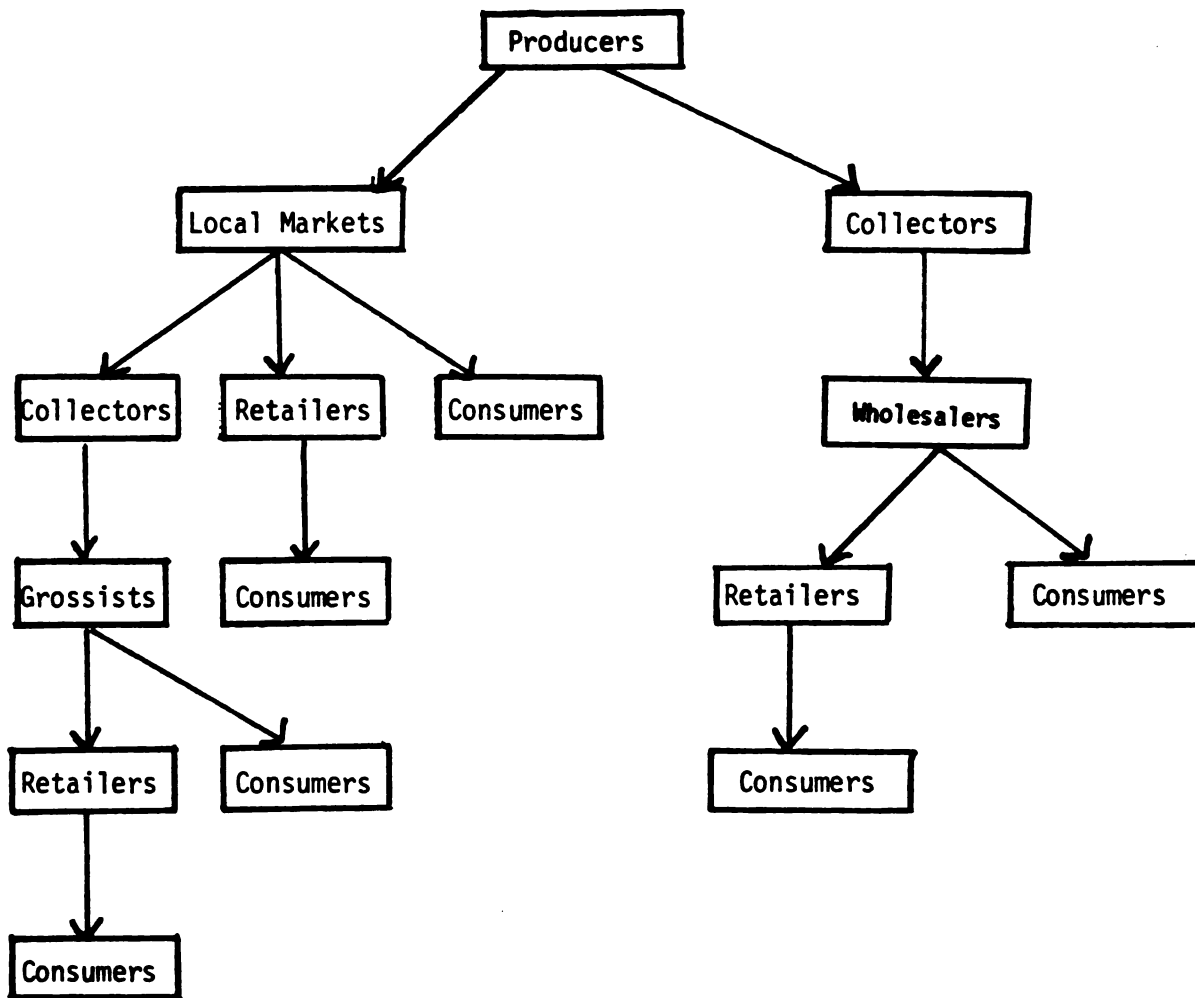
village groups are then turned over to Ofnacer which sells them directly to urban consumers or retailers (see Figure 3.7).

Reliable sources estimate that since its creation in 1971,¹ Ofnacer purchases and sales of coarse grain marketed, or 1% of the total annual production. Many reasons explain the weak performance of Ofnacer in the grain trade. First, Ofnacer has a primary role of distributing food and grain to the deficit areas. The continuing drought has stressed this role. As a result, the office has put too much emphasis on the distribution side rather than concentrating on grain collection and marketing. Secondly, the lack of funds and personnel have prevented Ofnacer from competing with private traders. Ofnacer starts its buying campaign too late when the farmers, tired of waiting, have already sold their products to whomever it can at a price which is often lower than the official price. Third, Ofnacer lacks sufficient transportation and storage capacity as well as authority, unlike the other national institutions also involved in the grain trade, such as: the ORDs and the food security organizations, "Comite National et Sous Comite de Collecte de Cereales." These reasons explain the board failing to carry out its initial tasks, and concentrating essentially on distribution of food-stuffs assistance.

3.2.1.2 The Private Marketing Channel

Marketing of millet and sorghum through private or traditional sector is well developed. With this circuit, the producer has many options to sell his produce. He can sell it at the village level markets to

¹ John W. Kohering: Upper Volta: Grain Marketing Development, opt. cit. p. 87.



Source: John W. Kohering: Upper Volta: Grain Marketing Development. Project No. 686-0243. p. 90. USAID, OUAGADOUGOU. Upper Volta, n.d.

Figure 3.7

Flow Chart of Traditional Grain Marketing Channel in Upper Volta

consumers or to retailers and collectors. The produce is then sold by the retailers and collectors to wholesalers who then, turn it over to small retailers for the benefit of the final consumer as indicated in Figure 3.7.

Farmers' marketable surplus can also be bought directly at the farm level by the collectors. The grain is then, turned over to grossists who sell it to retailers and consumers.

Private traders play an important role in the grain trade. Both licensed and unlicensed traders control 80% of the cereal trade business. There are three main reasons why private traders are so successful in collecting the grain as compared to Ofnacer and the ORD's. First of all, although they don't offer a better price, they share production's risks with farmers by providing them cash credit during the "soudure"¹ and, on occasion, by buying the crop in the field rather than after harvest. Second, the poor transport systems make some remote areas unattractive for the official traders who leave them to the private ones.

Ofnacer's ongoing policy is to buy large amounts of millet and sorghum to be marketed so that it can force the producer prices up and the consumer prices down. This is a good policy. Unfortunately, there is no cooperation from farmers for whom the only strategy is to sell their produce on a first come first serve basis. Their decisions are dictated by the need for money, the lack of adequate storage capacity, the lack of official marketing structures at the village level for grain collection, the inability of the government organizations to get funds to buying points on time and to purchase all offered supplies.

¹Soudure is the hungry season we were talking about in our introductory chapter.

3.2.2 Marketing Services

Marketing services include transportation, storage, processing, grading, packaging and risk sharing. The purpose of this section is to identify those who are performing these services and how well they are performing them. Since grading and packaging services are of minor importance in millet and sorghum production and marketing, we will not discuss them here. These services are not well developed yet.

3.2.2.1 Transportation

Transportation is an important function in millet and sorghum production and marketing. From the field to the granary, transportation of harvested millet and sorghum is made by head, by donkey carts or by bicycle. But neither of these means of transportation can carry large volumes. As a result, most harvested crops stay longer on the field, increasing the risk of losses from animals, birds and insect attacks, and destruction by late heavy rains. The planning bureau of the Kaya ORD has estimated that between the field and the granary, there is about 10% grain losses.¹

The lack of good transportation infrastructure causes a serious bottleneck in cereal distribution. Transportation problems limit the quantity of millet and sorghum to be marketed since those who want to sell their produce do not have the means to bring large quantities to the market place. High transportation cost is the prime bottleneck in millet and sorghum marketing for both private and public traders. According to the World Bank, transportation cost represents 42% of all

¹ORD def Kaya. Bureau of agricultural planning and economic analysis (BAEP), "Enquetes microeconomiques, 1980." KAYA, Upper Volta, 1980.

marketing costs incurred by private cereal traders. Transport costs as a percentage of total marketing costs are much higher for the central, northern and eastern regions than for the western and southeastern regions. In the former case, transport distances are much longer because millet and sorghum production is spread out over a much larger area and villages are widely dispersed. Transport costs are very high because of the poor roads and the long distances involved in moving the grain from the producing to the consuming areas, or from internal distribution points to village consumption areas.

Ofnacer's financial problems come mainly from its operation in the central and northern regions. In these regions its trucks often travel long distances to pick up or to deposit small loads and most of their runs are one way pay loads. Furthermore, collection of grain from producing areas and its distribution to consuming areas are spread out over the year due to Ofnacer's lack of internal organization. As a result, trucks and vehicles remain in operation for a full year, running empty over hundreds of kms daily. This shortens the vehicles working life. As of March 1980, Ofnacer transport capacity was estimated to be 318 metric tons out of which 69 tons, equivalent to six broken vehicles, go unused.¹

One way to reduce transport costs is to abandon collection operations in marginal production areas, or to pay lower producer prices in these areas in order to compensate for high transport costs. Unfortunately, this will lead to a complete take over of these areas by

¹U.V. Bureau des Operations speciales de secours (OSRO): Rapport de Mission FAO/PAM sur l'Evaluation de la situation alimentaire. Rome, March 1980.

private traders who, until now, seem to be against the government policy. Instead of the present policy of pan-territorial pricing, Ofnacer could charge a higher price to reflect the higher cost of service. But there would also be the risk that this price differentiation may lead to serious social unrest that any government would not like to face.

3.2.3 Storage

Millet and sorghum are stored at two main levels: rural and urban areas. Farm or rural level storage of millet and sorghum is undertaken by producers just after harvest. Granaries are the most common means of storage. Their size and also the material used to make them vary from one region to another. In the central region, they are made of straw while, in the southwestern, they are made of banco (mud-brick silo). In the first case, millet and sorghum are stored in "epis" (grain in the ear) without any processing. In the second case, only treshed grains are stored.

In Upper Volta, it is assumed that there is enough storage capacity at farm level. Euroconsult (1980) estimates that storage losses at farm level from attacks of insects and rodents or from excess moisture are less than 5%. This is a good indication of efficiency. However, that efficiency could further be increased by providing small and flexible credits for storage or to allow farmers to get storage chemicals (e.g. phostoxin). This will increase the quality of the grain and, in addition, allow farmers to wait to sell their produce when prices are attractive. This is the bottom line of the development of village level cereal banks policy. However, it should be kept in mind that increased technology of farm level grain storage is associated with increased

costs. For instance, the average annual storage cost at farm level is estimated to be about 1,180 CFAF per ton at 1973 prices.¹ This cost is not high when compared to the modern storage systems that total 6,680 CFAF per ton. But its high enough for a relatively less monetized economy (villages) where most farmers consume the bulk if not all of their grain within 7 months.

Urban storage of millet and sorghum is undertaken by Ofnacer and some private traders. Millet and sorghum are either packed in sacks and/or stored raw in silos or warehouses. Storage losses with these systems are estimated to be .1 and 1 percent respectively.²

The government marketing board policy on storage comprises two main objectives: 1) to ensure the availability of an emergency or security stock; and 2) to maintain a stabilization or buffer stock.

The objective of the stabilization stock policy is to regularize supplies of coarse grain between harvests. The security stock on the other hand is to assure supplies over time and to palliate crop fluctuations or to offset severe production shortfalls. The overall capacity for both kinds of storage is estimated to be about 52,500 tons³ exclusive of private storage capacities. This is 28% below the minimum required stocks suggested by FAO and which amounts to 67,000 tons.

¹David Wilcock: The Political Economy of Grain Marketing, Feb. 1978 WP No. 24, p. 117. Converted in CPA using exchange rate release by the World Bank. U.V. Livestock Subsector Review, Nov. 1982.

²Option cit. p. 23.

³OECD/CILSS: Development des cultures pluviales en Haute Volta, p. 97 Ouagadougou, Upper Volta, September, 1982.

3.2.4 Risk Bearing

In a previous chapter, we indicated that millet and sorghum are risky crops which may yield revenue to the farmer in one year and little or none in another year. Here, we are interested in identifying who assumes the risk in millet and sorghum production and marketing process? By risk, we mean decrease in revenues due to production shrinkages, quality deterioration and decrease in prices as a result of an uncertain event. The risk is assumed by the farmers during the production period yet the private traders also share in the risk because they buy the crop prior to harvest. The cost is then passed along to consumers and producers in two forms: higher consumer prices and lower producer prices. The government does not share in any risk because most of its interventions come after harvest and on a limited scale. It can be concluded that the government's willingness to share in the risk may help to attain its long-standing goal of food grain self-sufficiency.

3.2.5 Pricing Policy

Millet and sorghum producer prices are set each year by the government at the end of November following harvest for the current production. The official price for government purchase is fixed for the crop year while for both producer and consumer, the market price fluctuates. The price determined by the government is to some extent arbitrary and does not take into account production costs, market information and supply and demand levels. Official prices are too low, thus, providing little or no incentives to farmers. Figure 3.4 shows that official prices have always been lower than the market price. The latter has dramatically increased following the drought period.

With regard to the pricing policy, a relevant question is whether it is justified for the government to follow the structure of fixed annual prices. In the first place, there is no problem if in fixing the price to be paid to the producer, sufficient inducement is offered to maintain or to expand his production. More flexible credits at lower interest rates, subsidization of key inputs, continuing education for both farmers and extension workers are some of the possible inducements. The government has no incentives of these kind. Therefore, setting an adequate producer price may help to achieve food self-sufficiency. Not only should this price be high enough to provide the farmer with a reasonable profit, but it should be announced on time to influence planting decisions. However, it is worth noting that fixing higher prices is not an end by itself. Past experiences have shown that producers pay more attention to stable or rising prices than prices which fluctuate year to year. Therefore, establishment of higher producer prices should be sustained, based on a long term trends basis.

CHAPTER IV

RESEARCH PROCEDURE

This chapter presents a detailed discussion on the nature of the data used and the limitations of the study. There is no doubt that the validity of a study depends on the availability of accurate and up to date data sets. The data used in this study are not up to date, and their accuracy is questionable. The reasons for this are explained in the first part of the chapter. The second part is devoted to presentation of analytical procedures to be followed in evaluating the equations on the basis of statistical properties and the appropriate economic theories.

4.1 Sources and Limitations of Data

This section will first review what data are needed in this study and what are their sources. Like many developing countries, factors determining supply and demand for millet and sorghum in Upper Volta are complex.

Economic theory suggests that production should respond to the product's own price and the prices of related products (substitutes or complements). In the Voltan agriculture, cotton and groundnuts compete with sorghum and millet in the use of the factors of production, particularly land. It is hypothesized that farmers' planting decisions are based on the relative profitability of sorghum, millet, groundnuts and

cotton. But, testing this hypothesis requires knowledge of market price relationships among sorghum, millet, etc.

For sorghum and millet, since official prices are known only after harvest, the relative profitability is based on some notions of an expected price, which is influenced by the price in the previous year.

In some cases, prices do not reflect market forces. As a result, variables other than price variables are important to know. One of the most important supply variables for millet and sorghum production is rainfall. In his study of cereals availability in the Sahelian Entente countries of Niger and Upper Volta, Becker¹ found that a one percent decrease in rainfall resulted in approximately a one percent decrease in aggregate yields. The same result was arrived at by a World Bank study. Specifically, they reported that a 2 percent decrease in yield results each day that the rains are late in starting.² On the demand side, population and income growth are the main factors influencing demand in addition to price. The sources of the different data needed are discussed below.

4.1.1 Production Data

Data on production area cultivated and yields of millet and sorghum are available between 1961 to 1982 from the World Bank. The year 1961 corresponds to the agricultural production campaign of 1961-1962 and 1982 to the agricultural campaign of 1981-1982. There is no particular

¹John A. Becker. Analysis and Forecast of Cereals Availability in the Sahelian Entente States of West Africa. AID Report No. AID/CM/Afr.-C-78-20, Jan. 1974, pg. 162.

²IBRD. Emergency grain reserves for the Sahelian Countries, Special Survey, USDA, Washington 1975.

reason for starting with 1961 except the availability of an uninterrupted time series data, since the country achieved its independence from France in 1960.

The data are obtained from different sources, mainly from the Government USDA, FAO, CILSS¹ and the World Bank. The diversity of sources is an indication of the difficulties of finding reliable data. Certainly these different data are not always consistent with each other. Both the FAO and the World Bank have the same type of data sets within the range of the drought period (1970-1974). This indicates a probable joint effort at that time to deal with the problem.

Even the CILSS which is based in the capital city has data which conflicts with those reported by the Government sources. It happens that the CILSS reports different sets of data in two different official documents.² The USDA figures are closer to those of the FAO and the WB than those furnished by the CILSS and the Voltan government.

The disparity in the data is attributable to the procedure of collecting them. The government gets its figures by compiling the statistics obtained from the 11 ORDs. Until 1976, at the ORD level, each encadreur (extension agent) is responsible for estimating the area, the yields and the production of each crop in all the villages placed under his control. Most often, no adjustment is made for missing information.

¹See page of acronyms to see the meaning of each abbreviation.

²The time series data reported by CILSS in Berg report: Marketing, price policy and storage of food grains in the Sahel Vol. 2, p. 77 are different from those reported in their document. Development des Cultures pluviales en Haute Volta, Sept. 1982 pg. 21.

Between the different organizations, the disparity comes from their ability or inability to adjust for missing information. In general the government's figures for millet and sorghum are lower in the range of 10% indicating either the incapacity of the DSA to adjust for missing information or the willingness of the government to show up low figures in order to attract more food aid. Thus, the accuracy of the data is questionable. Nevertheless, we have attempted an empirical study using the World Bank's data. This is because these data are the most recent, and because they have been established using both the government and the FAO data sets which have been adjusted for missing information.

4.1.2 Price Data

The price data series have been obtained from the same W.B. document cited above, from the 1977 CILSS's document (opt. cit.) and the CILSS/OECD document (1982, p. 21). The most recent figures have been obtained from some government draft papers. While all the different data sources give almost the same figures for the producer price series, the case is different for the consumer price series where there is no available uninterrupted series.

The market retail consumer prices which are being used in this study are based on purchases of very small quantities in different urban markets and mainly in Ouagadougou the capital city. For practical reasons (availability of uninterrupted series) the market price for February-April was employed. There is no question that a price obtained from a given market is a poor indicator of the average aggregate price for the country as a whole.

For millet and sorghum, a single price is obtained by taking a simple average of prices for millet and sorghum. Cotton is seldom sold on the market. Cotton prices used here are the official government prices furnished by the CILSS/OECD (1982) and World Bank document previously cited. Both the official producer prices and the consumer price series for groundnuts have been obtained from the two sources cited above. The same sources provide prices for rice collected in Ouagadougou market.

For many reasons, price information is not reliable. First of all, the four main agencies (ORDs, DSA, BCAA, OFNACER) responsible for collecting price data do not try to coordinate their efforts. For instance, some ORDs, which have been discarded from marketing activities in 1974, are reluctant to collect price data. For them, this activity belongs to Ofnacer agents. On the other hand, because Ofnacer buying and selling prices are set by the government, this agency is not interested in collecting free market prices.

Secondly, price data contain measurement errors. Seldom do responsible collecting agents care whether or not grain quality and measure sizes are uniform. Quality differences according to John W. Koehring¹ may depend on: 1) the age of the grain; 2) the variety; 3) presence or absence of foreign material in the grains; and 4) the presence of damaged grains. The lack of adequate training of price reporters prevents them from taking account of any of these variables.

¹John W. Koehring: Upper Volta: Grain marketing development project. Project No. 686-0243. USAID, OUAGADOUGOU. Unclassified document Jan. 1979.

4.1.3 Population and Consumption Data

Population is an important factor in demand analysis. Population data are obtained from the USDA statistical bulletin No. 623 and 656 and also from the World Bank document (opt. cit. p. 12). Customarily, consumption data are estimated by the DSA using the 1975 Census of population as a base. It is assumed that on average, each person, rural or urban, consumes 180 kg of cereals grain per year. No consumption figures were provided for millet and sorghum. For the purpose of this study, a proxy for consumption was used. It is equivalent to average annual production of millet and sorghum minus exports plus imports. Changes in stocks as well as provisions for seed and losses are ignored according to this definition.

4.1.4 Weather Data

The precipitation data that are needed here are those covering the seeding, growing and harvesting periods of millet and sorghum plants. In order to take account of early and late seasonal precipitation, we will calculate aggregate quantities of April-October period.

The series of rainfall from 1960 to 1972 is obtained from Becker (1974). Rainfall data are excellent for the period covering 1961-72. April-October rainfall data from 1972 to 1982 are calculated by averaging monthly climatic data for the world furnished by the "World Meteorological Organization." Where data are missing, the quantities of rainfall collected at Ouagadougou the Capital City, and at Bobo, the second biggest City, have been selected to represent the overall rainfall variation. This is because a long range of data is available for each of these cities and they represent the two predominate climatic zones in the country.

4.2 Method of Analysis

To answer the questions posed earlier an econometric supply and demand model will be constructed. The procedure will be to estimate each equation separately and then combine and solve simultaneously to better handle the input-output relationships. Evaluation based on economic and statistical properties as well as our knowledge of the milieu will then follow.

4.2.1 Estimation Techniques

A multiple linear regression model will be used for both demand and supply equations. While the demand equation is represented by one equation in the model, the supply of millet and sorghum is estimated in two pairs of equations for each crop: one representing the area cropped, the other the achieved average yield during a given campaign. Yield and area are then multiplied together to give the total output.

CHAPTER V

EMPIRICAL RESULTS

This chapter is divided into two parts. The first part presents the most satisfactory formulations that have been selected to form the recursive model used in the analysis. Each estimated equation is discussed in detail with particular focus on the magnitude of the regression coefficients, and the validity of their signs with regard to economic theory, before calculating demand and supply elasticities.

In the second part of the chapter, the predicted values from estimated equations and actual observations are plotted against time to show the performance of the equations.

5.1 Equations Formulation and Estimation

5.1.1 The Demand Equation

In its explicit form, the demand equation for millet and sorghum described in a previous section is stated as follows:

$$MPCE = f(POP, GNPOP, DMT, MPR, D, e_t)$$

where:

MPCE = average market price of millet and sorghum in CFA/kg,

POP = population in thousands unhabitants,

GNPOP = per capita income (CFA/capita),

DMT = total demand or net availability of millet and sorghum
(thousands metric tons),

MPR = market price of rice (CFA/kg)

D = dummy variable, equal to 1 for the drought period (1971-74)
and 0 in all other years,

e_t = error term.

Although rice consumption is not widespread in rural areas, it has been used as a substitute in consumption of millet and sorghum and its price (MPR) is introduced in the equation for this reason. However, the model was fit with and without this variable because of the small proportion of total consumption rice represents.¹ Whether the specified demand equation is appropriate or not will depend primarily on how the behavior of the variables, after estimation, corresponds with what economic theory predicts. For instance, economics theory suggests that there is an inverse relationship between the price and the quantity demanded of a given commodity; e.g., in our model, the coefficient of DMT is expected to be negatively related to MPCE.

Likewise, as a substitute in consumption, we expect the coefficient of MPR to be positive. When the price of rice goes up, people will consume more millet/sorghum instead of rice and total quantity of millet/sorghum consumed (DMT) should go up, and ultimately, its price also. However, we expect the value of the coefficient of MPR to be small. Rice consumption is urban based so that fluctuations in its price will not cause much variation in the total quantity of millet/sorghum consumed. The coefficient of population is also expected to be positively related to MPCE since the larger the population is, the greater the demand for food and the higher the price. Millet/sorghum is a staple

¹Rice represents 3% of total food consumption.

food and there is no close substitute in consumption. Therefore, population size is expected to be a major factor influencing the level of demand.

For the coefficient of the income variable, GNP, economic theory suggests that there should be a positive relationship between income and the quantity of demand provided that the good is a normal good. Due to the subsistence nature of the economy and the food shortage problems, it is believed that an increase in income will probably be directed toward more millet/sorghum purchases. The coefficient of GNP is therefore expected to be positive meaning that when their purchasing power increases, people will consume more millet and sorghum, raising its price.

5.1.2 The Supply Model

In establishing the supply model, four basic relationships were developed. For millet and sorghum, equations were estimated for area planted and yield. Total production of millet and sorghum was the obtained by multiplying yield per hectare of each crop by the area planted and then summing the results. For each equation, several formulations were tried. The following equations were selected. For sorghum, the acreage and yield dependent equations are respectively:

$$AS = f(LMPCE, POP, GNP, TOTAC, e_t)$$

where:

AS = acreage planted to sorghum (thousands ha),

LMPCE = average market price of millet and sorghum lagged one year (CFA/kg),

POP = population (thousands inhabitants),

GNP = income (thousands CFA),

TOTAC = total area of crop planted (1000 ha),

e_t = error term, and

$YLDS = f(RAIN, FERTM, AS, T, e_t)$

where:

YLDS = average yield achieved for sorghum (kg/ha),

RAIN = April-October average quantity of rainfall in mm,

FERTM = annual quantity of fertilizer applied to cereals (metric tons),

AS = acreage planted to sorghum (1000 ha),

T = time trend,

e_t = error term.

For millet, the corresponding acreage and yield dependent equations are as follows:

$AMI = f(LMPCE, TOTAC, LAMI, LOPG, e_t)$

where:

AMI = acreage planted to millet (thousands ha),

LMPCE = average market price of millet and sorghum lagged one year,

TOTAC = total area under crops at time t,

LAMI = acreage planted to millet lagged one year (thousands ha),

LOPG = official producer price of groundnut lagged one year,

e_t = error term, and

$YLDM = f(RAIN, T, e_t)$

where:

YLDM = average yield of millet in time t(kg/ha),

RAIN = April-October average quantity of rainfall in mm,

T = time trend,

e_t = error term.

As can be seen from the two acreage models, only the price of millet and sorghum and the total acreage planted are common to both equations. The time trend variable was not included in either equation due to its high correlation with other variables, and also because the effect of technology on millet and sorghum production has been negligible. The subsistence nature of these crops limits the level of capital investment in their production process.

Groundnuts and millet can be grown on the same land. Therefore, groundnuts are a competing crop for land use in millet production just as cotton is for sorghum production. However, when these variables are included in the acreage equations, cotton did not perform well and was dropped from the analysis. The reason for including total acreage variable (TOTAC) is based on the belief that acreage of millet or sorghum planted is influenced by total acreage under cultivation during a given production period.

For the yield equation, yield per hectare is the dependent variable. It is assumed to be a function of quantities of rainfall and the frequency of rainfall during critical period (April-October). It is also function of applied fertilizer and the quantity of productive factors available per unit of surface resulting in lower yields. The inclusion of a time trend variable is an attempt to pick up some of the variations of omitted relevant variables not explicitly included in the model; such as the effect of the use of animal traction, pesticides, or new improved seed varieties.

5.1.3 The General Model

Assuming that consumers' tastes and preferences remain constant during the period of analysis and that no anticipated improvements in production are expected, the different equations comprising the analytical model outlined above can be rewritten in their specific stochastic forms as follows:

$$\text{Equation 1: } AS = \alpha_0 + \alpha_1 \text{ LMPCE} + \alpha_2 \text{ POP} + \alpha_3 \text{ GNP} + \alpha_4 \text{ TOTAC} + e_1$$

$$\alpha_1 > 0 \quad \alpha_2 > 0 \quad \alpha_3 < 0 \quad \alpha_4 > 0$$

$$\text{Equation 2: } AMI = \beta_0 + \beta_1 \text{ LMPCE} + \beta_2 \text{ TOTAC} + \beta_3 \text{ LAMI} + \beta_4 \text{ LOBG} + e_2$$

$$\beta_1 > 0 \quad \beta_2 > 0 \quad \beta_3 > 0 \quad \beta_4 < 0$$

$$\text{Equation 3: } YLDS = \gamma_0 + \gamma_1 \text{ RAIN} + \gamma_2 \text{ FERTM} + \gamma_3 \text{ AS} + \gamma_4 \text{ T} + e_3$$

$$\gamma_1 > 0 \quad \gamma_2 > 0 \quad \gamma_3 < 0 \quad \gamma_4 > 0$$

$$\text{Equation 4: } YLDM = \mu_0 + \mu_1 \text{ RAIN} + \mu_2 \text{ T} + e_4$$

$$\mu_1 > 0 \quad \mu_2 > 0$$

$$\text{Equation 5: } MPCE = \lambda_0 + \lambda_1 \text{ POP} + \lambda_2 \text{ GNPOP} + \lambda_3 \text{ DMT} + \lambda_4 \text{ D} + \lambda_5 \text{ MPR} + e_5$$

$$\lambda_1 > 0 \quad \lambda_2 > 0 \quad \lambda_3 < 0 \quad \lambda_4 > 0 \quad \lambda_5 > 0$$

$$\text{Identity } QMS = (YLDS * AS)/1000 + (YLDM * AMI)/1000 + \text{Imports} - \text{Exports}$$

The five equations together with the identity form our general model which is to be solved simultaneously, using the Gauss Scidel method and historical data from 1961 to 1981.

5.1.4 Estimation

To test hypotheses about relationships between variables, the five equations included in the general model are first estimated using ordinary least squares (OLS). While this method is used for estimation purpose, some basic assumptions governing the specification of the model

have to be made in order for the method to provide BLUE estimates, efficient prediction and forecast. In particular, the disturbance term is assumed to be normally distributed with a zero expected mean and constant variance, with no correlation between the error terms and the regressors.

The empirical results of the estimated multiple regression equations explaining price, areas cropped and yields of millet and sorghum are summarized in Table 5.1. In general the performances of the different equations are satisfactory as can be seen from visual plots which compare the actual and the estimated values against time (see Figures 5.1 to 5.6).

5.2 Evaluation

5.2.1 Economic Evaluation of the Model

Economic evaluation of the estimated equations refers mainly to the sign and magnitudes of the estimated parameters as postulated in section 5.1.3.

On the demand side, the estimated OLS regression, equation 5, indicates that the actual market price of millet and sorghum, MPCE is directly related to population (POP), to per capita income (GNPOP), and to the binary variable (D), but inversely related to total consumption (DMT). These results were expected. Inclusion of rice as a substitute in consumption of millet and sorghum was later rejected on economic grounds. The sign of MPR was inconsistent with our theoretical expectations. In addition, its coefficient was insignificant and could not be used to suggest a possible existence of complementarity between the two products. The sign of each included variable is also consistent with a priori

TABLE 5.1 Summary of Equations Used in the Study

| Ind. Vars.
Dep. Vars. | C | LMPCE | POP | GNP | RAIN | FERTM | GNPOP | AS | TOTAC | DMT | LAMI | LOPG | T | D | R ² | F | DW |
|--------------------------|--------|-------|------|--------|-------|-------|-------|-------|-------|--------|------|------|------|-------|----------------|-------|-----|
| 1. AS | -980.6 | .075 | .187 | -.0027 | | | | | .61 | | | | | | .831 | 19.2 | 1.9 |
| t | -3.59 | .88 | 2.51 | -2.57 | | | | | 6.37 | | | | | | | | |
| SE | 272.73 | .855 | .074 | .001 | | | | | .095 | | | | | | | | |
| 2. AMI | -206.9 | .69 | | | | | | | .37 | | .22 | -.80 | | | .74 | 11.4 | |
| t | -1.13 | 1.12 | | | | | | | 4.16 | | 1.36 | -.84 | | | | | |
| SE | 183.58 | .663 | | | | | | | .089 | | .159 | .954 | | | | | |
| 3. YLDS | 387.2 | | | | .273 | .0035 | | -.142 | | | | | 7.58 | | .62 | 6.4 | 2.2 |
| t | 2.58 | | | | 2.07 | .82 | | -1.54 | | | | | 2.61 | | | | |
| SE | 149.99 | | | | .132 | .004 | | .092 | | | | | 2.90 | | | | |
| 4. YLDM | | | | | .492 | | | | | | | | 2.56 | | .98 | 112.0 | 1.9 |
| t | | | | | 15.87 | | | | | | | | 1.27 | | | | |
| SE | | | | | .031 | | | | | | | | 2.01 | | | | |
| 5. MPCE | 18.78 | | .029 | | | | 5.044 | | | -.227 | | | | +5.16 | .94 | 68.4 | 2.0 |
| t | .415 | | 1.97 | | | | 4.924 | | | -4.156 | | | | +.683 | | | |
| SE | 46.34 | | .015 | | | | 1.02 | | | .055 | | | | 7.55 | | | |

Notes:

AMI = acreage of millet (ha)
 YLDS = yield of sorghum (kg/ha)
 C = constant
 MPCE = market price of M&S (CFA/kg)
 POP = population (thousands)
 GNP = gross national product (thousands)
 RAIN = rainfall (mm)
 FERTM = applied fertilizer
 GNPOP = per capita income (GNP)
 AS = acreage of sorghum (ha)

TOTAC = total area planted (ha)
 DMT = total demand of M&S (1000 tons)
 LAMI = lag acreage of millet (ha)
 OPGE = official price of groundnut (CFA/kg)
 T = time
 D = dummy variable
 R² = coefficient of determination
 DW = Durbin Watson
 T = t value

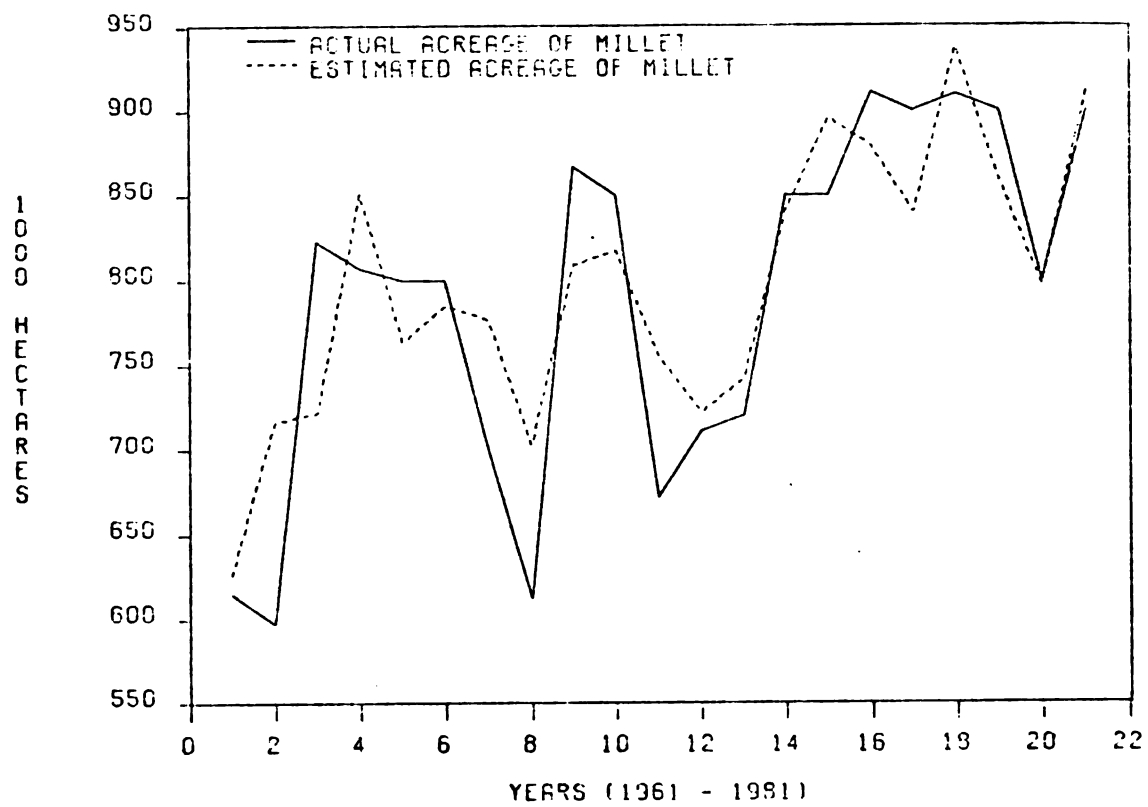


Figure 5.1
Actual and Estimated Acreage of Millet

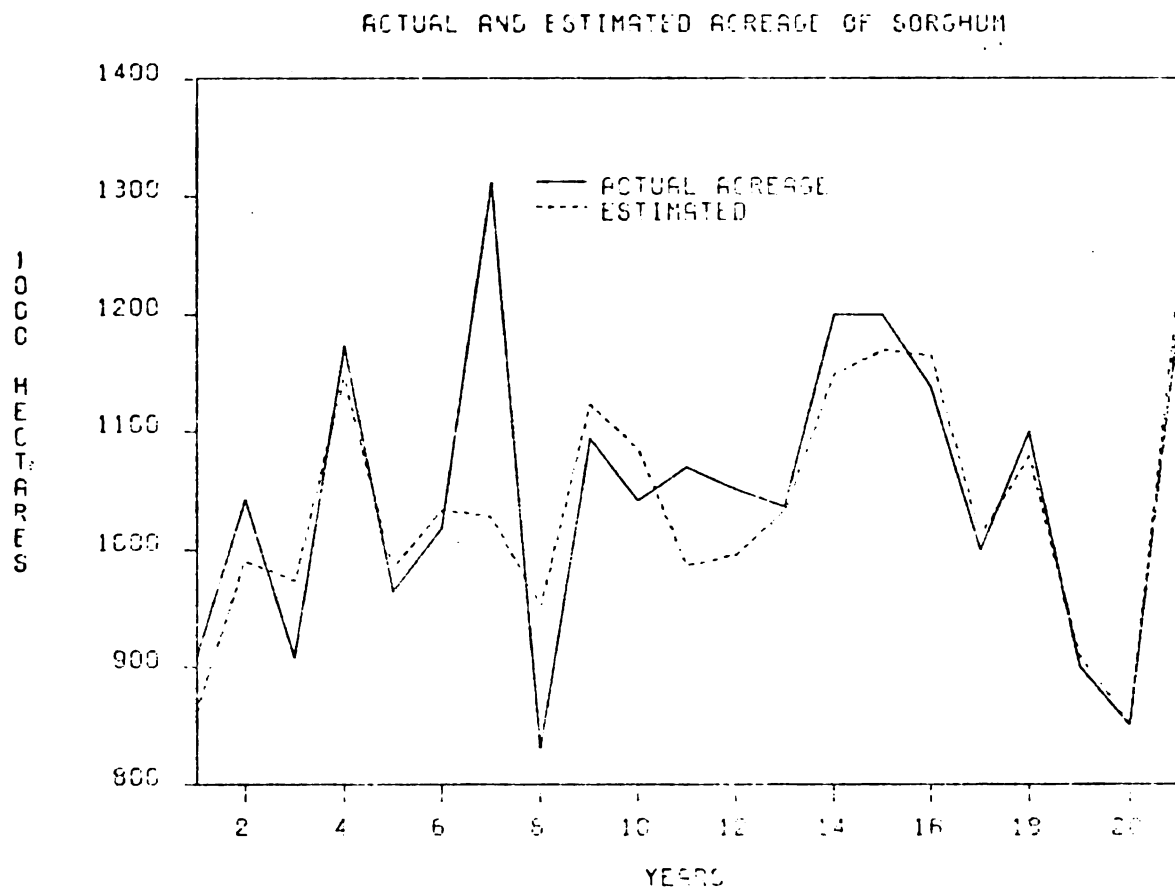


Figure 5.2
Actual and Estimated Acreage of Sorghum

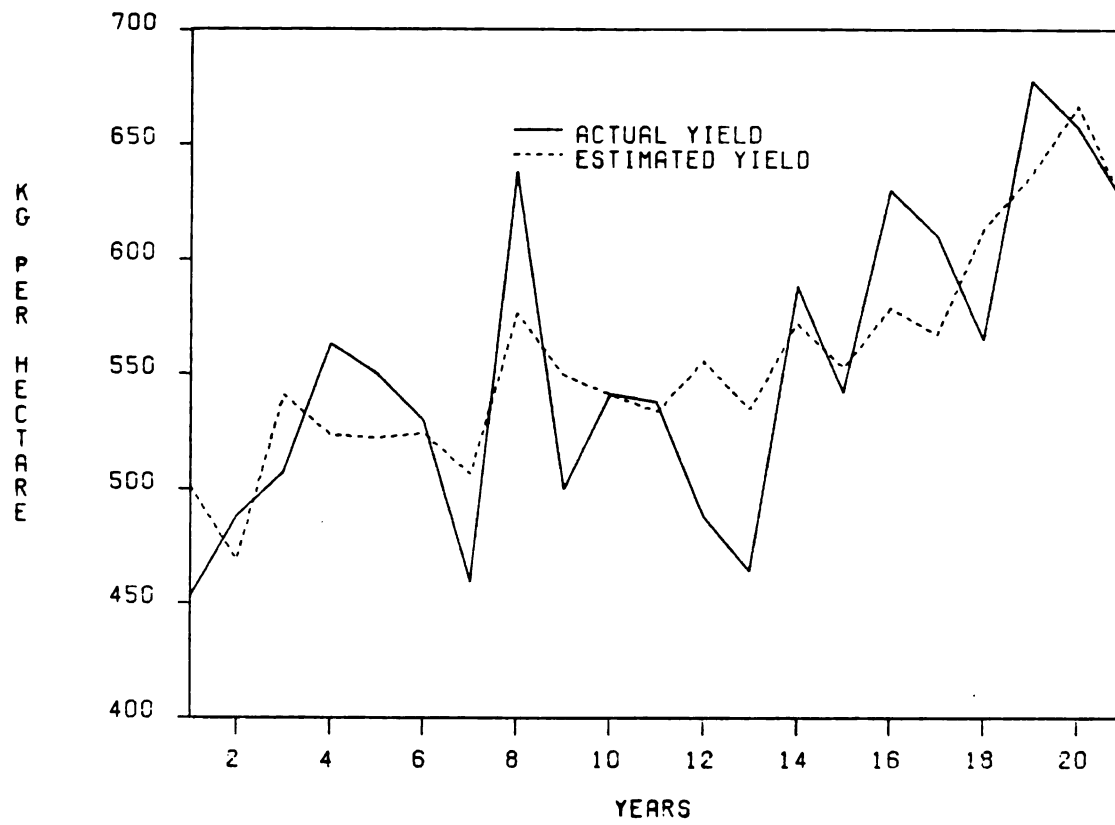


Figure 5.3
Actual and Estimated Yield of Sorghum

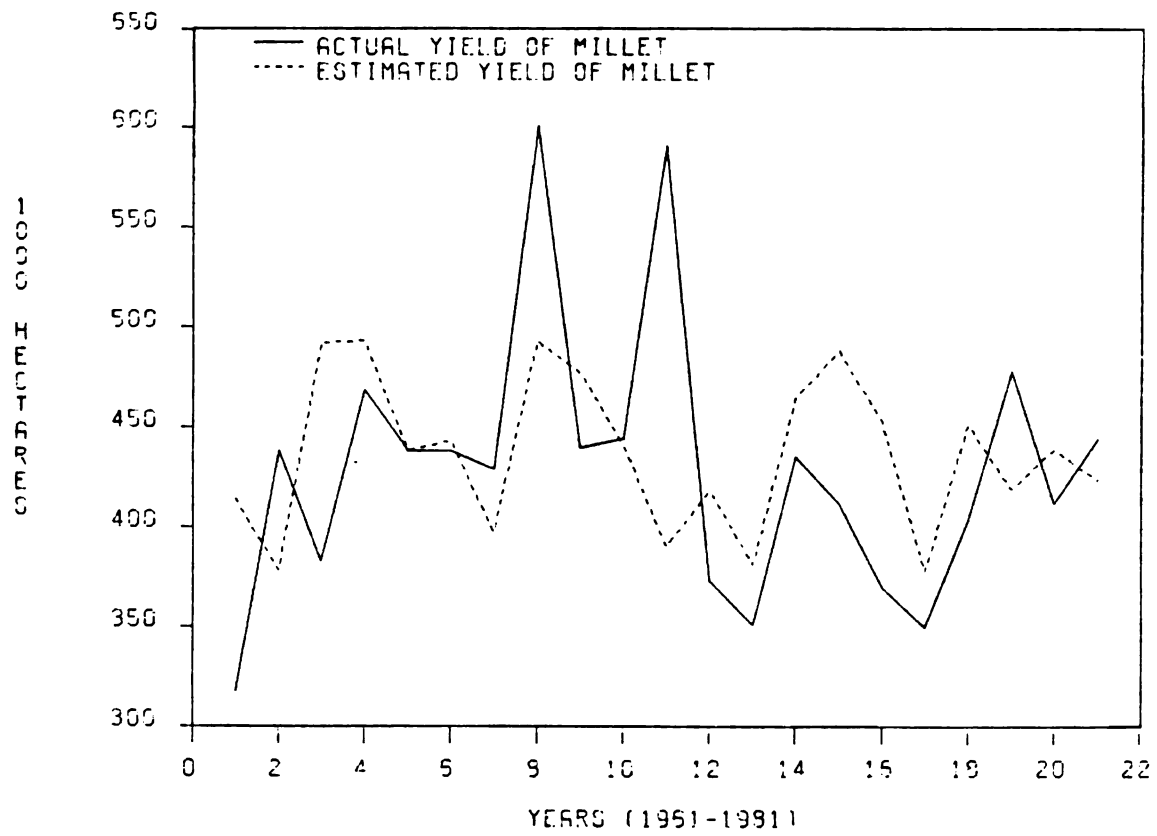


Figure 5.4
Actual and Estimated Yield of Millet

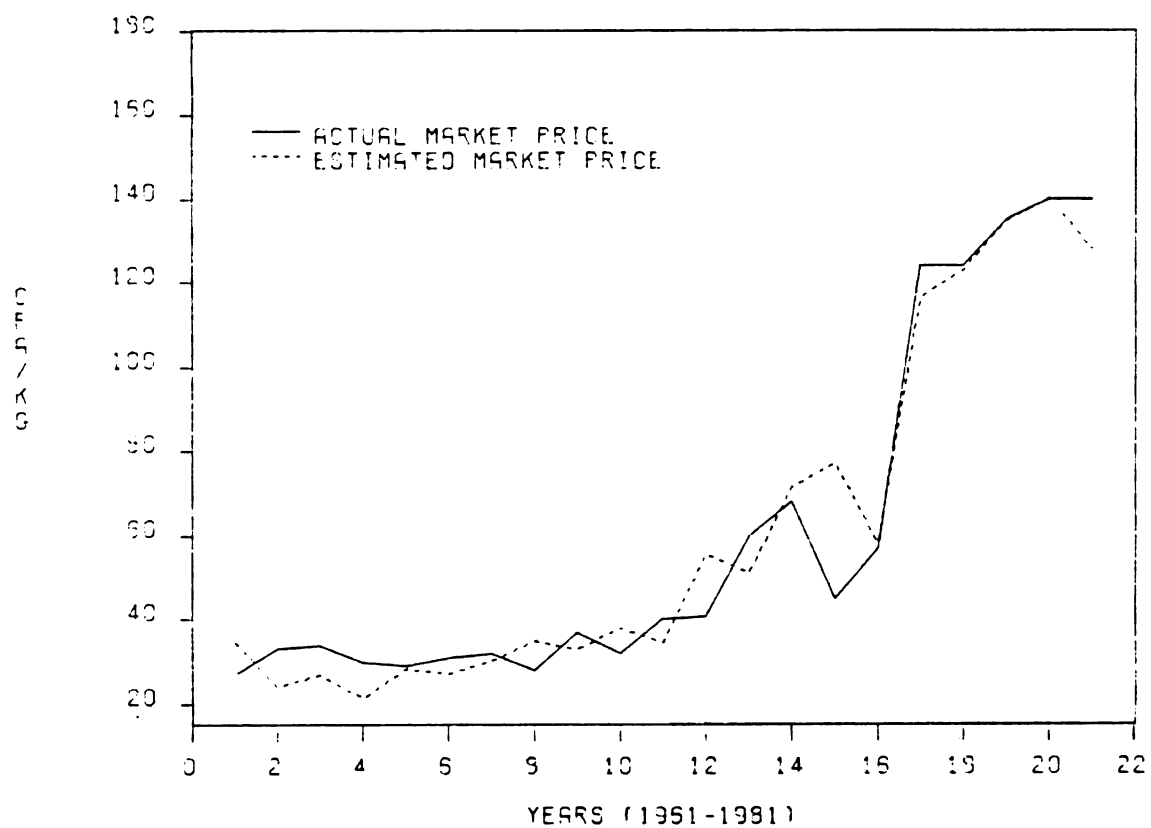


Figure 5.5

Actual and Estimated Market Price of Millet and Sorghum

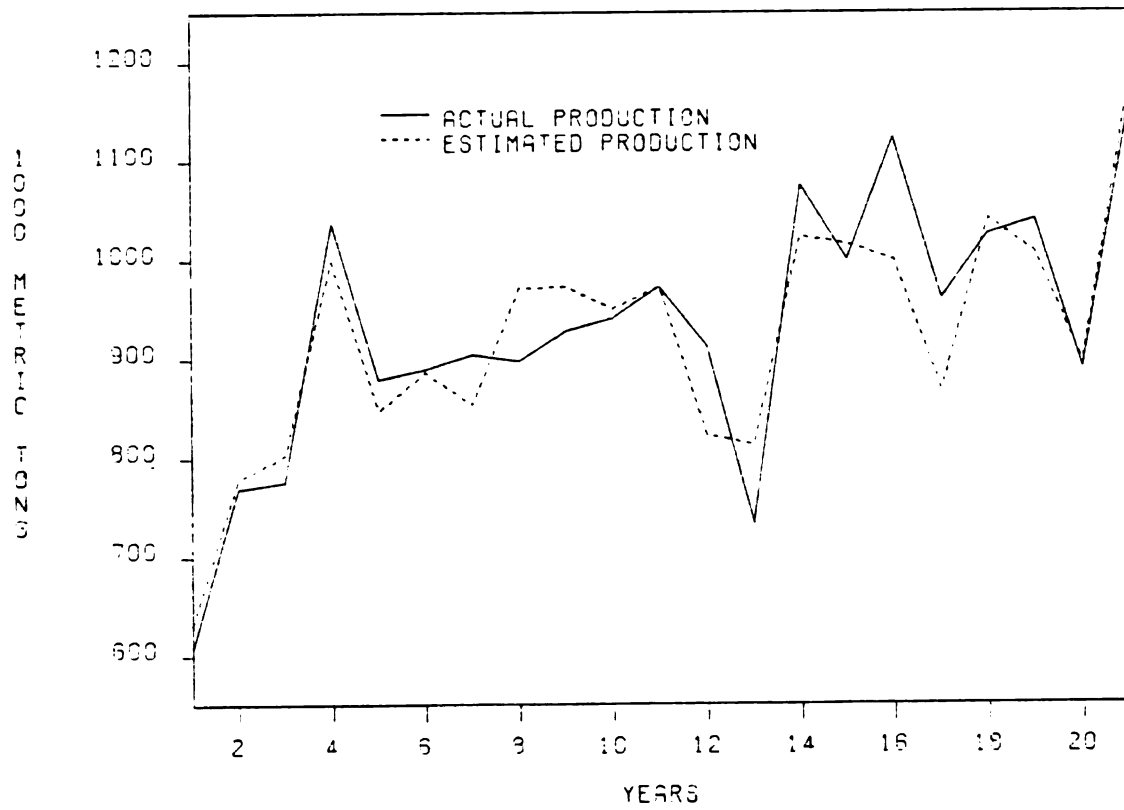


Figure 5.6
Actual and Estimated Production of Millet and Sorghum

economic theory. The same applies to the yield equations (equations 3 and 4). For instance, estimated equation three indicates that the level of average yield of sorghum (YLDS) is inversely related to acreage planted to sorghum (AS), but directly related to rainfall, applied fertilizer, and to the time trend as might have been expected.

On economic grounds, expectations concerning the signs of the estimated coefficients are also met for the two acreage equations (equations 1 and 2). Except for GNP and OPG, all the variables are positively related to acreage as expected. The positive relationship between area cropped (AS and AMI) and price of millet and sorghum means that when the price goes up, farmers will increase the area planted in order to produce more in response to price incentives. The magnitude of these responses are provided by the short run price elasticities computed at mean values (see section 2.4).

There is a negative relationship between the lagged price of groundnuts (LOPG) and AMI in equation 2. This is consistent with economic theory. As the price of groundnuts increase, more area will be allocated to its production at the expense of millet since the two crops compete for the same type of land.

5.2.2 Statistical Evaluation

Statistical evaluation of a regression model is concerned mainly with: 1) the goodness of fit, or how the regression line fits the observed points as measured by the value of R^2 ; 2) the dispersion of the estimated regression coefficients around the true parameters indicated by the value of their standard errors (SE); and 3) tests of significance of the entire regression equation as well as its individual estimated

parameters as embodied in the F and t-tests, respectively. All the appropriate information is summarized in Table 5.1.

The value of R^2 varies from a low of .62 in equation three, to a high of .94 in equation 5. In general, the higher R^2 is, the closer is the functional linear relationship between the dependent and the explanatory variables. How high R^2 should be to be accepted is not known. However, given the nature of the data, the R^2 presented in Table 5.1 (each explaining more than 60 percent of the total variation) can be judged as satisfactory.

In general, a t-value less than two implies that the regression coefficient is not significantly different from zero when tested at $\alpha=.05$ level of significance. In model 1, which explained about 83 percent of the variation, only the price variable (LMPCE) was not significant at $\alpha=.05$ level. In contrast, for equation 2 which explained nearly 74 percent of the variation in AMI, none of the coefficients except TOTAC are significant at the 5 percent level. Due to its large size, the presence of TOTAC might have some influence on the other regressors. However, when AS or AMI were substituted for TOTAC, wrong signs were obtained or the variables were insignificant. Although some coefficients were not significant in equation 2, as was the case of β_1 or γ_2 in equation three, both economic theory and our knowledge of the milieu suggest that the corresponding variables should not be dropped from the analysis.

To test the overall significance of the estimated OLS regression equations, we have reported the calculated (FC) values of the F-test on Table 5.1. These values range from 6.4 to 112 while the corresponding tabulated values range from 2.9 to 3.3. Since the calculated F ratio for each individual equation exceeds the tabular or theoretical value

of F, the hypothesis is accepted that for each equation, the estimated OLS regression parameters are (jointly) significant at the 5 percent level.

5.2.3 Econometric Evaluation

Econometric evaluation refers to verification that the basic assumptions of OLS governing the disturbance term are satisfied in order to insure that the estimated parameters are consistent, efficient, and unbiased.

As can be seen from the information presented in Table 5.1, the different models meet all econometric properties. In particular, there is no problem of serial correlation as indicated by the Durbin-Watson statistics which range from 1.9 to 2.2 (for estimated equations 1, 2, 4, and 5) and the visual plots. However, use of the lagged dependent variable (LAMI) as an independent variable in equation 2, might introduce serial correlation. It is known that in such a case, the usual Durbin Watson test is biased and therefore, is not appropriate for testing serial correlation. Applying the Durbin h statistic, we found a value of -1.67 for h. At the 5 percent level, the critical value of the normal distribution is -1.65. Since -1.67 is very close to -1.65, we cannot reject, nor accept the null hypothesis of no serial correlation in equation 2. It was also thought that problem of multicollinearity was present in model 5 where neither estimated λ_1 , nor λ_4 is statistically significant at the 5 percent level while their standard errors and R^2 are large (see Table 5.1). Since both the standard errors and the corresponding calculated regression coefficients are expressed in the same units, it is desirable for the former to be generally less than half the

latter in absolute terms. However, presence of multicollinearity was not confirmed; there are relatively low values for the simple correlation coefficients between the two variables. Even if multicollinearity was present, dropping either variable from the regression will lead to biased estimates because economic theory and our knowledge of the situation suggest that those variables should be included in the price dependent equation.

5.3 Elasticities

In order to use both supply and demand equations for economic inferences and policy analysis, we computed supply and demand elasticities at mean values. For the demand equation (equation 5) the coefficient of own price elasticity of demand is $-.28$. This is to say that, holding everything else constant, an increase of millet and sorghum price by 1 percent will lead to a reduction in their quantity demanded by about .28 percent. The magnitude of this coefficient of elasticity seems reasonable. In a similar case, Niane found an own-price elasticity of -1.1 for Senegal and concluded that while the sign is consistent with theoretical expectation, the magnitude is rather large.¹ This is quite true because consumption of millet and sorghum is not rigorously affected by price change because of the large amount that is self-consumed. As a staple food, millet and sorghum is demanded in urban areas whatever their price because of the absence of close substitutes. Rice is a poor substitute in consumption of millet and sorghum because it has expensive complements (e.g., meat, fish).

¹Amadou D. Niane: opt. cit. p. 37.

The gross national product (GNP) was introduced in the demand equation as a proxy measure of income change. The growth of personal consumption expenditure would have been more appropriate but the data were not available. The GNP coefficient (income elasticity of demand) computed at the mean is .49. Accordingly, an increase in income by 1 percent will result in an increase in millet and sorghum consumption of .49 percent *ceteris paribus*.

The own and cross price elasticities of supply were also computed at the mean using equations 1 and 2. From equation 1, the short-run own price elasticity of area of sorghum cropped was found to be .004. In equation 2, the coefficients of short and long-run elasticities of area of millet cropped are .053 and .068 respectively. While the signs are consistent with theoretical expectations, the magnitude of these elasticities seem rather small, especially in the case of equation 1. However, low supply elasticities of staple food are not rare in the literature. For instance, Medani found short and long run elasticities of millet acreage in Syria of .09 and .36 for the period 1951-1965. Madhouvan found for the region of Madras, a short run price elasticity of sorghum that varies between .02 and .20 for the period 1947-1965.¹ Given these results, it would be arbitrary in our case to draw some conclusions from these coefficients of elasticity because LMPCE was not significantly different from zero in either equation 1 or 2.

The cross price elasticity for change in the price of groundnuts, which measures the responsiveness of quantity of millet supplied to

¹Hosei Askari and John T. Cummings: Estimating agricultural supply response with the Nerlove model, a survey. AJAE, 1976, p. 257.

change in the price of groundnuts (a competitor in production for millet) was also derived from equation 2 and amounts to $-.04$. This implies that a 1 percent increase in the price of groundnuts would result in a .04 percent reduction in area planted of millet, *ceteris paribus*.

5.4 Summary of Empirical Results

In this chapter, an econometric model was specified and estimated structure of demand, acreage, yield of millet and sorghum made, using time series data.

Estimated elasticities at mean values were:

- .004 = short run own price elasticity of area cropped for sorghum (from equation 1),
- .053 = short run own price elasticity of area cropped for millet (from equation 2),
- .068 = long run own price elasticity of area cropped for millet (from equation 2),
- $-.04$ = cross-price elasticity of substitute in production (groundnut, from equation 2),
- $-.28$ = own price elasticity of demand for millet and sorghum (from equation 5), and
- .49 = income elasticity of demand for millet and sorghum (from equation 5).

Although the magnitude of these elasticities appears small, we are confident with these results because the overall statistical properties of the different equations seem reasonable and the signs of the regression coefficients are consistent with theoretical expectations. Further refinements to the above model could be made especially if regional data

were available. In the following chapter, we will use the model developed above as a basic framework to make forecasting of production and demand of millet and sorghum.

CHAPTER VI

SUPPLY AND DEMAND PROJECTION OF MILLET/SORGHUM

This section uses the estimated equations of demand and supply as a basic framework for making projection under different assumptions.

The quantity of millet/sorghum demanded and the quantity supplied from domestic production are now forecasted from 1982 to 1990 using the regression model and then the FAO model. Comparison between the projected supply and demand values will determine within the projection period, the deficit which has to be covered by imports or the surplus to be exported or processed.

6.1 General Methodology

Projections of supply and demand of staple foods in developing countries is rather an intellectual exercise when one looks at the poor quality of the data and equations that derive them. The many assumptions that are required in order to make these forecasts often render the results useless, and/or inappropriate for policy inferences.

Here, the approach is to use the estimated equations presented in Table 5.1 as a basic framework to make the forecasts instead of using a simple linear trend. Because of that, we have first projected each pre-determined variable separately based on past trends, and then inserted them into the estimated equations. The system of equations is then solved simultaneously to give the forecasted values.

These values for the supply equation are compared to those obtained from the demand equation and estimates obtained using the FAO-OECD method.¹

The difference between the supply and demand forecasts as reported in Table 6.3 indicates in the case of surplus, the potential supplies available for export or processing, and in the case of deficit, the need for imports or for domestic price adjustment.

These demand and supply projections are based on the conventional assumptions of constant tastes and preferences, the maintenance of relative prices between substitutes and complements and no explicit anticipated improvements in production.

6.2 Demand Forecast Using the Regression Model

Forecast of demand using the model developed requires some assumptions concerning the rate of changes of the exogeneous variables included in the model. The following paragraphs report how each variable has been projected before being introduced in the model.

6.2.1 Population Projection

Population is an important factor in the determination of a country's future demand and potential of production. However, this variable is not often well known. The population projections are based upon the 2.4

¹The FAO-OECD method of projecting demand is based on income elasticity and the population growth rate. The functional form of the demand equation is a log-log which allows for a constant expenditure elasticity and is given by the following formula: $D_t = D_0(1 + U_{pop} + E_D n_y)^t$ where D_0 = consumption at $t=0$; U_{pop} = rate of growth of population; E_D = income elasticity of demand; n_y = rate of per capita income; t = time; D_t = projected demand in period t .

percent growth rate assumption made by IFDC in 1976.¹ The INSD, however, has projected a much lower growth rate, 2% between 1975 and 1990. In this study, total population is projected to increase at 2.0 and 2.4 percent per annum from 1981 to 1990 to take both good and worse case scenarios into account.

6.2.2 Consumption Projection

Estimates of consumption figures were obtained by uniformly multiplying the 131 kg per capita consumption of millet/sorghum provided by IFDC by the projected population. This of course does not allow any regional adjustment that could take into account, some differences in the degree of urbanization in the consuming areas. A break down between town and rural per capita consumption would have given more realistic national consumption figures if data had permitted.

6.2.3 Income Projection

Between 1977 and 1979, the GNP growth rate estimated by the World Bank was 4.7 percent in real terms. If in the short run, the estimate of the Voltan economic growth rate was more favorable, the opposite is true for the long run for which the World Bank estimates an increase of only 1.3% between 1960 and 1979. As no prospects for increased economic growth are expected (substantial decrease in development assistance is expected due to the country's political instability), we have projected a 1.3 and an alternative 2.0 percent per year growth of GNP from 1982 to 1990.

¹International Fertilizer Development Center (IFDC): "Etude sur les engrais en Afrique de l'Ouest Vol. 4, Haute Volta, AID/Afr. C. 1176.

6.2.4 Projection of Prices

Because prices are not established by a true supply-demand relationship, we have avoided the use of sophisticated methods to determine how prices will be determined in the future. Rather, we have used a straightforward method of projection, that is, a simple linear time trend based on the assumption that the factors that have determined their pattern in the past will determine a similar pattern in the future.

The estimated equations for the price of rice and for the price of groundnuts used in the analysis are presented in Table 6.1 along with their statistical characteristics. In each case, the time trend T starts from one for 1961 and then increases as time goes on. The projected values are also listed in Table 6.1. The same procedure has been used to project the quantity of fertilizer used.

Projection of millet/sorghum price (MPCE) can be made using model 5 in Table 5.1 along with the projected values of POP, GNP, MPR, and consumption, assuming that the dummy variable (D) is equal to zero. Because we did not want to involve any equation that will give us forecasting values of MPCE outside the entire model, we have used a time trend instead. The high trend projection values of MPCE corresponds to the true market prices. The low trend values represent the trend obtained using price data of period 1961 to 1976, removing the unusual prices of 1977-1981.

Table 6.3 contains the forecasted values of demand from 1982 to 1990 obtained from a simultaneous resolution of the entire set of equations (five equations and one identity) using the Gauss Seidel Method. According to the figures, total demand will increase at a rate of 1.5%

annually, passing from 1,172 thousand tons in 1982 to 1,331 thousand tons in 1990 using a low price trend (MPC2).

6.3 Demand Projection Using the FAO-OECD Method

In order to determine if the Voltan Economy will produce millet/sorghum grain surpluses over the demand for human consumption and also in the desire to compare the above figures obtained from the demand equation, demand projections have been made using the FAO-OECD method.

As described under Table 6.4 the demand for millet/sorghum was projected using an income elasticity of .60, a total population growth of 2 and 2.4% per year and an annual income growth rate of 1.3 and 2.0 percent. The two different kinds of projected demand values are presented in Table 6.4 along with production figures obtained from the model and using MPC1. According to our figures, total demand for millet and sorghum by 1990 will vary from 1,330 to 1,428 thousand tons depending upon the income growth rate as displayed in Table 6.4. Using 1976 as a base year, FAO has set a 1990 demand target of 1,417 thousand tons for millet, sorghum and corn.

6.4 Forecast of Supply

Like in the demand case, forecasts of millet and sorghum production using the regression model requires that some assumptions be made concerning the rate of change of the variables entering the supply equation. Table 6.2 displays these rates of changes expressed in percent per annum. Total area of millet under cultivation amounted to 900 thousand hectares in 1981 and is expected to increase to 967 thousand hectares in 1990 for an annual increase of approximately .8% as reported in Table 6.2.

TABLE 6.1 Projection of Prices, Consumption and Fertilizer Use

| Year | MPCE ₁
(CFA
/kg) | MPCE ₂
(CFA
/kg) | MPR
(CFA
/kg) | OPG
(CFA
/kg) | CONS
(1000
tons) | FERTM
(tons) | POP
(2.4%)
(1000
hbts) |
|------|-----------------------------------|-----------------------------------|---------------------|---------------------|------------------------|-----------------|---------------------------------|
| 1981 | 64.5 | 119.9 | 140 | 67 | 1039 | 7669 | 6728 |
| 1982 | 66.7 | 126 | 146 | 70 | 1060 | 8142 | 6889.5 |
| 1983 | 68.9 | 131 | 152 | 73 | 1082 | 8614 | 7054.8 |
| 1984 | 71.0 | 137 | 157 | 75 | 1104 | 9087 | 7224.1 |
| 1985 | 73.2 | 143 | 163 | 79 | 1127 | 9560 | 7397.5 |
| 1986 | 75.4 | 149 | 169 | 81 | 1150 | 10033 | 7575.0 |
| 1987 | 77.6 | 155 | 174 | 84 | 1175 | 10505 | 7756.8 |
| 1988 | 79.8 | 160 | 180 | 87 | 1199 | 10978 | 7943.0 |
| 1989 | 81.9 | 166 | 185 | 90 | 1224 | 11450 | 8133.6 |
| 1990 | 84.1 | 172 | 191 | 93 | 1250 | 11923 | 8328.8 |

Note: 1981 is the base year. Projection of consumption is made under the assumption of 131 kg of per capita annual consumption of millet and sorghum and a decade average of 1,039 thousand tons (see Table 3.1). MPCE₁ = millet/sorghum price using low trend projection as opposed to MPCE₂. Population is projected assuming an annual growth rate of 2.4 over the entire projection period.

Millet and sorghum price, rice and groundnut prices as well as fertilizer consumption are estimated through time. The estimated equations for MPR and OPG are respectively: MPR = $22.77 + 5.62T$ ($R^2 = .898$); OPG = $7.0 + 2.9T$ ($R^2 = .50$)
(4.17) (12.9) (.83) (4.3)

TABLE 6.2 Projection of Acreage and Yield

| Years | AMI
(.8%) | AS
(1.8%) | AR
(1%) | AG
(3%) | AC
(2.8%) | ACORN
(1%) | YLDS
(.8%) | YLDM
(.5%) |
|-------|--------------|--------------|------------|------------|--------------|---------------|---------------|---------------|
| 1981 | 900 | 1200 | 40 | 170 | 90 | 164 | 625 | 444 |
| 1982 | 907 | 1221 | 40 | 175 | 92 | 166 | 630 | 446 |
| 1983 | 914 | 1243 | 41 | 180 | 95 | 168 | 635 | 448 |
| 1984 | 921 | 1266 | 41 | 185 | 97 | 170 | 640 | 450 |
| 1985 | 929 | 1288 | 42 | 191 | 100 | 171 | 645 | 453 |
| 1986 | 936 | 1312 | 42 | 196 | 103 | 173 | 650 | 455 |
| 1987 | 944 | 1335 | 42.5 | 202 | 106 | 175 | 655 | 457 |
| 1988 | 951 | 1359 | 43 | 208 | 109 | 177 | 660 | 459 |
| 1989 | 959 | 1384 | 43 | 215 | 112 | 178 | 666 | 462 |
| 1990 | 967 | 1409 | 44 | 221 | 115 | 180 | 672 | 464 |

Note: The data in parenthesis are assumed rates of growth of each variable, expressed in percentage per annum. They represent the natural growth of the variable under consideration between 1975 (two years after the drought) and 1981. 1981 is a base year for the projection period.

AMI = acreage of millet (1000 ha) AC = acreage of cotton (1000 ha)
AS = acreage of sorghum (1000 ha) ACORN = acreage of corn (1000 ha)
AR = acreage of rice (1000 ha) YLDS = yield of sorghum (kg/ha)
AG = acreage of groundnut (1000 ha) YLDM = yield of millet (kg/ha)

TABLE 6.3 Supply and Demand Balances Using the Regression Model (1000 t)

| Year | Production 1 | Demand 1 | Surplus/
Deficit | Production 2 | Demand 2 | Surplus/
Deficit |
|------|--------------|----------|---------------------|--------------|----------|---------------------|
| 1982 | 948.1 | 1147.5 | -199.4 | 937.4 | 1172.1 | -234.7 |
| 1983 | 1060.0 | 1249.6 | -189.6 | 1046.1 | 1279.5 | -233.3 |
| 1984 | 956.4 | 1249.7 | -293.3 | 943.0 | 1284.8 | -341.8 |
| 1985 | 1124.0 | 1250.0 | -126.0 | 1106.3 | 1290.6 | -184.3 |
| 1986 | 1097.8 | 1251.0 | -153.2 | 1079.5 | 1297.0 | -217.5 |
| 1987 | 1170.8 | 1252.2 | - 81.4 | 1150.0 | 1303.9 | -153.9 |
| 1988 | 1174.3 | 1254.4 | - 80.1 | 1152.6 | 1314.1 | -161.5 |
| 1989 | 1266.0 | 1256.0 | + 10.0 | 1241.3 | 1322.3 | - 81.0 |
| 1990 | 1295.3 | 1257.6 | + 37.7 | 1269.4 | 1331.1 | - 61.7 |

Note: Production 1 and Demand 1 figures are obtained using a higher price trend for MPCE, that is, the market price. Production 2 and Demand 2 figures however are obtained by using a lower price trend as given in Table 6.1.

TABLE 6.4 Supply and Demand Balances Using the
FAO Model (1,000 tons)

| Year | Production | Demand 1 | Surplus/
Deficit | Demand 2 | Surplus/
Deficit |
|------|------------|----------|---------------------|----------|---------------------|
| 1982 | 948.1 | 1067.9 | -119.8 | 1076.4 | -128.3 |
| 1983 | 1060.0 | 1097.6 | - 37.6 | 1115.1 | - 55.1 |
| 1984 | 956.4 | 1128.1 | -171.7 | 1155.3 | -198.9 |
| 1985 | 1124.0 | 1159.4 | - 35.4 | 1196.9 | - 72.9 |
| 1986 | 1098.0 | 1191.7 | - 93.7 | 1239.9 | -141.9 |
| 1987 | 1170.8 | 1224.8 | - 54.0 | 1284.6 | -113.8 |
| 1988 | 1174.3 | 1258.8 | - 84.5 | 1330.8 | -156.5 |
| 1989 | 1266.0 | 1293.8 | - 27.8 | 1378.8 | - 27.8 |
| 1990 | 1295.3 | 1329.8 | - 34.5 | 1428.4 | - 34.5 |

Note: Production is obtained from the model, using MPC, (see Table 6.3). Demand 1, 2, and 3 are estimated using the FAO method under the following assumptions: Demand 1: rate of growth of GNP = 1.3%, elast. of dem. = .6. Demand 2: rate of growth of GNP = 2.0%, Inc. elast. of dem. = .6. Population growth rate is 2% in Demand 1 and 2.4% in Demand 2.

When all the changes of the variables have been specified, the values calculated and inserted into the model and solved simultaneously by the Gauss Seidel Method, we have obtained the following simulation results (Table 6.5) which represent the forecasted values of the variables under consideration.

6.5 Supply and Demand Balances

Forecasts of the supply and demand for millet and sorghum under different assumptions using the same general model are presented in Table 6.3 and 6.5. They indicate that significant deficits are expected for 1985 to 1990. Under a low price trend, for instance, the deficit in 1990 is expected to reach 62 thousand tons (Table 6.5). Under a higher price trend however, some modest surpluses are expected for the last two years (1989 and 1990) of the decade. The FAO/OECD method gives also comparable results as shown in Table 6.4. Total millet and sorghum production, which has been increasing at a rate of about 1% in the last past 10 years, is expected to increase at a somewhat faster rate in the next 8 years. Total production amounted to an estimated 1,060 thousand tons in 1983, and is projected to reach 1295.3 thousand tons in 1990 for an annual increase of approximately 2.8% which can be favorably compared to the population growth of 2.4%. Table 6.5 shows that within the same period and under more favorable conditions, millet and sorghum production will increase by 7.5% annually passing from 3,033 thousand tons in 1983 to 1,656 thousand tons in 1990. This increase in production is mainly due to increased yield and rainfall variables, and also due to expansion of millet and sorghum production acreage.

TABLE 6.5 Millet and Sorghum Production Under Alternative Rainfall Price, and Yield Scenarios (Simulation Results)

| Year | Production | Demand | Surplus/
Deficit |
|------|------------|--------|---------------------|
| 1982 | 963.8 | 1285.0 | -321.2 |
| 1983 | 1033.3 | 1305.7 | -272.4 |
| 1984 | 1107.4 | 1324.6 | -217.2 |
| 1985 | 1185.1 | 1344.4 | -159.3 |
| 1986 | 1268.9 | 1365.0 | - 96.1 |
| 1987 | 1357.0 | 1386.7 | - 29.7 |
| 1988 | 1450.8 | 1411.9 | + 38.9 |
| 1989 | 1550.4 | 1435.5 | +114.9 |
| 1990 | 1656.4 | 1460.0 | +196.4 |

Note: For this table for which self-sufficiency will be achieved by 1988, the following assumptions have been made: 5% increase in yields and rainfall; rate of growth of GNP = 2%; rate of growth of population = 2.4%. Simulation has been made using the high price trend.

CHAPTER VII

SUMMARY AND POLICY STATEMENTS

This chapter will present a brief review of the major findings of this study of the supply and demand of millet and sorghum in Upper Volta. This study's main purpose was to analyze the actual situation prevailing in the millet and sorghum sector of Upper Volta, and to determine the most important variables affecting its supply and demand; then to estimate the demand and supply elasticities for use in policy analysis. Finally the study proposed to make forecasts to assess the food self-sufficiency problem.

Based on the supply/demand for millet and sorghum conditions in Upper Volta and on data availability, models were formulated and variables were selected to estimate relationships. A multiple regression formulation was used to test the models using time series data for the period 1961 to 1981. Despite the poor quality of the time series data, the different equations performed reasonably well, both statistically and on economic grounds; with the exception of the yield equation for millet. The results of the study support the following inferences:

1. Millet and sorghum production and consumption are only slightly responsive to prices:
 - For the production, the short run price elasticity at the mean values are .058 and .04 for millet and sorghum respectively. These estimates are quite low when compared to the .69 value found by A.

Niane for Senegal. As expected, there is a negative relationship between groundnut prices and millet acreage. The cross price elasticity for changes in groundnut prices is $-.04$ confirming its role as a real competitor of millet/sorghum in terms of area.

It was also thought that cotton competes with sorghum in terms of area; but, this assumption was not empirically supported. When the price of cotton was introduced in the two acreage equations of millet and sorghum, its coefficient was not significant at either $\alpha=.05$ or $\alpha=.10$, and its sign was not correct. There was no improvement by taking the cost of fertilizer into account in the price of cotton. This might be due to the fact that at market prices, millet/sorghum production can be advantageously compared to that of cotton or groundnut.

On the demand side, the own price elasticity for millet/sorghum was $(-.28)$ when measured at the average quantity and price. A one percent change in the price of millet/sorghum will result in a .28 percent change in the quantity demanded in the opposite direction.

This modest value of the elasticity coefficient might be an indication of inelasticity in the demand of millet and sorghum. An inelastic demand would mean that the magnitude of a price variation will be large. However, the projected demands, under the assumptions of low and high price trends, are very similar. The cross price elasticity of rice (.075) is also low given the importance of rice in the diet of urban people.

2. The analysis of the situation of millet/sorghum supply and demand shows that:

a. There is a need to improve the accuracy and reliability of both regional and national data to permit more useful analysis of the cereals subsector.

b. The increase in millet and sorghum production is limited by a low level use of fertilizer and other technological packages, attributable to credit unavailability, unstability in rainfall and prices.

c. For the country as a whole, the annual increase in millet/sorghum production within the range of data did not keep pace with the increase in population: millet/sorghum production is growing at a rate of approximately 1 percent per annum, while population is growing at a rate of more than 2.4 percent per annum.

d. Increases in production seems to be dependent on both increase in productivity and area cultivated (Table 3.3). But increases in productivity in the Central region are limited by the lack of capital, and suitable land and rainfall. Increases in production in the Eastern region are achieved through increases in area cultivated, while, in the Western regions, the increase in production is primarily due to increased yields.

3. According to our empirical results, rainfall seems to be more important than fertilizer in terms of contribution to increased production. The coefficient of the fertilizer variable in the yield equation was not significant when tested at $\alpha=.05$ level.

4. The results of forecasts indicate that self-sufficiency in quantitative terms is possible in the year 1988. But this forecast is made under the following assumption: 5 percent increase in yields (YLDM and YLDS) and rainfall, rate of growth of population and GNP equal

2 and 2.4 percent respectively, using the high price trend. Using our model and assuming a low price scenario, direct human consumption is predicted to increase 18 thousand tons per year within the projection period (see Table 6.3). Under the same low price assumption, if the FAO model were considered, the increase could reach 25 thousand tons annually (see Table 6.4). This will generate deficits that could be absorbed by the other remaining cereals, mainly corn, wheat, and rice.

5. An increase of millet and sorghum price represented by the high price trend assumption in our study, leads to an increase in millet and sorghum production by only 2 percent higher than that with the lower trend by 1990. The model is not very price responsive in production. The increase in production is higher if the increase in price is accompanied by an increase in yields and in rainfall. It is under such conditions that self-sufficiency can be realized by 1988 (see Table 6.5).

While such a situation is highly desirable, the assumptions leading to its achievement are not realistic. For instance, it is difficult to assume an increase in rainfall when for the past 10 years, only 1975/76 was considered as a normal rainfall year. Increases in yield or productivity is limited not only by rainfall as expressed in equations 3 and 4, but also by the quality and quantity of the work force as discussed in section 3.1.

With respect to prices, increasing producer prices in order to achieve food self-sufficiency and eliminate imports is not a new theme. However, if such policies are not implemented, it is because its implementation involves some unnecessary risks for the government. Not only its impact on production is questionable as can be seen by the low supply elasticities (see section 5.3), but an increase in producer prices will

be followed automatically by a raise in Ofnacer selling price by at least the same amount to avoid financial losses. This will be unpopular in urban areas where the agency stores and sells most of its stocks. Retaliatory movements may unite to force the government to grant salary and wage increases as a result. At the same time, rice will be imported in large quantities as people try to substitute millet and sorghum for rice. This substitution away from grains to rice will be most pronounced in cities. Under such conditions, the government should try to tax the imported rice as well as cotton and groundnuts and use the revenue which is generated to subsidize the production of food crops. This will encourage the production of millet and sorghum and local rice. On the other hand, it will undoubtedly discourage the production of the two major cash crops. For cotton, we don't know how important the effect will be because we don't know the price elasticity of substitution in production between millet and/or sorghum and cotton. The value of that elasticity is $-.04$ for groundnuts. As stated before, this is low. It suggests that farmers would undoubtedly stay with their current cropping pattern if such a tax policy was implemented. In fact, because farmers use cash crops revenues to finance the purchase of inputs, there is a danger that taxation of cash crops may discourage the cultivation of millet and sorghum.

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CHAPTER VIII

CONCLUSION AND SUGGESTIONS FOR FURTHER RESEARCH

8.1 Conclusion

This study has attempted to improve the knowledge of millet and sorghum industry in Upper Volta. It is hoped that it will provide a useful framework to the government for decision making concerning its agricultural policies and specific options for the development of millet and sorghum production and marketing. In particular, the study supports:

1. The reinforcement of the government ongoing program of migration from the Mossi Plateau, an ecologically poor area, to the Volta Valley where soils are richer. This can help to increase both yield and labor productivity. But for this program to contribute to the achievement of food self-sufficiency, the government should encourage cereals and not cash crop production in these areas to avoid increase in yields and labor productivity which would be offset by a shift of farmers from food to cash crops.

2. The removal of some obstacles to efficient production and marketing of millet and sorghum such as credit and transportation facilities. Development of transportation facilities is needed not only within the country between the producing and the consuming areas, but also between the country and the neighboring coastal ports to facilitate movement of large supplies, especially in emergency periods.

3. The encouragement of millet and sorghum consumption by facilitating their preparation. This can be done by creating new marketing services for coarse grains such as grading, processing, and packaging facilities. This will increase millet and sorghum consumption in urban areas and drive their price up, making their production much more attractive to farmers.

8.2 Further Research Needs

Due to data problems, our understanding of the sector still remains limited. The study has provided answers for a part of the overall picture described in chapter one. A great deal more information is still needed to completely understand millet/sorghum production and consumption in Upper Volta. For instance, little is known about the cost structure of millet and sorghum production, the effects of the adoption of new technology, income distribution, structure of the population, nor why productivity of millet and sorghum is decreasing steadily through time.

Further detailed information is needed in the area of rainfall and prices. We need regional market prices for producers and consumers for each crop as well as average rainfall recorded at all rain gauge stations in each region. Such information is needed to better estimate both supply and demand equations because by aggregating the data, this study has overlooked detailed differences between regions. For instance, neither cotton, nor rice or corn appeared as substitutes in production in the supply equations. But between 1971 and 1981, the area planted to cotton has increased by 60 percent in the western regions and decreased by about the same (65 percent) for the rest of the country.

Undoubtedly, a clearer picture would have been obtained by disaggregating the national figures into regional ones. This would have allowed us to find for each region, the most appropriate substitute in production for each crop.

A great deal more information is also needed in the area of marketing. We would like to know how much production of millet and sorghum is marketed through public channels and how much by private traders, and how much of the remaining production is home-consumed. Such information is needed since use of the quantity produced rather than quantity marketed as an exogeneous variable (DMT) in the demand equation might have influenced the magnitude of the coefficient of that variable.

Accurate, complete income and consumption data for rural and urban people should be obtained also in order to improve the demand model. The supply equations would also improve if labor costs were taken into account.

Further detailed information is needed also in the area of the timing of farm sales of coarse grains. Transportation and storage difficulties oblige many farmers to market their production between mid-October and mid-December resulting in a seasonal glut and lower prices. Further research in this area will help determine the "correct price" to which farmers respond to in making their production decisions.

APPENDICES

APPENDIX I
DATA USED IN THE STUDY

Table A1

| | Millet | | | Sorghum | | | Rice | | |
|------|----------------------|-------------------|----------------------|----------------------|-------------------|----------------------|----------------------|-------------------|----------------------|
| | Area
(1000
ha) | Output
(1000T) | Yield
(kg
/ha) | Area
(1000
ha) | Output
(1000T) | Yield
(kg
/ha) | Area
(1000
ha) | Output
(1000T) | Yield
(kg
/ha) |
| 1960 | | | | | | | 38 | 31 | 816 |
| 1961 | 615 | 195 | 317 | 908 | 411 | 453 | 54 | 30 | 556 |
| 1962 | 597 | 261 | 438 | 1042 | 508 | 488 | 67 | 45 | 672 |
| 1963 | 823 | 316 | 383 | 908 | 460 | 507 | 33 | 25 | 758 |
| 1964 | 807 | 378 | 469 | 1173 | 660 | 563 | 35 | 34 | 971 |
| 1965 | 800 | 350 | 438 | 964 | 530 | 550 | 35 | 34 | 971 |
| 1966 | 800 | 350 | 438 | 1018 | 540 | 530 | 35 | 34 | 971 |
| 1967 | 700 | 300 | 429 | 1312 | 604 | 460 | 36 | 44 | 1222 |
| 1968 | 612 | 368 | 601 | 831 | 530 | 638 | 46 | 40 | 870 |
| 1969 | 867 | 382 | 440 | 1094 | 547 | 500 | 40 | 34 | 850 |
| 1970 | 850 | 378 | 444 | 1041 | 563 | 541 | 41.2 | 36.3 | 881 |
| 1971 | 672 | 397 | 591 | 1070 | 576 | 538 | 40 | 36.9 | 923 |
| 1972 | 711 | 400 | 373 | 1051 | 512 | 488 | 40.4 | 33.6 | 832 |
| 1973 | 720 | 253 | 351 | 1037 | 481 | 464 | 41.4 | 31 | 748 |
| 1974 | 850 | 370 | 435 | 1200 | 705 | 588 | 42 | 39 | 929 |
| 1975 | 850 | 350 | 412 | 1200 | 650 | 542 | 41.3 | 38 | 920 |
| 1976 | 911 | 406 | 370 | 1138 | 717 | 630 | 42.1 | 36.5 | 867 |
| 1977 | 900 | 350 | 350 | 1000 | 610 | 610 | 41.6 | 32.4 | 778 |
| 1978 | 910 | 404 | 404 | 1100 | 621 | 565 | 41.2 | 31.5 | 765 |
| 1979 | 900 | 431 | 478 | 900 | 610 | 678 | 41 | 31.5 | 768 |
| 1980 | 800 | 430 | 412 | 850 | 559 | 658 | 40 | 28 | 700 |
| 1981 | 900 | 400 | 444 | 1200 | 750 | 625 | 40 | 29 | 725 |

Sources: Data from 1961 to 1979 for millet and sorghum are from World Bank: Upper Volta: Agricultural issues study, Report No. 3296 UV, October 1982, p. 204. The last two year data are from F.A.O. Statistical Yearbook, Data for rice are from WARDA: Rice Statistics Yearbook, 1981.

Table A2

| | Cotton | | | Groundnut | | | Popula-
tion
(1000
ibts) | Rain-
fall
(mm) |
|------|----------------------|-------------------|----------------------|----------------------|-------------------|----------------------|-----------------------------------|-----------------------|
| | Area
(1000
ha) | Output
(1000T) | Yield
(kg
/ha) | Area
(1000
ha) | Output
(1000T) | Yield
(kg
/ha) | | |
| 1960 | | | | | | | 4152 | |
| 1961 | 22.9 | 2.3 | 111 | 113.5 | 56.8 | 500 | 4235 | 836.7 |
| 1962 | 36.0 | 6.6 | 180 | 127 | 63.5 | 500 | 4320 | 758.3 |
| 1963 | 45.8 | 8.0 | 190 | 100 | 50 | 500 | 4406 | 984.5 |
| 1964 | 52.5 | 8.8 | 170 | 127 | 70 | 551 | 4494 | 981.7 |
| 1965 | 49.7 | 7.5 | 140 | 130 | 73 | 562 | 4584 | 865.2 |
| 1966 | 52.4 | 16.3 | 310 | 136 | 76 | 559 | 4676 | 869.7 |
| 1967 | 65.4 | 17.3 | 260 | 142 | 80 | 563 | 4769 | 771.5 |
| 1968 | 71.6 | 32.0 | 450 | 150 | 85 | 567 | 4865 | 961 |
| 1969 | 84.1 | 36.2 | 430 | 137 | 71 | 519 | 4962 | 923 |
| 1970 | 80.6 | 23.5 | 290 | 140 | 68 | 484 | 5061 | 844.2 |
| 1971 | 74.1 | 28.1 | 380 | 144 | 66 | 458 | 5162 | 736.7 |
| 1972 | 70.1 | 32.6 | 470 | 105 | 60 | 577 | 5266 | 787.7 |
| 1973 | 66.6 | 26.7 | 410 | 167 | 63 | 376 | 5371 | 709.2 |
| 1974 | 61.5 | 30.6 | 500 | 120 | 65 | 382 | 5478 | 892.5 |
| 1975 | 68.0 | 50.7 | 750 | 180 | 80 | 444 | 5588 | 752.1 |
| 1976 | 79.2 | 55.3 | 700 | 164 | 87 | 533 | 5700 | 839.2 |
| 1977 | 68.8 | 38.0 | 550 | 165 | 85 | 515 | 5814 | 679.5 |
| 1978 | 71.7 | 60.0 | 840 | 170 | 70 | 412 | 5930 | 823.7 |
| 1979 | 77.8 | 75.1 | 960 | 144.6 | 69.9 | 480 | 6049 | 753 |
| 1980 | 90 | 78 | 861 | 170 | 77 | 453 | 6170 | 788.4 |
| 1981 | 90 | 71 | 789 | 170 | 77 | 453 | 6728 | 751.6 |

Sources: Data for cotton, groundnuts are from World Bank and from FAO, Statistical Yearbook (idem). Rainfall data 1962-75 are from World Meteorological Organization: Monthly climatic data for the World. Data from 1976 to 1981 are obtained from FAO/PAM: Rapport de Mission sur l'evaluation de la situation alimentaire (Rome 1980). Population data are from WARDA: Rice Statistics Yearbook, 4th Edition, June 1981, Table 34.

Table A3

| | Millet and Sorghum | | | Cotton | Groundnuts | Rice |
|------|-------------------------------|-------------------------------|-----------------|------------------------------|------------------------------|-----------------|
| | Official
Producer
Price | Official
Consumer
Price | Market
Price | Official
Product
Price | Official
Product
Price | Market
Price |
| 1960 | | | 22 | | | |
| 1961 | 12 | 18 | 27 | 34 | 25 | 36 |
| 1962 | 12 | 25 | 33 | 33 | 25 | 40 |
| 1963 | 15 | 25 | 34 | 33 | 25 | 45 |
| 1964 | 13 | 25 | 30 | 34 | 26.75 | 48 |
| 1965 | 11 | 24 | 29 | 34 | 26.75 | 57 |
| 1966 | 13 | 26 | 31 | 34 | 26.75 | 60 |
| 1967 | 14 | 28 | 32 | 32 | 26.75 | 63 |
| 1968 | 12 | 30 | 28 | 32 | 26.75 | 73 |
| 1969 | 12 | 39 | 37 | 32 | 25.75 | 79 |
| 1970 | 12 | 32 | 32 | 32 | 25.75 | 58 |
| 1971 | 12 | 31 | 40 | 32 | 25.75 | 70 |
| 1972 | 14 | 26 | 41 | 32 | 25.75 | 66 |
| 1973 | 18 | 30 | 60 | 35 | 26.85 | 78 |
| 1974 | 22 | 37 | 68 | 40 | 34.0 | 93 |
| 1975 | 18 | 30 | 45 | 40 | 34.0 | 121 |
| 1976 | 23 | 35 | 57 | 40 | 38.0 | 115 |
| 1977 | 32 | 45 | 124 | 55 | 44.0 | 115 |
| 1978 | 40 | 57 | 124 | 55 | 54.29 | 125 |
| 1979 | 40 | 57 | 135 | 55 | 54.29 | 125 |
| 1980 | 40 | 64 | 140 | 55 | 54.29 | 144 |
| 1981 | 45 | 67 | 140 | 60 | 60.0 | 165 |

Sources: Data for millet and sorghum, cotton, groundnuts are from CILSS/CLUB and Sahel: Developpement des cultures pluviales en Haute - Volta, Sept. 1982 p. 60 and from World Bank: Upper Volta, Agricultural issues study (idem). Prices for rice are from WARDA. Recent figures are from government sources.

100-100000

APPENDIX II

ACRONYMS AND CURRENCY EQUIVALENTS

1. Exchange Rates: 1\$US Equivalent in CFA*

| | | | | | | | |
|------|---------|------|---------|------|--------|------|--------|
| 1961 | 246.853 | 1966 | 246.853 | 1971 | 277.03 | 1976 | 238.98 |
| 1962 | 246.853 | 1967 | 246.853 | 1972 | 252.21 | 1977 | 245.67 |
| 1963 | 246.853 | 1968 | 246.853 | 1973 | 222.70 | 1978 | 225.64 |
| 1964 | 246.853 | 1969 | 258.064 | 1974 | 240.50 | 1979 | 212.72 |
| 1965 | 246.853 | 1970 | 277.70 | 1975 | 214.32 | 1980 | 210.00 |
| | | | | | | 1981 | 205.00 |

*Period average.

2. Acronyms Used in Text

1. BAEP: Bureau of Planning and Economic Analysis (Bureau d'Analyse Economique et de la Planification)
2. BCAO: Central Bank of West African States (Banque Centrale des Etats de l'Afrique de l'Ouest)
3. BND: National Development Bank (Banque Nationale de Developpement)
4. CILSS: Permanent Inter-State Committee of Drought Control in the Sahel (Comite Permanent Inter-Etats de Lutttes Contre la Secheresse au Sahel)
5. CFDT: Compagnie Francaise pour le Developpement des Fibres Textiles (French Textile Company)
6. CNCA: Caisse Nationale de Credit Agricole (National Credit Fund for Agriculture)
7. DSA: Direction des Services Agricoles
8. FAO: Food and Agricultural Organization of the United Nations
9. FDR: Fonds de Developpement Rural - (Funds for Rural Development)
10. FED: Fonds Europeen de Developpement (European Development Fund)
11. ICRISAT: International Crops Research Institute for the Semi-Arid Tropics
12. IDA: International Development Association
13. IFDC: International Fertilizer Development Center

SECRET DOG

14. INSD: Institut National de la Statistique et de la Demographie
15. IRAT: Institut de Recherche d'Agronomie Tropicale et des Cultures Vivrieres
16. OECD: (Research Institute Organization of Economic Cooperation and Development on Tropical and Food Crops
17. OFNACER: Office National de Cereales (National Cereals Agency)
18. ORD: Office Regional de Development (Regional Development Office)
19. OSRD: Office of Sahelian Relief Operations
20. PAM: Program Alimentaire Mondial (World Food Program)
21. SDP: Service Departemental de Plannification
22. SOFITEX: Societe Voltaique des Fibres Textiles. The Voltaic Cotton Company (the old CFDT)
23. SOSUHV: Societe Sucriere de Haute Volta (Upper Voltan National Sugar Society)
24. USDA: United States Department of Agriculture
25. USAID: United States Agency for International Development

APPENDIX III
OVERTIME REGIONAL EVOLUTION OF CEREALS
PRODUCTION (1973-1980/1981)

| Regions | 1973/74 | 74/75 | 75/76 | 76/77 | 77/78 | 78/79 | 79/80 | 80/81 |
|----------|---------|-------|-------|-------|-------|-------|-------|-------|
| WEST | | | | | | | | |
| A | 466 | 434 | 606 | 506 | 526 | 549 | - | 558 |
| P | 264 | 289 | 429 | 338 | 400 | 431 | - | 440 |
| Y | 567 | 666 | 710 | 668 | 760 | 785 | - | 789 |
| EAST | | | | | | | | |
| A | 116 | 129 | 158 | 159 | 183 | 131 | 161 | 201 |
| P | 63 | 83 | 87 | 93 | 106 | 93 | 98 | 84 |
| Y | 543 | 643 | 551 | 585 | 579 | 710 | 609 | 418 |
| CENTRAL | | | | | | | | |
| A | 1145 | 1198 | 1280 | 1143 | 1195 | - | - | - |
| P | 445 | 629 | 645 | 469 | 521 | - | - | - |
| Y | 389 | 525 | 504 | 410 | 436 | - | - | - |
| SAHEL | | | | | | | | |
| A | 119 | 134 | 149 | 128 | 150 | - | 122 | - |
| P | 20 | 43 | 44 | 42 | 31 | - | 44 | - |
| Y | 168 | - | 295 | 328 | 207 | - | - | - |
| U. VOLTA | | | | | | | | |
| A | 1846 | 1895 | 2193 | 1936 | 2054 | - | - | - |
| P | 793 | 1045 | 1205 | 941 | 1058 | 1125 | 1145 | 987 |
| Y | 430 | 550 | 550 | 486 | 515 | - | - | - |

Source: CILSS/OECD: Developpement des cultures pluviales en Haute Volta, Club du Sahel, report no. Sahel D(82) 177, September 1982. Appendix 3.2 p. 177 and Appendix 3.3 p. 178.

The term cereal here includes millet, sorghum and corn. Data for millet and sorghum only are not available for individual regions.

A = area planted in 1000 ha
P = production in 1000 tons
Y = yield in kg/ha

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