A DESCRIPTIVE AND ECONOMETRIC ANALYSIS OF RELATIONSHIPS IN THE RICE SUBSECTOR OF BURKINA FASO

By

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To

my father, Mamadou Hébié, and my mother, Assita,

for their blessings

and to

my wife, Kounadi, and my daughters,

Alimatou and Maimouna,

in appreciation for their love

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CHAPTER I

INTRODUCTION

As in almost all sub-Saharan African countries, agriculture plays an important role in the economic life of Burkina Faso.[1/] The World Bank's 1983 report indicates that agriculture's contribution to the country's Gross Domestic Product (GDP) was 41 percent in 1981 compared to 16 percent for the industrial sector. In 1980, exports of agricultural products (basically cotton, groundnuts, and livestock) accounted for 89 percent of total export earnings. The country is primarily agricultural, with nearly 90 percent of the population dependent on agriculture as a livelihood. Yet it is well known today that Burkina Faso, going into its third decade as a sovereign nation, is still facing, like its Sahelian counterparts, one of the biggest challenges of economic development: how to feed its growing population.

Basically, the challenge is how to achieve what is usually termed "food security," which is defined by Haggblade (1984) as the ability to assure consumption of a nutritionally adequate diet to all members of a country's population. Although the government of Burkina Faso has not specifically outlined a set of food security goals, its actions since the early 1960s indicate that it equates food security with food self-sufficiency. A review of the statistical evidence reveals that the country is far from meeting its food security goals.

Aggregate production of cereals, the main Burkinabé staple, almost stagnated during the last 20 years, while the annual population growth rate remained between 2 and 2.4 percent. For the entire Sahel, cereal production

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[1/] Until 1984, Burkina Faso was known as Upper Volta. Most of the references cited in this paper refer to the country under its old name.

declined on average by 1.6 percent per year from 1962-64 to 1972-74 (USDA, August 1981). The same source indicates that in 1970 the per capita food production index in Burkina Faso was 24 percent lower than its 1961-65 level and in 1979 it was 33 percent lower. The lowest index observed was 58 in 1973, at the peak of the drought that affected the entire Sahel region. Since this drought, in fact, food production has not reached a satisfactory level in this region, as indicated in Table 1. In general, per capita food production in Burkina Faso has been very unstable, with large annual fluctuations, but the trend is clearly declining. From a level of 215 kg in 1962-69, per capita net cereal output fell to 204 kg in 1975-79 (World Bank), making it about equal to the FAO minimum requirement. This situation may appear not very serious for the country as a whole if the distributional pattern of the production throughout the territory is ignored. However, in 1979 per capita cereal output ranged from 267 kg in the southwest to 102 kg in the Sahel. In the Eastern and center regions (the most populated areas of the country), production was 184 and 173 kg per person, respectively. This variation is basically a function of climate, soils, and technology. So, it is clear that the achievement of the food security goal pursued by the government since the early 1960s is highly dependent on both an increase in production and on its distribution. Efforts are needed not only to reverse the declining production trend but also to supply food to deficit producing areas and urban centers, the population of which has been rapidly growing during the last decade.

The consequences of this situation are numerous and interact with each other to accentuate the food crisis. The most widely cited consequences are: decreasing nutritional status; deteriorating economic status of peasants, especially increasing migration of the labor force from agriculture to cities where unemployment is already high and to coastal countries (especially Ivory

Table 1. Indices of Per Capita Food Production in 4 Sahelian Countries, 1970-79 (1961-65 = 100)

Year	Mali	Niger	Senegal	Burkina Faso
1970	84	104	64	76
1971	86	109	87	70
1972	65	105	56	66
1973	67	66	68	58
1974	86	91	90	72
1975	88	76	100	76
1976	97	103	87	74
1977	82	92	59	67
1978	105	106	88	69
1979	75	85	68	67

Source: U.S. Department of Agriculture, Economic Research Service, Foreign Agricultural Research Report No. 166, Food Problems and Prospects in Sub-Saharan Africa: The Decade of the 1980s. Washington: August 1981 (p. 3).

Coast); and increasing dependency of the country on outside food supplies. FAO (1979)[1/] estimates that the amount of protein available per person per day fell from 66.6 grams in 1966 to 59.6 grams in 1977. Per capita calories available per day also declined from 2,041 to 1,877 calories during the same period, which is very low by world standards. For the Sahel, the minimum calorie ration required, as estimated by FAO, was about 2,370 calories per day in 1974.[2/] Cereal imports (including food aid) valued at 600-800 millions Francs CFA[3/] before 1973 increased to an annual average of three billion Francs CFA thereafter. During 1974-78, the value of cereal imports equaled about 67 percent of the value of total agricultural exports (World Bank). The scope to reinvest in the agricultural sector from its generated export earnings was thus severely reduced. For, if the estimates are correct, only about 33 percent of these funds was left not only for investment in agriculture but also for investment in other sectors of the economy. As a result, the growth rate of the economy has been very small. Per capita GNP grew only by .4 percent per year during the 1960-79 period according to the World Bank.

The deteriorating economic and food conditions are generally perceived as a result of several factors, among which are the harsh physical and climatic environment, population pressure, the low technological level in the production process, the inheritance of a colonial development strategy oriented toward production of export commodities, and the underdevelopment of the

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[1/] Quoted in CILSS/Club du Sahel (July 1979).

[2/] This estimate is the same as for 1982 (see Haggblade, 1984, pp. 1-2, footnote 1).

[3/] CFA stands for Communaute Financière Africaine. The local currency is the Franc CFA and abbreviated F. CFA. U.S. $1 = 205 F. CFA (average exchange rate for 1981).

financial and marketing institutions. In sum, ecological, socioeconomic, and political factors have played a big role in what is known today as the food crisis in Burkina Faso and in the Sahel region in general. The alleviation of this crisis is best conceived as a long-run process that will require continuous commitment by both national governments and the international community.

Short-run adjustment through imports and/or food aid may prove to be unviable, given the limited capacity of the Sahelian countries to import from the world market, which is characterized by unstable prices, and the unreliable nature of food aid. Experience also shows that both imports and food aid may have a disincentive effect on the expansion of domestic food production. However, this does not mean that either food aid or imports should be banned. Food aid as a source of relief for droughts or for other natural disasters should be encouraged and is justifiable on both humanitarian and economic grounds. On the basis of its resource endowment and on national security grounds, a country may decide to import or produce domestically a commodity or adopt a mixed strategy. Thus, an import or food aid policy, if carefully designed, may represent a good alternative to solve a food problem. For the Sahel as a whole, food aid and imports have been very important policy instruments both during and after the 1969-73 drought. And, it may take a long time again before requests for food aid cease, given the current unfavorable weather conditions which cripple domestic production in the face of a growing population.[1/]

In the search for a long-term solution to its food problem and the improvement of the country's economic status, Burkinabé governments since

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[1/] USDA (1981) projects that the Sahel population will grow by about 2.5 percent per year from 1985 to 1990. "Assuming that real 1975 per capita income and price levels prevail in 1990, the Sahel would need to import 1.22 million tons of cereal to meet consumption demand" (p. 222 and especially Table 67, p. 223).

1960 have stated that agricultural development is their first priority. Yet the Berg report (1983, p. 184) indicates that only 1.7 percent of the government's budget went to agriculture in 1977, while the defense sector and general public services received 21.8 and 22.3 percent, respectively. In the third five-year plan (1978-82),[1/] the main objectives of the government's agricultural development strategy include:

- to develop rainfed agriculture by promoting improved farm practices, while integrating cropping and livestock activities;
- to ease migration from the densely populated and relatively infertile north central plateau to areas in the west and southwest which have low population densities and a good agricultural potential; and
- gradually to intensify the development of swamp lands and irrigated agriculture, thus helping to protect the nation against the catastrophe caused by drought; and to ensure national self-sufficiency in food crops, particularly by replacing rice imports.

It is more specifically in the last objective that we are interested in this paper. The objective itself calls for the mobilization of more resources (land, water, labor, and capital) into food crop production in general and more specifically rice production. The potential offered by such strategy is suggested by the following.

It is estimated that Burkina Faso has a potential irrigable land of about 150,000 hectares (ha).[2/] These are mostly lowlands that are currently underexploited due to technical constraints given the hydromorphic nature of their soils and the poor distribution of rainfall throughout the wet season. These

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[1/] The 1978-82 plan is not available. Information given in this section is from P.T. Fotzo (1983, p. 63).

[2/] Ministere du Developpement Rural (MDR), DSA, January 1982.

lowlands are located in almost all parts of the country, including the "land-scarce" north central Mossi plateau regions. Such areas, if provided with water control systems, can be used to grow rice, the most suitable grain crop on these soils. The gains from such a policy are:

- a shifting of cultivation from the already overexploited upland soils (especially in the north-central plateau) to the underexploited but relatively fertile lowlands, permitting at the same time a longer fallow period in the upland areas;
- an easing of peasant settlements in the south and southwest regions and a release of population pressure on land in the north central plateau (hence a move toward the accomplishment of the second objective of the general plan);
- generation of more employment in rural areas both during the wet season and the dry season. Rice cultivation is relatively more labor-intensive than growing millet or sorghum (the major farming activity) and also offers the possibility of double-cropping under complete irrigation. Vegetable production can also be undertaken in some rice growing perimeters in the dry season, a period during which underemployment is high in rural areas.
- On the production side, rice has proven to be more responsive to changes in technology (i.e., fertilizer) than sorghum and millet (under actual farm conditions). Average farm level yields of rice in Burkina Faso range from 500 to 900 kg/ha against 300-600 kg/ha for millet and sorghum. Rice also presents a better future, given the existing low scientific knowledge on millet and sorghum in the country.

- Finally, the most important advantage (on technical grounds) of irrigated production over dryland agriculture stems from the reduction in the risk of crop failure as a result of weather vagaries. This risk has been very high recently in the Sahel and because of this the promotion of rice cultivation in improved seasonally flooded bas-fonds (lowlands) has been viewed as a better way of ensuring higher and regular crop output.

By increasing rice production, the government intends (besides the above effects on the agricultural sector) to match domestic supply with the already "high" demand. Average per capita rice consumption in Burkina Faso is about 5 kg and probably never went beyond 8 kg during the last two decades. Burkina Faso is thus a small rice consumer compared to countries like Senegal, Gambia, or Mali. However, although the staple food grains are sorghum and millet, rice is of growing concern to policy makers because in towns it is rapidly replacing millet and sorghum in the diet. This change in consumption habits coupled with an increasing urban population, which also enjoys a relatively higher income than the rural population and is certainly favored also by government food price policy, has pushed demand beyond the domestic production capacity.[1/] D. Ouédraogo estimates that in 1968 per capita consumption in the capital city, Ouagadougou, was already as high as 31 kg of rice per year. Domestic production barely covers 65 percent of demand in any year. As a result of the increase in rice consumption, imports soared from 2,341 tons in 1961 to 29,000 tons in 1980, which deeply affected the already strained government trade balance. Around the year 1990, demand is predicted to reach

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[1/] The shift to more rice consumption is also probably due to the shortfall in the supply of the other cereals during and after the drought of 1969-73, which in turn increased their prices relative to rice.

about 80 to 90,000 tons.[1/] This provides an incentive for the country to cut imports of food that it can produce satisfactorily itself (WARDA, 1981).[2/] To become self-sufficient in rice implies that domestic production would probably have to double by the 1990s. And, knowing whether or not this can happen depends on how much we know about the country's rice subsector and on how committed the government and its allies are with respect to the country being self-sufficient in rice. The latter question has already been discussed; basically the decision has already been made to expand foodgrain production in general and the government has given a high priority to promoting rice cultivation. Our attention in this paper shall be focused on the first question, namely, improving the understanding of how the rice subsector in Burkina Faso operates.

Objectives of the Study

Despite the government's concern to expand rice production, little is known about the behavior of both the production and the consumption of this commodity in the country. In general, the agricultural sector has until recently received very scanty attention from economists and statisticians. Agronomists and to some extent sociologists and geographers have examined in some detail the soils, cultural practices, land tenure systems, tools, and basic techniques used by farmers. Their efforts, however, have failed to produce much needed information such as crop acreages, yields, prices, and other data most relevant for policy formulation. Recent studies conducted under the auspices of international organizations and donor agencies (WARDA,

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[1/] Club du Sahel/CILSS, October 1979, p. 3.

[2/] Quoted in P.T. Fotzo (1983).

FAO, CILSS/Club du Sahel, USDA, etc.).[1] have succeeded in obtaining approximations which not only are rough but also are on a regional basis (i.e., the Sahel), which handicaps their uses in many situations. Rice is among the least documented crops in the country with respect to the responsiveness of both the supply and the demand to factor changes.

In 1980/81, P.T. Fotzo collected and analyzed detailed input/output data on cropping activities involving primarily rice growing in the eastern ORD.[2] This work has greatly contributed to our knowledge of the economics of lowland rice production at the farm level. However, the usefulness of the results on a country-wide setting is limited because they do not lend themselves to generalization throughout the entire country. Fotzo's study also involved only one cropping season and didn't concern itself with consumption.

The design and implementation of a food self-sufficiency program depend on, among other things, a good knowledge of how the food subsector operates and of how responsive both the demand and the supply of food goods are to various factors, such as the prices of food and of agricultural inputs. Thus, some basic understanding of the relationships within the rice subsector in the present context is desirable, and to the extent that reliable quantitative analysis is feasible, it can contribute to better policy formulation.

The specific objectives of the study are as follows:

(1) To provide an overview of the rice subsector in Burkina Faso.

(2) To develop an econometric model based on theory and knowledge of the economic relationships in the Burkinabé rice subsector.

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[1] WARDA stands for West Africa Rice Development Association.

[2] ORD stands for "Organisme Régional de Développement" (regional development organization).

(3) To formulate and estimate a statistical model of supply and demand relationships and to test whether the statistical results conform with our economic model.

(4) To interpret and apply the model to current conditions.

(5) To use the model in forecasting demand and supply for rice in Burkina Faso.

(6) To attempt, on the basis of the results, to provide a framework for taking action toward improving the current situation.

It is hoped that the analysis will contribute toward our understanding of the evolution of the subsector in general and may be useful for policy makers in formulating food security plans in Burkina Faso.

Plan of the Remaining Chapters

Chapter II takes a detailed look at the Burkinabe rice subsector. It is mostly a descriptive and diagnostic study of the evolution of the subsector since 1960. Chapter III sets the theoretical framework for the empirical supply and demand analysis, the results of which are discussed in Chapter IV. The results obtained from Chapter IV are used in Chapter V to project demand and supply and to draw some policy implications. This chapter is followed by a brief summary and conclusion in Chapter VI.

CHAPTER II

OVERVIEW OF THE RICE SUBSECTOR IN BURKINA FASO

Rice is an ancient crop in West Africa and is grown under a wide range of conditions. It is the fourth most important crop in sub-Saharan Africa in terms of acreage, after millet, sorghum, and maize. In the Sahel region of which Burkina Faso is a part, the expansion of rice cultivation, through the introduction of modern techniques (irrigation, biological material, mechanical materials, etc.), is not a new phenomenon. It goes back to the colonial era where the French government (the ex-colonial power), under the need to supply food to workers and especially to cities (like Dakar in Senegal), undertook the development of irrigated rice perimeters. One of the best known perimeters by Burkinabés is probably the Office du Niger in Mali. For its realization, the colonial power recruited hundreds of farmers from Burkina Faso (especially from the Yatenga region in northern Burkina Faso) to serve as a work force. Many of these farmers are now permanent migrants in the Office du Niger. Those who returned to Burkina Faso after independence are considered experienced farmers in irrigated rice cultivation. In the early years of independence (the 1960s), the new government of Burkina Faso, in the search for ways to promote its agricultural sector and more generally its economy, gave particular attention to rice production. The government's major motive for promoting rice production was similar to the motive under the French rule: to supply cities with enough food and especially with rice (the demand for which was already important) and at the same time reduce the country's dependence on outside food supplies. Since then, the government interest in the rice subsector and in general in the food sector has been increasing, as is true in the other Sahelian countries as well. The drought that plagued the

Sahel's agricultural sector in the 1969-73 period (and from which it hasn't recovered yet) drew more attention to the need for a new agricultural development strategy. Moving towards a more balanced strategy giving greater emphasis to food crops instead of the previous policy of concentrating solely on cash crops was viewed as a necessity in order for the region to survive. Sahelian governments moved from a passive role in the development of the food sector towards a more active role. Increasing food crop production and more specifically cereal output at "whatever cost" under the objective of food self-sufficiency became the backbone of many economic development plans. It is under this umbrella of assuring "food security" that high priority is given to the expansion of rice production alongside that of millet and sorghum in Burkina Faso.

As a result, the rice subsector,[1/] which was given little attention in the early 1960s, became, a decade later, a major concern for the Burkinabe' authorities. Since then, the government has been active at both the production and the distribution stages of this commodity. At the production level, the state is involved in various ways: development of lowlands, construction of dams and development of their downstream areas, provision of a total water control system (i.e., the Kou Valley case), organization of producers, and provision of inputs and extension services. At the marketing stage, the policies take the forms of price fixing and control, of buying and selling rice, and of restricting private entry in the cereal market in general through a system of licensed traders. These policies have contributed by and large to

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[1/] James D. Shaffer defines a subsector as a meaningful grouping of economic activities related vertically and horizontally by market relationships. The rice subsector is conceived in the same way in this study. It includes all the activities from farm-level production of paddy to the distribution and consumption of milled rice. It also includes the distribution of inputs used in rice production.

shaping the existing structure of the rice subsector and have also affected its performance.

A. Production[1/]

Rice is grown in Burkina Faso in seasonally flooded lowlands or bas-fonds scattered throughout the country, with a high concentration in the southwestern and southeastern regions (see Figure 1). As a result, the production tends to be concentrated in these areas where annual rainfall ranges from 800 to 1,200 mm. C.P. Humphreys and S.R. Pearson (1979-80) estimated that riceland represented an average of 1.4 percent of total cropland from 1976 to 1978, yielding an annual production of paddy of 33,000 tons (T) during the same period. Production practices are characterized by low and variable yields, ranging from 500 to 900 kg/ha on average. Depending on the degree of water control, four major types of production systems or techniques can be identified: the traditional production system, production in developed bas-fonds, production downstream of dams, and production under total water control. Each of these will be considered below.

1. The Traditional Production System

Under this technique, there is almost no attempt to control the flood in rice plots. This system represented almost 90 percent of total riceland in 1976 and contributed over 70 percent of domestic paddy production. Rice fields per farm unit rarely exceed .25 hectare (ha) and are minor compared to millet, sorghum, or maize fields. Family labor equipped with hand tools constitute the major input in the production process and may account for over

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[1/] Information presented here on the four types of production systems is drawn largely from Club du Sahel/CILSS, 1979.

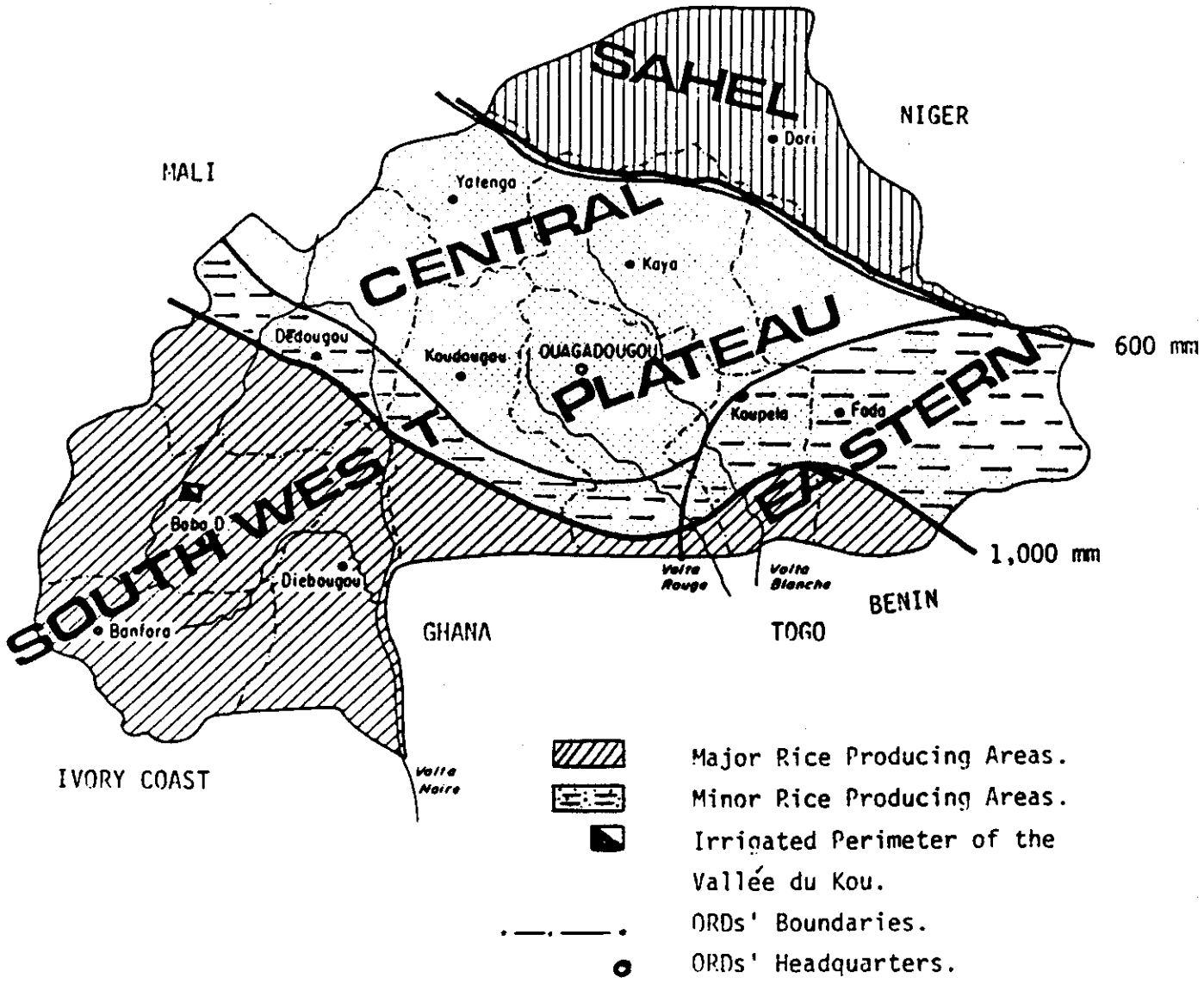

Figure 1 : Map of Burkina Faso with an Indication of Some Rice Producing Areas.

Source: Adapted from FAO, "Perspectives du Développement Agricole à Long Terme de la Haute-Volta".

70 percent of total production costs (see Table 2).[1/] The use of fertilizer, selected seeds, or animal traction is uncommon. Yields are very low and fluctuate widely from year to year according to rainfall. In general, the risk of crop failure under this system is high.

2. Production in Developed Bas-fonds

The development of bas-fonds has occurred for many years in Burkina Faso but it has expanded since 1972 within the framework of activities financed by the Rural Development Fund (known as FDR in the country) through IDA/IBRD loans to the government of Burkina Faso. The development of the bas-fond consists of building dikes to retain water on the plot longer than otherwise would occur naturally. Besides the investment costs estimated at about 45,000 F. CFA/ha and entirely borne by the government, local communities provide the necessary work force to build the dikes. Land is distributed through the initiative of the traditional community organization to families who participate in development activities, with each family receiving a parcel of about .2 ha. Since 1972, over 2,200 ha have been developed, most of them located in the north-central plateau and in the eastern part of the country (Club du Sahel/CILSS, 1979). The main problem with this system of improvement, as reported by Fotzo, is that after heavy rains the wings of the dike are wiped out with the consequence that water does not stay on the plot long enough for the investment in building dikes to be worthwhile. In addition, there have been frequent disputes over land holding rights and difficulties in selling the output from the bas-fond at remunerative prices.

[1/] Figures in this table are an illustration of costs and returns for four production systems identified by P.T. Fotzo in the Eastern ORD (1980/81 cropping season).

Table 2. A Comparative Financial Analysis of the Four Major Rice Production Techniques in the Eastern ORD, Based on Survey Data from 116 Households, 1980-81

Criteria	Production Technique			
	Traditional Bas-Fonds	Semi-Traditional Bas-Fonds	Improved Bas-Fonds	Irrigated Bas-Fonds
	I	II	III	IV
I. General Characteristics				
1. No. of Cases	64	76	45	62
2. Average Size (ha)	.411	.270	.488	.151
3. Average Yield (kg/ha)	458.3	1,172	501	1,736
4. Seed Rate (kg/ha)	23.6	50.8	38.0	57.7
II. Financial Situation (CFA/ha)				
1. Gross Income	27,773	48,872	32,916	89,925
2. Variable Costs	2,858	6,161	5,696	15,816
3. Total Expenditures (including depreciation on tools and equipment)	3,708	7,085	5,930	17,042
4. Opportunity Costs of				
4.1 Family Labor	11,515	44,200	28,490	80,352
4.2 Equity Capital	157	406	355	1,177
5. Total Costs	15,380	51,691	34,775	98,571
III. Performance Measures				
1. Gross Margin (II.1 - II.2)	24,915	42,711	27,220	74,109
2. Net Margin (II.1 - II.3)	24,065	41,787	26,986	72,883
3. Net Returns to Land, Family Labor & Management (CFA/ha) (III.2 - II.4.2)	23,908	41,381	26,631	71,706
4. Net Returns to Land and Management (CFA/ha) (III.3 - II.4.1)	12,393	-2,819	-1,859	-8,646
5. Net Returns Per Hour of Family Labor (CFA/phr) (III.3 + Total FL)	97.6	18.7	51.4	24.1
6. Total Costs of Production (CFA/kg)	33.6	44.1	69.4	56.8

Source: P.T. Fotzo, "The Economics of Bas-Fond Rice Production in the Eastern Region of Upper Volta: A Whole Farm Approach," Unpublished Ph.D. dissertation, Michigan State University, 1983.

The unwillingness of traders to offer attractive prices to farmers may be due to several reasons: high costs of producing and marketing rice compared to the cost of imported rice, possibly inadequate competition among rice traders in rural areas, and poor flows of market information within the subsector. Documenting the relative importance of these various reasons is an important area where further research is required.

All these factors have handicapped a rational exploitation of the perimeters. Probably no more than 50 percent of these developed lands are put under production each year. Yields are lower than expected, .7 to 1 T/ha, as opposed to expected yields of 1.5 to 2.5 T. The pattern of input use is similar to the traditional system described above.

3. Downstream Dam Production

This system consists of building a dam to store water and irrigate the plots downstream. Costs of investment are about 1 million F. CFA/ha. This land development activity is carried out by the "Office National des Barrages et de l'Irrigation (ONBI)," a national dam and irrigation office. Currently, the development of the dams covers a net irrigated rice area of 800-900 ha during the rainy season. Some 10 to 20 percent of this area can be irrigated during the dry season for vegetable production. Rice yields are higher than under the previous type of system, ranging from 1.5 to 2.5 T/ha. However, they also lie below their minimum expected level of 3 T/ha. Average land holding per farmer is between .25 ha and .50 ha. The risk of crop failure due to weather vagaries is reduced because of the possibility of irrigating when rainfall is irregular during the growing season. Although in some perimeters farmers may use fertilizers, the general patterns of input use still remain dominated by family labor, as in the previous systems.

Producers in this system are organized into cooperatives, or "groupement villageois," which are in charge of maintaining the perimeter, of helping in the procurement of inputs (such as fertilizer) and of organizing output marketing. User fees for the perimeter facilities amount approximately to 15,000 F. CFA/ha/year. The collection of these sums, however, has been difficult for both the co-ops and the ORDs which provide the technical assistance in the production process. The poor performance of these perimeters to date is due to both technical and socioeconomic factors. Poor design of the dams, resulting in defective filling up of the reservoir, and poor or inadequate drainage systems are not infrequent. The ORD's extension agents are not qualified in the management of irrigated perimeters, nor do many of the farmers have experience in rice cultivation under irrigation. Poor maintenance of the system and waste of water are consequences of this lack of technical know-how. Among the socioeconomic factors, it should be mentioned that rice cultivation is still a minor activity for many farmers. Millet and sorghum still dominate both their production and consumption activities. In general, they seem less inclined to devote the necessary time to grow rice than they do for millet and sorghum. As a consequence, their rice fields are poorly maintained in general. A probable explanation for this lies in the finding that growing rice is less profitable than growing millet and sorghum. Finally, disputes over land holding rights, which oppose migrants (or semi-migrants) and traditional landholders are not infrequent, resulting in the abandonment of some plots. In general, the co-existence of the different interest groups in these areas has never been easy; both the co-ops and the ORDs wind up not being trusted by many farmers.

With respect to the above three production systems, P.T. Fotzo (1983, pp. 110-112) gives comparative financial costs and returns per hectare for

typical farmers in the Eastern ORD. His classification of production techniques is, however, slightly different from the one adopted here. In his study, the first two systems, defined respectively as traditional bas-fonds and semi-traditional bas-fonds, are lumped together in this paper under the traditional production system. The so-called improved bas-fond and irrigated bas-fond refer respectively to our second and third production systems. Table 2 summarizes his findings.

In all cases, family labor accounts for the bulk of total production costs. Variable costs comprised mostly seeds. It is only in Fotzo's system four that fertilizer is used; in that system, fertilizer accounts for almost 43 percent of total variable costs. In general, the per-unit cost of production rises with the degree of sophistication in water control, which is clearly an indication of the relatively low productivity under these systems. The net return per hour of family labor declines from 97.6 F. CFA in the traditional system to 24.1 F. CFA in the irrigated bas-fonds.

4. Production Under Total Water Control: The Vallée du Kou Perimeter

In this system, rice is grown twice a year under complete irrigation. This rice project started in 1967 under the supervision of irrigation specialists from Taiwan and was completed and released to the Burkinabé authorities in 1975. Since then, its management has been taken care of by the ORD of the "Hauts-Bassins." A total of 1,270 ha of irrigable land has been developed, of which 1,200 ha are for rice cultivation and 70 ha for truck farming and fruit plantations. Out of the 1,200 ha reserved for rice, only 940 ha are currently in production. This project, the largest ever undertaken in the country, has permitted settlement of approximately 1,000[1/] families, the majority of which

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[1/] In 1978, D. Ouédraogo reported 940 families on the perimeter. The initial project was designed for the settlement of about 1,200 families.

originate from the north central plateau. The cost of relocation to the government is estimated at about 560 million F. CFA.[1/] In general, each migrant receives a plot of one hectare or more, depending on the size of the labor force he has in his family unit. Farmers are organized into a cooperative assisted in its activities by the ORD staff. The co-op organizes the marketing of rice, operates a milling facility, procures inputs, and manages collective equipment such as threshers. It is also responsible for the maintenance of the perimeter and collection of various farm loan repayments. D. Ouedraogo reports that besides the above activities the co-op is even involved in settling disputes between households, and in taking care of crime and delinquent wives or husbands. These activities are uncommon for a co-op and may handicap its functioning as a tool for fostering agricultural development.

Compared to the previous system, the Vallée du Kou production technique makes an intensive use of both labor and non-labor inputs. The total work force in each household is almost entirely devoted to rice growing. The cropping calendar is enforced by the settlement contract and there is little chance to get a field outside the perimeter. In sum, for migrant farmers there is little possibility to shift labor (or other inputs) from rice to other cropping activities (i.e., millet, sorghum, maize, or cotton) as is the case under the previous systems. The use of fertilizer is very substantial, over 300 kg/ha. Improved rice varieties are available from the agricultural research station located nearby and their use is required. In 1977, D. Ouedraogo estimated that there was a total of 194 oxen plows in the area, or

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[1/] At 1966 prices. This sum was a loan to be disbursed to families which accepted to settle in the perimeter. For more details on the use of the loans and the settlement arrangements, see D. Ouédraogo, "La Vallée du Kou (Haute Volta): Un sous-espace aliéné."

approximately one plow for every three households, which is very high by national standards.

In general, however, both the government's and farmers' expectations with respect to production and the desired socioeconomic status of the producer have not been met. Yields have steadily declined through time. From a level of 7 or 8 T/ha in the early years of exploitation, they have declined to around 3.5 to 5 T on average and rarely exceed 6 T in any year (see Table 3). The lack of experienced extension agents in irrigation, the poor drainage system, and the declining soil fertility are among the factors that contribute to this situation. On the farmer's side, D. Ouédraogo mentions an undesirable social climate between migrant and indigenous populations. Not only do differences in cultural backgrounds exist between these groups but also the indigenous group has viewed the migrants as usurpers of its traditional usefruct right of land. Ouedraogo also cites the relatively low and declining returns from production as a major reason for declining yields. Unfortunately, a lack of data on costs and returns prevents an appraisal of this assertion. It is, however, said that many farmers have abandoned the perimeter partly because of this problem.

The production from the Vallée du Kou project is sold in bulk to a parastatal (initially SOVOLCOM and then OFNACER)[1/] or to private traders under an arrangement made by the co-op. The government official producer price is in general enforced here, which is not necessarily the case elsewhere in the country. However, due to its poor management and its overextended activities, many producers have little faith in the operation of the co-op. They sometimes bypass its market arrangement by selling part of their rice

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[1/] SOVOLCOM stands for "Société Voltaïque de Commercialization" and OFNACER for "Office National des Céréales."

Table 3. Evolution of Rice Production and Uses in the Vallée du Kou (1970-77)[a]

Year	Harvest (No.)	Area (ha)	Production (T)	Yield T/ha	Marketed (T)	Home Consumption (T)
1970	2nd	100	670	6.7	578.9	91.1
1971	1st	100	687.5	6.9	584.2	103.3
	2nd	312	2,162	6.8	1,915.6	246.4
1972	1st	316	2,140.8	6.6	1,957.7	182.4
	2nd	621	3,653.8	5.9	3,153.8	500
1973	1st	621	2,484	4.0	1,070	1,414
	2nd	921	4,114	4.5	2,310	1,804
1974	1st	889	4,326	4.9	2,876.8	1,444
	2nd	820	3,617.7	4.4	2,219.7	1,400
1975	1st	867	3,952.2	4.5	2,552.2	1,400
	2nd	867	3,648.6	4.5	2,248.6	1,400
1976	1st	867	4,299.3	5.0	3,299.3	1,000
	2nd	850	2,686.2	3.1	2,086.2	600
1977	1st	938	3,400	4.5	2,600	800
	2nd	965	3,500	3.7	2,700	800

[a]All figures are rounded to one decimal.

Source: D. Ouédraogo, Communications, La Vallée du Kou (Haute-Volta): Un sous-espace aliéné, C.N.R.S.T., Ouagadougou.

directly to consumers or wholesalers. This practice is also encouraged by the delay in cooperative payments for delivered produce.

Because of the various problems encountered in the exploitation of this type of perimeter and the cost incurred for its development, sociologists and economists have come to question its raison d'être and its future. Currently, a project to rehabilitate it (correct deficiencies in the irrigation system and restore soil fertility) has been designed and external funding sought. This project, if implemented with an adequate staffing, may help alleviate only technical problems. For the socioeconomic ones, there seems to be no solution in the near future, and the government even attempts to ignore them. The following statement from a document of the Ministry of Rural Development (MDR) serves as a testimony: "In general, migrant peasants have adjusted well to the environment, and in a global sense, the project can be considered as a success. . ."[1/] Thus, the decline in productivity is considered only as a technical matter. Obviously, there is a need to look at the problem in another perspective, and a thorough investigation beyond what has been done up to now may be necessary. The high migration level (well known in the country) both internally and externally is primarily an economically induced phenomena. This rationale of the migrants, if not recognized, may result in the failure of many settlement projects in the country.

In general, the opportunity sets of producers under these four production techniques differ. The more sophisticated the water control system is, the lower the risk of crop failure. The degree of crop substitution in the first three systems is higher than under the fourth system, and rice cultivation for farmers in the first three systems is a minor activity. The

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[1/] MDR, SG, DSA; Annex I, Production végétale (January 1982, p. 38).

so-called substitution, however, should be viewed only as the possibility for farmers to shift all or part of their inputs except land away from rice in any year; lowlands (bas-fonds) are well suited only for rice.

Production costs, in general, tend to rise with the degree of water control, while productivity does not necessarily increase enough to justify the investment cost for water control.[1/] All producers rely on the government for the supply of chemical inputs, improved seeds, and animal traction equipment. Since 1972, the government has subsidized these inputs (including improved seeds) at a rate ranging from 25 to 53 percent of their real costs (C.R. Humphreys and S.R. Pearson, 1979-80). This policy has indirectly made government the sole legal input supplier in the country.

With respect to the output market, it appears that the higher the concentration of producers in a given area, the more likely the official producer price is to be enforced. This is also consistent with OFNACER's buying pattern, as we will see later. These areas of concentrated rice production are primarily the Vallée du Kou and to a certain extent some irrigated perimeters below dams. Marketable surplus is likely to be higher in these areas despite the relatively high level of home consumption, as shown in Table 3.

In sum, two points can be mentioned with respect to government input and output price policy:

- The bulk of the rice production does not directly benefit from the input subsidy.
- Only a small proportion of product is traded at the official price (at least as documented). The bulk of the marketable surplus is traded at prices not really known by price reporters in the country.

[1/] Humphreys and Pearson advocate that on economic grounds, and given current technology, rice production is viable only under the traditional system. P.T. Fotzo also has come to a similar conclusion.

5. Evolution of Rice Production in the Country

In any year, the proportion of rice produced under each technique is poorly known. Rather, aggregate production is recorded for the entire country. The evolution of acreage, yields, and production from 1963 to 1981 is shown in Table 4, and Table 5 gives a comparative evolution with other crops.

From an annual average of 35,000 ha in 1963-67, total acreage increased to 41,000 ha in 1969-73. During the next five-year period (1974-78), a net increase of about 2 percent above the 1969-73 period level is noticed. In general, during this 19-year period, total acreage under rice increased by some 1.2 percent per year on average. Yields, on the other hand, fluctuated from year to year but the trend is clearly declining. They never reached their 1963-67 level since the drought of 1969-73. It is difficult to detect from the table any direct association between the annual variation of yield and rainfall. However, one may be tempted to say that the data tend to support a priori the existence of a positive correlation. Low yields, in general, correspond to years of poor rainfall and high yields to years of relatively high rainfall. This, however, remains to be verified.

Total production increased by approximately .7 percent per year from 1963-65 to 1979-81. The gain in production has resulted only through an increase in area (yield has declined by .7 percent per year). This result is similar for groundnut production. Cotton is the only crop which performed relatively well through a substantial increase in yields (about a 9.5 percent gain per year). Sorghum, the major food crop, performed relatively well despite the harsh environment. However, as indicated by the World Bank, the increase in sorghum yields is probably the result of rotation on fertilized cotton fields in the more favorable southwest region. Compared to other crops, cotton benefits not only from a long research experience (both inside

Table 4. Evolution of Rice Production in Burkina Faso, 1963-1981

Year	Area (1,000 ha)	Yield (kg/ha)	Production (1,000 T)	Rainfall[a/] (mm)
1963	33	758	25	984.5
1964	35	971	34	981.7
1965	35	971	34	865.2
1966	35	971	34	869.7
1967	36	1222	44	771.5
1968	46	870	40	961
1969	40	850	34	923
1970	41.2	881	36.3	844.2
1971	40	923	36.9	736.7
1972	40.4	832	33.6	787.7
1973	41.4	748	31	709.2
1974	42	929	39	892.5
1975	41.3	920	38	752.1
1976	42.1	867	36.5	839.2
1977	41.6	778	32.4	679.5
1978	41.2	765	31.5	823.7
1979	41	768	31.5	753
1980	40	716	28.6	788.4
1981	40	725	29	751.6

[a/] National average.

Sources: Data for rice are from WARDA, Rice Statistics Yearbook, 4th ed., June 1981, Monrovia, Liberia. Rainfall data, 1963-75, are from World Meteorological Organization (WMO), Monthly Climatic Data for the World (various issues). Data from 1976 to 1981 are obtained from FAO/PAM, Rapport de Mission sur l'évaluation de la situation alimentaire, Rome, 1980.

Table 5. Compound Annual Average Percentage Change in Area, Yield, and Production for the Six Major Crops in Burkina Faso from 1963-65 to 1979-81

	Rice	Millet	Sorghum	Maize	Cotton	Groundnuts
Acreage	1.3	.4	-.2	-2.7	2.9	1.7
Yield	-.7	.2	1.1	2.1	9.5	-.8
Production	.7	.6	.8	-.7	12.7	.8

Figures are growth rates based on changes between the average figures for 1963-65 and 1979-81. The sum of the changes in yield and acreage may differ slightly from the figure for the change in production due to rounding. Data used for the calculation are taken from "Rapport Mission Conjointe Banque Mondiale/FAO/ISNAR sur la Recherche Agronomique en Haute Volta, 1983."

and outside the country, especially in Mali) but also from a well-organized market network.

In sum, the various government land development programs undertaken since 1967 have certainly been key elements in increasing rice production in the country. They have, however, failed to provide enough "ingredients" to push upward yield levels. Therefore, efforts on production research are needed to supplement these programs.

B. Marketing

Marketing of staple food crops in Sahelian countries involves different interest groups with sometimes conflicting objectives. The food grain distribution channel involves private traders, parastatals, and producers acting either on an individual basis or under a cooperative or "groupement." Private traders and individual producers, who dominate the system (in terms of both number and quantity of produce handled), have been present in the market for centuries. Government participation in food grain marketing is in that sense a recent phenomenon. In fact, while governments in the Sahel were active in the cash crop market since independence, their emergence in the food crop market dates in general only from the early 1970s. They engage in food grain trading through parastatals as a way to implement their cereal policies. If, in general, the idea of having a parastatal as a marketing body was initiated by political authorities in those countries, funding for their realization and their initial operating capital has been largely provided by external donors. In some instances, these donors provided also management assistance. Yet, on the basis of their performance during the last decade, criticisms concerning the effectiveness of these agencies as policy instruments to promote the food sector abound in the current literature. The appraisal of these

criticisms is, however, beyond the scope of this paper and as so is not attempted.[1/] Only a brief description of the Burkinabé agencies is presented in what follows.

In Burkina Faso, there are basically three government organizations present in the cereal market--the ORDs (Organisme Régional de Développement), SOVOLCOM (Société Voltaique de Commercialization), and OFNACER (the Office National des Céréales). The ORDs were created starting in 1966. There are eleven of them currently, one in each of the administrative regions of the country. Each ORD is in charge of coordinating all the rural development activities in the region it operates. Their operating expenditures and their activities are financed from the government budget and from external funds. However, because the statute that created them states that the ORDs should in the longer term be able to self-finance their activities, they were granted the right to engage in revenue-generating activities. More specifically, they were authorized to engage in both production and commercial activities whenever they found it profitable to do so. Their buying and selling of grains in the early 1970s is partly understood on this ground. However, more generally, the ORDs were allowed to participate in the cereal market in order to help the government enforce its official grain prices.

SOVOLCOM was created in 1967 and operates under the Ministry of Commerce. It is active in the marketing of various commodities ranging from construction materials to household items and food goods. Its participation in the cereal market is dominated by the importation and distribution of rice and wheat flour. It doesn't, however, hold any monopoly right on imports. In the

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[1/] For discussions of the historical evolution, roles, and performance of parastatal or grain marketing boards in Sahelian countries, see: Barbara Harriss, 1982; CRED, Vol. II, 1977; CILSS/Club du Sahel, 1979; and Ismael Ouedraogo, 1983.

country, it also buys and sells local rice. In general, its presence in the market is noticeable only in cities through retail outlets and in the Vallee du Kou to a certain extent.

OFNACER, created in 1971, has emerged as the main instrument of government cereal market policy. Its mandate can be summarized as follows: stabilization of producer and consumer prices both within and between years, facilitation of grain movement from surplus areas to deficit areas, and creation of an emergency food grain reserve.[1/] Besides the purchasing and selling of domestically produced cereals, OFNACER has been granted the right to import and handle the flow of food aid, which has been important since 1972/73.

Both producer and consumer prices are fixed by government, and trading in grain is legal only under the delivery of a license. A total of 64 licensed dealers operated in 1969/70 and 51 in 1970/71.[2/] In 1974, a monopoly right of grain assembly was granted to the ORDs and traders licensed by OFNACER, which in turn was given the monopoly of grain distribution to consumers. However, the poor performance of OFNACER as a market leader and of the ORDs, which in fact never succeeded in agricultural product marketing, forced the government to repeal the monopoly rights in 1978. Since then, the ORDs have almost stopped their market operations and OFNACER uses its own agents, village groupements or co-ops, and licensed traders to carry out its marketing function. Even "illegal" merchants are said to serve OFNACER. In the rice market, all the above parties are present. They compete and/or cooperate, guided by market incentives and/or political aims.

[1/] Ismael Ouedraogo (1983, pp. 26-27).

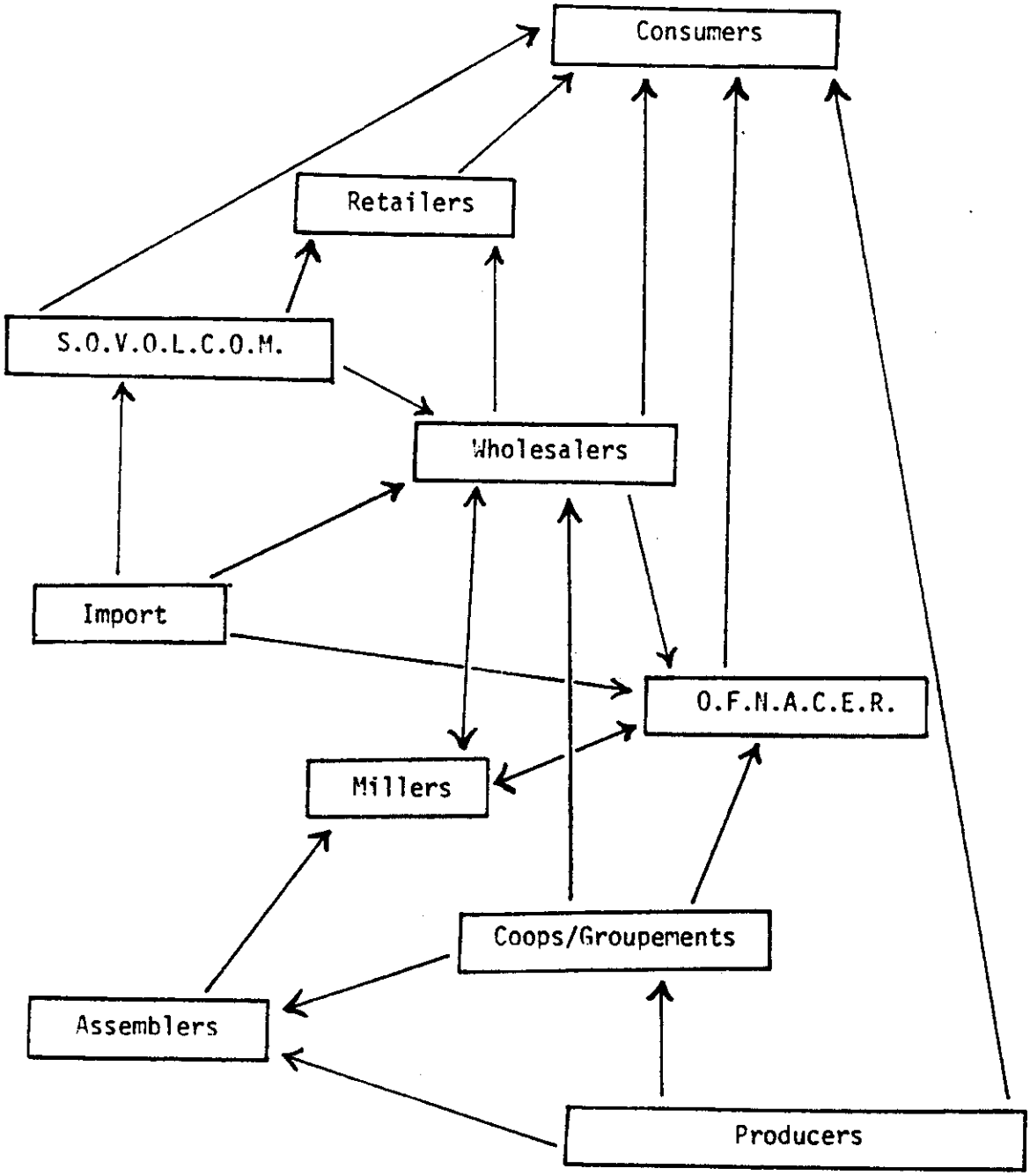
[2/] Alden A. Ackels, et al. (1970, p. 113).

1. Rice Distribution Channels

Figure 2 is a representation of the existing distribution channels for both domestic and imported rice. There has been no attempt to indicate any outflow of domestic production to neighboring countries because of the lack of firm information on such movement. This does not mean that we deny the existence of such a flow. Price differentials between countries may induce such flow since borders are not well controlled. Rice could flow either to the Ivory Coast, Niger, or Togo. On the figure, arrows indicate the direction of major flows.

Except for the participation of SOVOLCOM, the marketing circuit for rice is not different in general from that of other cereals. There is a remarkable dominance of private trade despite government "restrictions" in its attempts to enforce both its minimum producer and floor consumer prices. Producers may sell directly to consumers at village market places or to an assembler acting on behalf of a wholesaler. It is also at the village market level (and even at the farm gate) that many women in the restaurant business get partly supplied. Small quantities (usually about 50 kg) are offered at a time for sale, requiring a good effort of collection on the part of assemblers. A producer co-op or groupement may deliver its product to either a private dealer at a negotiated price or to OFNACER at the official price. In general, price "negotiation" may exist except when selling to a government agency, which pays the official price. So prices received by farmers through their transactions in the private circuit are not really known. Many government sources, however, report that in general prices in these private transactions are lower than the official prices because of the "exploitative" behavior of private traders and the lower bargaining power of farmers. This belief, coupled with the desire to provide urban residents with grains at low prices, has been a key element

Figure 2 : Rice Distribution Circuit.



in the creation of government grain marketing agencies. From 1974/75 to 1978, purchase and sale of rice was the responsibility of the ORDs and OFNACER. However, given their limited budgets and the government interest in promoting irrigated rice, their operations have been limited to only few large perimeters where co-ops and groupements are also strong (e.g., the Vallée du Kou). So, the bulk of the production still goes through the unofficial circuit.[1/] Another interesting feature of OFNACER is its direct link with the private system, as indicated in the figure. The latter is regularly contracted by OFNACER to provide buying services, transport, and storage facilities. The import of rice is the domain of SOVOLCOM, OFNACER, and licensed traders. Both retailers and wholesalers also are supplied by SOVOLCOM with imported rice. This practice makes it easier for the government to enforce the official consumer price.

In fact, until recently, the government succeeded in controlling imports in order to protect local production. After 1974, the food shortage in the country made this policy difficult to implement and imports rather than domestic production tended to be the source of supply to the large urban market. This was especially the case in the 1977-79 period, when imports dominated local production. Another rice importer (as mentioned by the World Bank in its 1982 study) is the army, which "imports large quantity of rice without regulation or payment of tariffs."

Food aid has been important in the country since 1969-73. It is handled by OFNACER and some voluntary organizations. Unfortunately, statistics on food aid flowing into the country since this period are very poor. Various

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[1/] The World Bank estimates that 16 percent of annual paddy is produced in large perimeters and 8 percent on improved lowlands that have received some investment.

organizations (both domestic and international) give different quantities for each year, as is illustrated by Table 6. Statistics on commercial imports suffer also from the same lack of accuracy. However, the various figures in Table 6 indicate that the proportion of rice as food aid has remained small compared to sorghum, millet, and maize. If received by OFNACER, it has been usually sold at the official consumer price.

Finally, with respect to milling facilities, little is known. Their number, size, location, and operation remain a domain to be investigated. The mills usually mentioned are two large government-operated ones: the first is in Sissalia and the second in the Vallee du Kou, both situated in the neighborhood of Bobo-Dioulasso. Besides these, there are several small-scale mills privately operated in major cities. Hand pounding is still dominant in rural areas.

In view of the above, it can be concluded that the rice market in Burkina Faso and the cereal market in general involve both the private and the public sector. Despite a so-called control being exercised over the private sector, it continues to dominate the market and even provides various services to the public sector (i.e., OFNACER).

2. Prices

Table 7 gives the evolution of some agricultural commodity prices from 1965 to 1980 and Table 8 depicts changes in the relationship between the price of rice and that of other crops. The data presented and used for the calculation of the various ratios are not exempt from criticism with respect to their accuracy. So the analysis and the results derived are bound to the quality of these data. With respect to input prices (not shown on either table), no major change in nominal prices has occurred over the last two decades. They

Table 6. Comparative Food Aid Estimates
(Tons)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1. Sorghum, Millet & Maize													
a) Official	-	-	-	-	-	-	-	-	-	9,184	1,085	19,682	-
b) PAM	-	-	-	-	-	-	-	-	30,091	8,710	32,297	33,137	20,614
c) OFNACER	-	33,900	30,000	26,000	19,200	0	0	28,939	15,617	14,691	9,945	27,267	12,584
d) USAID	-	-	-	-	-	-	-	84,000	32,000	29,000	30,000	42,000	30,000
e) French	-	22,000	22,000	54,000	3,000	1,000	17,000	106,000	31,000	-	-	-	-
f) FED	-	21,900	22,000	53,500	2,900	700	18,000	70,200	34,000	-	-	-	-
2. Rice													
a) Official	-	-	-	-	-	-	-	-	-	5,503	3,558	929	-
b) PAM	-	-	-	-	-	-	-	-	5,377	5,940	5,366	4,355	3,449
c) OFNACER	-	200	0	700	0	0	0	3,262	2,397	2,696	0	2,372	3,030
d) USAID	-	-	-	-	-	-	-	4,000	6,000	8,000	7,000	4,000	3,000
e) French	0	1,000	3,000	9,000	0	0	3,000	0	3,000	-	-	-	-
f) FED	-	500	3,000	8,500	0	0	3,300	2,500	5,400	-	-	-	-

Source: Steve Haggblade, "An Overview of Food Security in Upper Volta," July 16, 1984.

Table 7. Evolution of Official (Producer and Consumer) Prices and the Market Consumer Prices of Selected Crops (F. CFA/kg)

Year	Rice			Millet and Sorghum			Groundnuts (Shelled)	Cotton
	Producer (Paddy)	Consumer	Market	Producer	Consumer	Market	Producer	Producer
1965	-	-	57	11	24	29	26.75	34
1966	18	-	60	13	26	31	26.75	34
1967	18	-	63	14	28	32	26.75	32
1968	19	-	65	12	30	28	26.75	32
1969	19	-	79	12	39	39	25.75	32
1970	19	-	74	12	32	32	25.75	32
1971	19	-	62	12	31	40	25.75	32
1972	19	59	66	14	26	41	25.75	32
1973	28	70	78	18	30	60	26.83	35
1974	35	-	93	22	37	68	34	40
1975	35	121	121	18	30	45	34	40
1976	35	115	144	23	35	57	38	40
1977	55	115	174	32	45	124	44	55
1978	63	125	165	40	57	124	54.29	55
1979	63	125	176	40	57	135	54.29	55
1980	63	125	176	45	69	129	81.9	55
1981	68	-	198	50	80	135	130.8	62
1982	68	-	151[a/]	60	83	80[a/]	138.8	62
1983	74	-	151[a/]	66	90	89[a/]	138.8	70

[a/] Haggblade reports that these prices may not represent market prices given the difficulties in procuring grain at other than official prices during these years.

Source: Official producer and market prices of rice (1965-67) come from WARDA, Statistics Yearbook, Monrovia, 1978 and 1981.
Prices from 1968 to 1979 are from World Bank (1981 and 1982).
Prices from 1980 to 1983 are from Steve Haggblade (1984), "An Overview of Food Security in Upper Volta."

Table 8. Evolution of the Ratio of the Rice Price to the Price of Other Crops[a/]

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Rice/Millet & Sorghum	1.6	1.6	1.6	1.6	1.4	1.5	1.6	1.9	1.5	1.7	1.6	1.6
Rice/Groundnuts	.7	.7	.7	.7	.7	1.0	1.0	1.0	.9	1.3	1.2	1.2
Rice/Cotton	:6	.6	.6	.6	.6	.8	.9	.9	.9	1.0	1.1	1.1
Rice/Millet & Sorghum	2.3	2.0	2.3	1.5	1.6	2.3	1.4	2.7	2.5	1.4	1.3	1.3

[a/] The first 3 rows are on the basis of official producer price and the last on the basis of market consumer price.

Source: Calculated from data in Table 8.

have been kept at the same level for several years and are subsidized prices, as mentioned previously. What can be said is that their real cost has steadily declined throughout time.

From 1968 to 1972, the official producer prices for all commodities remained unchanged. During the same period, the consumer price index rose on average by 4 percent per year,[1/] which translates into a decline in the real price of agricultural commodities. Official producer prices were allowed to rise in 1973 and 1974, probably as a way to induce more production after the drought and to raise farmers' incomes, which were severely reduced during this period. In relative terms, the ratio of the producer price of rice to other crops (millet, sorghum, groundnuts, and cotton) increased respectively by 44, 41, and 48 percent from 1972 to 1975. Rice growers have been thus more favored compared to their counterparts during this period and even after.[2/] Up to 1976, the opportunity gain of growing cotton remained relatively high compared to other crops but declined after that. The same thing is observed for groundnuts, up 1972 with respect to cereal crops. This phenomena, coupled with the relatively well-organized market for cash crops, appear to militate in favor of the general belief that the government agricultural policy is biased towards cash crops. The gains from this bias, however, are not fully captured by cotton producers. Calculation of nominal protection coefficients (NPC)[3/] by the World Bank using 1979/80 local market prices (except for cotton

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[1/] Percentage change in CPI is calculated from BCEAO price index data (1970=100).

[2/] This price movement reflects only government intentions and doesn't necessarily mean that producers got paid these prices. The trend in market consumer prices suggests that producers may have actually received lower relative prices for rice after 1976 despite the government's intention to maintain the price of rice relative to other crops above 1972 levels.

[3/] The NPC is defined by the World Bank as the ratio of the financial to the economic price. A coefficient greater than 1 indicates protectionism while a coefficient less than 1 indicates that producers are taxed. Income transfer is involved in both cases.

where the official price is used) indicates that cotton producers are taxed (the estimated coefficient was .83 on average). All coarse grains on this basis were taxed by some 15 to 25 percent according to the Bank.[1/] Groundnuts, with an average coefficient of 2.3, were highly protected. In fact, assuming that local market prices are higher than the official ones, the NPCs would be lower if calculated from the latter, which implies a higher tax on cereal producers. With respect to this point, Humphreys and Pearson (1979-80) wrote: "Domestic price policies tax producers or would do so if government purchase of paddy were significant." The net transfer involved in the process will probably be lower if we take into account the subsidy on farm inputs. The higher the level of input used in the production of a given commodity, the lower the income transfer from its producers. However, as seen previously, this is not likely to be the case for the majority of rice growers.

On the consumer side, the market prices have been consistently higher than the official ones, which may indicate that the government has not been able to keep prices at the desired level. During the 1977-80 period, the market price was double the official price for millet and sorghum and was 30 to 50 percent higher than the official price for rice. The rice to millet and sorghum market price ratio dropped from 2.3 in 1968 to 1.3 in 1973. It increased to 2.7 in 1975 and declined again in the 1977-79 period to 1.3. The relative gain made by sorghum and millet prices in the 1971-74 and 1977-79 periods was probably a result of the reduction in the supply of these grains during these periods, while rice was made available through imports. The changes observed in favor of rice in 1975 were possibly due in part to changes in the world price of rice in 1973 and 1974. In 1973, the world price

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[1/] The NPC for rice is about .9 which indicates that rice is barely taxed.

increased by some 65 percent from its 1972 level and by almost 98 percent in 1974 from its level in 1973.[1/] A lagged response in the domestic market might have happened due to the land locked position of the country; carryover from previous stocks were reported nil or negligible by WARDA. It can also be noticed that the magnitude of the increase in world prices was not fully passed on to domestic prices. The latter increased only by 19 percent between 1973 and 1974 and 30 percent between 1974 and 1975.

An alternative explanation of such differences in price variation between the two markets may be that the government either subsidized imported rice or obtained it from food aid programs. In 1974, for example, WARDA reports that out of a total of 18.7 thousand tons of imports, 17.5 thousand tons were food aid. Domestic production (less seeds and losses) was only 16.2 thousand tons of milled rice in that year. In general, starting from 1975, rice imports have been relatively important in some years, creating some problems for public authorities. A "confusing market situation," as noticed by the World Bank, existed, especially in 1978. In that year, in an attempt to protect producers (and to a certain extent consumers), the government raised the paddy price to 63 F. CFA and fixed the consumer price at 125 F. CFA. At the same time, imports were not controlled. The result, as reported by the Bank, was that instead of being sold at least at the official price (125 F. CFA), imported rice turned to be priced at 110 F. CFA on the retail market.[2/]

[1/] The percentage changes in the world rice prices are calculated from WARDA prices (1978, Table 17).

[2/] 1978 was an election year in the country. Therefore, this "confusing market situation" may not have been unintentional.

So in the late 1970s, the relative cheapness of rice compared to millet and sorghum for the consumer was likely the result of two things (among others): reduced supply of millet and sorghum and an increased availability of rice through external sources of supply. Production of maize, the third food crop, has also been small since 1969. The shift into more rice consumption (especially by urban residents) observed after the drought period is certainly a consequence of the above cereal market situation. Per capita annual rice consumption of about 7.5 kg during the 1975-77 period has been the highest throughout the last two decades.

From a global perspective, the government policy to expand rice production is handicapped by several aspects of the current marketing situation. Production is discouraged not only by the official pricing policy but also by the entire marketing system, which is poorly developed as opposed to the cash crop market. Producers are in several instances not sure to get a buyer for their product at remunerative prices. Private traders operate under high costs and risk, due especially to the lack of an appropriate road network. Even if the official price was attractive[1/] enough for producers, OFNACER would lack the necessary means to translate it into a corresponding change in marketable surplus. Another problem faced by producers is the high competition between domestic rice and imported rice.

Promoting domestic rice production will require, among other things, that either production and marketing costs be lower domestically or that a wedge be driven between international and domestic prices. Such a wedge can be accomplished in two ways: through trade barriers (tariffs and quotas) or

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[1/] With respect to this point, a CRED study (1977) pointed out that in fact cereal prices have not been generally low as commonly believed. The World Bank, in its 1982 study, argues that the terms of trade have turned in favor of agriculture since the drought of 1969-73. However, producers are still slightly taxed (see page 38).

subsidies on production, marketing, or consumption. Production and marketing costs do not appear to be falling in the country, nor has the government erected trade barriers against imports. Although some subsidies have been provided on production inputs, these have proven very costly and have not succeeded in making locally produced rice highly competitive with imports given current import policies.

Finally, the trend in the relative prices of food grains is likely in the future (unless it is reversed) to lead to a shift from rice production to that of sorghum, millet, or maize.[1/] This phenomenon is likely to be reinforced if the consumption patterns, dominated by millet and sorghum in rural areas, enter into play.

C. Consumption

With an estimated average annual per capita consumption of 6 kg[2/] of rice, Burkina Faso is among the smallest rice consumers in the Sahel region. Gambia and Senegal, with per capita consumptions of 88 and 47.2 kg, respectively, are considered the highest rice consumers in the region. Figures in Mali are lower (25 kg).

The diet of the Sahelians, in general, is dominated by cereals. About 60 to 70 percent of their daily caloric intake comes from cereals and more

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[1/] This assumes that the cost of production of the different grains remains stable. If the per unit cost of producing rice were declining, then its price could also decline with no reduction in production. Figures cited earlier, however, indicate that the cost of rice production has not decreased with the large projects. This may be a consequence of the lack of adequate production research to develop appropriate technology that might allow an increase in output and/or a decrease in cost.

[2/] Figures reported for the different countries refer to the 1975-77 period and come from CILSS/Club du Sahel, 1979, pp. 42-44. The per capita consumption of 6 kg given here is lower than the one calculated from WARDA's statistics for the same period (see p. 40).

specifically from millet and sorghum. Rice consumption, in general, is considered as an urban phenomena, especially in Mali, Niger, Senegal, and Burkina Faso. However, except in Mali (to a certain extent) none of these countries is a large rice producer nor does it have a comparative advantage in the production of this commodity. During the last decade, the rate of self-sufficiency in rice has steadily declined in the Sahel. Domestic supply lagged behind demand, owing largely to a relative reduction in production and a sustained population growth rate, especially in urban centers (about 6 percent per year in 1970-80 period). The cost of such a situation has been a rising import bill for these countries.

Burkina Faso, as part of the region, is not an exception to the above food problem. Expanding rice production to meet an increasing demand and to save on foreign exchange has been a concern for the state since independence in 1960. Except in 1963, when some 27.3 tons[1/] of rice were exported, the country has been a net rice importer. Import bills rose from 14.6 million F. CFA in 1961 to 115 million F. CFA in 1965 and to 810 million F. CFA in 1975. During these two decades, production lagged behind consumption, as indicated in Table 9. The rate of self-sufficiency fluctuated from year to year up to 1972, when it recorded its highest level (98) since 1963. The trend is clearly declining after this period. This decline in the rate of self-sufficiency possibly resulted from the following: (1) a small growth rate in production (as already mentioned); and (2) a substantial increase in total rice consumption, especially from 1972 to 1980 compared to its previous levels.

[1/] Jean Kellerman, February 1967, p. 57.

Table 9. Evolution of Rice Consumption and the Self-sufficiency Rate in Burkina Faso

Year	Domestically Produced Rice (Milled) (1,000 T)	National Rice Consumption (1,000 T)	Per Capita Consumption (kg)	Rate of Self-sufficiency (%)
1963	.23.5	21.3	4.8	110
1964	12.2	17.0	3.8	71.8
1965	17.2	20.4	3.6	84.3
1966	17.2	21.3	4.5	80.8
1967	17.2	24.7	5.3	69.6
1968	22.3	23.6	4.8	94.5
1969	20.3	21.8	4.4	93.1
1970	18.0	20.2	4.0	89.1
1971	19.5	20.6	4.0	94.7
1972	19.5	20.2	3.8	98.0
1973	17.8	29.6	5.5	60.1
1974	16.2	31.9	5.8	50.8
1975	21.0	39.0	7.0	53.8
1976	20.3	41.9	7.4	48.4
1977	19.5	47.9	8.3	40.7
1978	17.1	33.5	5.6	51.0
1979	16.6	34.5	5.7	48.1
1980	16.6	40.6	6.5	40.9

Source: WARDA, Rice Statistics Yearbook, 4th ed., June 1981, Monrovia, Liberia.

Reasons behind the substantial increase in national rice consumption (more specifically since 1970) are numerous. Population growth, urbanization, income, and the decline in its price relative to sorghum and millet, among other things, explain this change. During the two decades, the population growth rate remained at about 2 percent per year. National rice consumption grew on average by 5.1 percent per year. The high growth rate in total consumption is more likely to be an attribute of urbanization and/or price policy than a global population growth phenomenon. Since 1965, the country has experienced a high urban population increase as elsewhere in sub-Saharan Africa. During the 1965-75 period, the number of city dwellers increased on average by some 7 percent per year (WARDA, 1977, Table A-3, footnote 3).[1/] In general, while consumption in the countryside is said to be small, the share of rice in the diet of urban population is important. The 1963/64 consumption study[2/] by the Ministry of Rural Development (the only nationwide consumption study done up to now) showed a per capita annual consumption of 31 kg in Ouagadougou (the capital city) and 49 kg in Bobo-Dioulasso, the second largest city in the country. Figures reported in rural areas were low: 2.5 kg in the north central Mossi plateau region and 4 kg in the western region.

The differences observed between these two rural areas are not only due to population (the former is more populated than the latter) but more specifically a consumption habit effect, mostly related to the type of crop grown in each area. More rice is grown in the western region (where it has been part of the traditional agricultural system for centuries, especially among the Senoufo ethnic group near Ivory Coast) than in the north and central Mossi

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[1/] The World Bank 1983 report indicates an urban population growth rate of 6 percent per year for the 1970-81 period.

[2/] Jean Kellerman, February 1967, p. 57.

plateau. As a result, and given the subsistence agricultural system, the diet of both the rural and urban population in the western region has always comprised more rice than that of the population in the other regions.[1/] It is partly on the basis of this consumption and production that Kellerman in 1967 argued that programs to expand rice cultivation should primarily be undertaken in the western region.

The relatively high proportion of rice in urban diets is not a new phenomenon. It goes back to the colonial era when the French government, under the need to feed his functionnaries, students, and soldiers in West Africa started to operate production perimeters (in Senegal and Mali especially) and at the same time imported rice from Indochina. This tradition of eating rice has not been lost after independence. It has been rather strengthened to such a point that on the street the following is frequently heard with respect to food consumption habits: "rice for lunch and tô[2/] for dinner are the daily diet for a middle-class functionary." In the rural areas, however, rice is still largely consumed only during holidays and remains the preferred cereal for guests. Rightly or wrongly, it is conceived in many Burkinabé circles as a luxury good for rural people.

In sum, the increase in national rice consumption during the last two decades is by and large understable on urbanization and relative price grounds. The preference for rice by the urban population is explained by several other factors, such as their market environment, the opportunity cost of their time, and their social status. With large imports, it is easier to

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[1/] A possible economic explanation besides this is the relatively high income enjoyed by population in the west compared to other regions. This, again, is a function of agricultural production capacity.

[2/] Tô is the vernacular name for a meal made with sorghum, millet, or maize flour. It is the basic daily meal in the country.

market rice in the cities. The distribution channels are easier to organize than in the rural areas. As a result, rice can be made available to city dwellers at prices relatively lower than in rural areas. Access to rural markets is difficult and costly because of the poor transportation network. Also the number of intermediaries tends to increase along the chain when grains (including millet and sorghum) have to be moved from cities to rural areas (and vice versa) and from one rural area to another. This results in high marketing costs and consequently high consumer prices. So because of the distribution costs, rice--especially imported rice--tends to be sold mainly in cities. Besides the market environment, which facilitates the availability of rice in cities and therefore induces its consumption, there is also the opportunity cost of women's time which contributes to drive consumption toward rice. There are more women in the job markets in cities than in the rural areas. They work as professionals (i.e., school teachers, nurses, clerks, etc.) or, more frequently, as petty traders. Therefore, as their opportunity cost of time increases, they look for meals that are quicker to prepare. On this ground, rice is more convenient than millet and sorghum and, consequently, is preferred.

Because of the above phenomena and others not mentioned, rice has become the preferred food of urban consumers in the country. The flow of both local and imported rice is mostly directed to this group of consumers who also enjoy a relatively high income compared to their counterparts in rural areas.

From the previous paragraphs, one can see the role played by market conditions in contributing to the increase in rice consumption. Above all, the price relationship between cereals has turned in favor of rice consumption starting in 1971. The high consumption figures observed in 1973 and afterward may be the result of this situation. The conditions that prevailed in the cereals markets in the 1970s in Burkina Faso (and probably elsewhere in the

Sahel) may have also led to increased consumption of rice in rural areas. In Burkina Faso, rice is produced for both home consumption and for sale, but according to many intellectuals in the country, it is more a cash crop than a subsistence one. As a result, the level of marketable surplus in any year (as economic theory dictates) is likely to be a function of the relative price of rice to that of other cereals. The higher this ratio, the larger the quantity of rice peasants will be willing to sell, ceteris paribus. In contrast, the lower the ratio, the higher home consumption will be, ceteris paribus; selling rice to purchase millet or sorghum (assuming that this is the usual case given rural consumption patterns) may not be worth doing. The latter case has probably existed in Burkina Faso after 1975, and farmers who had good millet, sorghum, or maize harvests may have sold these crops to buy rice during this period.

So unless an adjustment in the agricultural sector takes place, the current situation is likely to continue in the near future. Rice consumption will increase in both urban and rural areas while domestic production will either stagnate or decline as it did in the past. Our ability to balance the supply and the demand for rice will depend on how much we know about the various factors affecting these two variables. The above description of the evolution of the subsector during the last two decades has provided some insight into this question. It fails, however, to give a clear indication on how influential any of these factors has been in driving up or down the rice supply and demand during this period. Therefore, an attempt to sort out the supply and demand responsiveness to changes in these factors (i.e., prices, technology, population, and income) may be a useful exercise if decisions have to be made to adjust the current situation. In the subsequent chapters of this paper, an econometric model is developed and estimated to attempt to answer some of these questions.

CHAPTER III

THEORETICAL FRAMEWORK

The supply-demand relationships for rice in Burkina Faso are complex. Prices and uses are determined not only by the supply of rice but also by certain other factors, the inclusion of which in a model may be difficult. Producers on irrigated perimeters and isolated individual producers scattered throughout the countryside are likely to act differently given their differing opportunity sets. Differences exist between rural and urban consumers in terms of both their socioeconomic status and their cultural backgrounds. These differences in the characteristics of market participants affect their decisions to produce, market, and consume. Unfortunately, those complexities cannot be easily modeled; data available do not disaggregate supply and demand according to the above factors.

In other words, we don't know how much is produced, marketed, or consumed by any individual group of participants or what price is paid for domestic rice or for imported rice. Basically, we are faced with an aggregation problem and the work will be carried out under the assumption that all participants behave in a similar manner in the market. Another assumption is that rice is grown for both home consumption and for sale. Thus, the present model is a simple one, tracing only the major relationships describing forces that affect the rice subsector. Aggregate data are used in the statistical analysis to quantify and sort out the direction of these forces. Both the statistical and economic models are presented below.

A. The Economic Model

The principal economic relationships and variables involved in the Burkinabe rice subsector are shown in Figure 3. Key points in this diagram are: area, yields, domestic production, imports, and consumption.

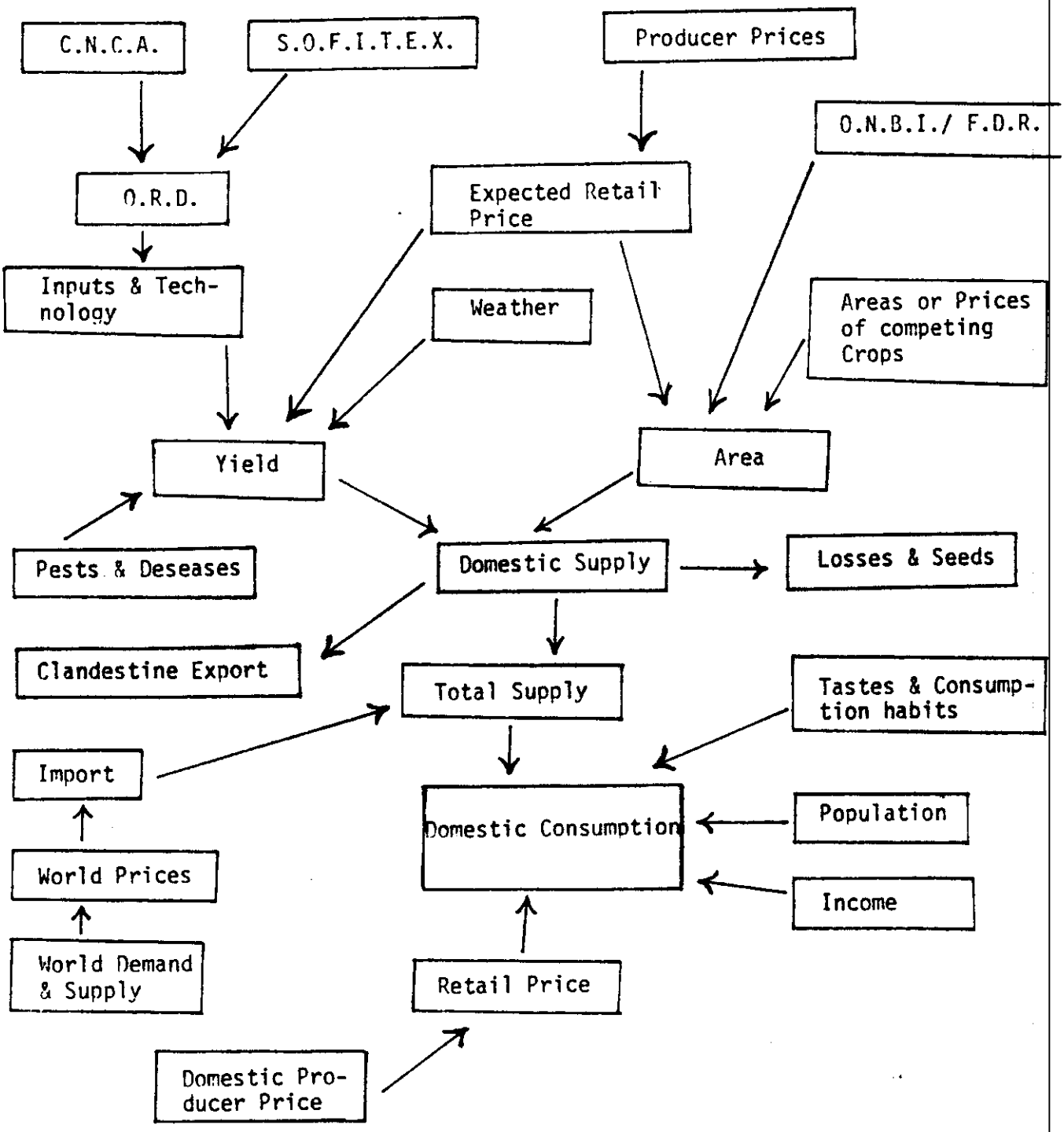
Factors affecting yield are weather, prices, inputs, technology, pests, and diseases. Weather includes total rainfall and its distribution through time and space, temperature, and humidity. The insufficiency of rain during the growing season is offset by irrigation in certain areas. Yields in these sites are less dependent on rain. Prices are fixed and announced by the government after harvest. However, as discussed previously, these prices are not enforced and farmers may get paid either lower or higher prices depending on market situations. Inputs are subsidized and are delivered to farmers through the ORDs.

Area under rice is affected to a certain extent by weather and more specifically by expected prices and the government land improvement programs carried out by ONBI and FDR. Other factors affecting this variable are the areas or the prices of competing crops. Rice competes, especially in terms of labor requirements, with millet, sorghum, and maize, which are subsistence crops, and with cotton and groundnuts, the two major cash crops.

Domestic production is dependent on both yields and area. The total supply is the sum of domestic production and imports from the world market, less any clandestine exports to neighboring countries.

Finally, domestic consumption is conceived as a function of the retail price, population, and income, taking into account the distributional patterns of these variables. Prices of substitutes and complementary foodstuffs and consumption habits are also determinants of the level of consumption.

Figure 3 : Major Relationships in the Burkinabé Rice Subsector. 1/



1/ C.N.C.A. stands for "Caisse Nationale de Crédit Agricole."

S.O.F.I.T.E.X. stands for "Société des Fibres Textiles."

O.N.B.I. stands for "Office National des Barrages et de l'Irrigation."

F.D.R. stands for "Fond de Développement Rural."

B. The Statistical Model

The statistical model is the representation of the above economic relationships between the supply and the demand for rice and the various factors affecting each of them. These variables are quantitatively related by constructing supply and demand equations. Data are then used to estimate the structural parameters of the equations, and the theoretical relationships are tested statistically. In the present analysis, equations describing domestic production are specified and estimated. Total supply (assumed to go through the market to meet demand) is conceived as the sum of domestic production and imports. So, imports are assumed to be exogenous given the current import policy, as we will see later. With this in mind, the supply and demand functional relationships are presented below.

1. The Supply Model

A common practice in estimating a supply relationship is to define production as the dependent variable in an equation. However, as argued by Tomek and Robinson, some details are lost in the process. This is due to the biological nature of the agricultural production process, the time lag involved between planting and harvest, and the generally extensive use of land and climate. This, in turn, "leads naturally to the separation of total crop production into acreage and yield components" (J.P. Houck and P.W. Gallager, 1977). In general, separate estimates of acreage and yield equations (whenever data permit) may provide more useful information in policy making than will estimates of structural parameters of a single production equation. A change in output and/or input prices, for example, may lead to changes in quantity produced through an increase (or decrease) either in area planted and/or in yield. Knowledge of the magnitude and direction of the changes in

area or yield can be of great interest in formulating production strategies in a country like Burkina Faso. On the basis of this belief, we hypothesize the following domestic production and total supply relationships for rice in Burkina Faso.[1/]

$$SR_t = f(MPR_{t-1}, ASM_t, CPI, DV, T)$$

$$Y_t = f(MPR_{t-1}, RF_t, CPI, T)$$

$$QD_t = SR_t \times Y_t$$

$$QS_t = QD_t + QI_t$$

where:

SR_t = area planted to rice in year t (1,000 ha)

MPR_{t-1} = nominal retail price of rice, lagged one year (FCFA/kg)

ASM_t = area planted to millet and sorghum in year t (1,000 ha)

CPI = consumer price index (1970=100)

DV = dummy variable (1963-67=0; 1968-81=1)

T = time trend (1963=1)

Y_t = rice yield in year t (kg/ha)

RF_t = rainfall in year t (mm)

QD_t = domestic rice production (milled) in year t (1,000 T)[2/]

QS_t = total supply of rice (milled) in year t (1,000 T)

QI_t = import of rice in year t (1,000 T)

2. The Demand Model

Many factors influence the quantity of a commodity a consumer purchases. Some of them are not measurable statistically. Changes in tastes and

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[1/] See section below on "choice of the variables" for the rationale for including these particular variables in the equations.

[2/] See the section below on "methodology" for the adjustment in QD_t before adding it to QI_t.

consumption habits due to institutional and psychological factors cannot be statistically isolated. Other factors such as quality considerations can be measured if extremely detailed statistical information is available. For most agricultural commodities, population, income, and relative price of a commodity appear to be the most important determinants of demand. The following demand relationships are hypothesized for rice in Burkina Faso.

$$QT_t = f(MPR_t, INC_t, POP_t, MPSM_t, CPI, DVI, T)$$

where:

QT_t = total quantity of rice demanded (consumed) in year t (1,000 T)

MPR_t = nominal retail price of rice in year t (FCFA/kg)

INC_t = nominal national income (gross national product) in year t (millions of FCFA)

POP_t = total population in year t (1,000 persons)

$MPSM_t$ = nominal retail price of millet and sorghum in year t (FCFA/kg)

CPI = consumer price index (1970=100)

DVI = dummy variable (1963-73=0; 1974-81=1)

T = time trend (1963=1)

C. Note on Data and Methodology

1. Data Collection and Limitations

In every econometric study, there are data limitations. This study is no exception. The data used are secondary data collected from various sources. Their accuracy is not guaranteed and the results of the analysis will be a function of the quality of the data. Throughout the collection process, a choice was made to use not only the source that provided the most recent information but also the one that gave the longest time series. By doing so, we attempted to avoid the mixing of different series whenever possible. The

reason behind this is that if a certain series is biased, this bias is likely to be constant throughout the whole range of the series. This, however, may not be true when we mix two series from different sources.

Another limitation of the study is the length of the time series. The analysis covers a period of 19 years (1963-81), which is short for a time-series analysis. Although we reason that the future is likely to be structured more like the recent past than the distant past, and might well prefer to base our model on as recent a time period as possible for forecasting or for policy-making purposes, statistical problems arise in working with a short time series. With about 20 observations, it is seldom possible to establish significant regression coefficients at the 5 percent level and with correct signs on more than 3 or 4 variables.[1/] Degrees of freedom become limiting. In addition, problems of multicollinearity tend to arise as the number of independent variables is increased. In such cases, both wrong signs and large variances of the estimated coefficients are likely to result. A suggested way to deal with this problem is to increase the sample size of the observations or to get new data. This is not possible for the present analysis because of data unavailability. A last resort is probably the use of ratios by which two or more variables are combined into a single one. This will be done here whenever possible.

2. Choice of the Variables

For the supply equations, acreage and yield are the dependent variables. Their variations through time are hypothesized to be explained by the following independent variables:

[1/] John N. Ferris, "Use of Ratios and Gross Margins in Time Series Supply Analysis," MSU, unpublished course material in agricultural price analysis.

- The retail price of rice lagged one year (MPR_{t-1}). Producer prices, as mentioned previously, are announced after harvest. So we have considered that farmers' expectations are based on prices prevailing during the previous period. Also, the time lag involved between planting and harvest militate in favor of the use of the lagged price as a decision tool for farmers instead of the current price, which in fact is unavailable during planting. Finally, the market retail price instead of the government official producer price is used. The reasons behind this are: the government official producer price is not enforced nor is the purchase of rice by parastatals (who buy at this price) important. The bulk of the production is marketed by private traders and prices received by farmers through this channel are not known. Wholesale prices could in such circumstances be used as proxies for prices received by farmers but they are unavailable. So, under the assumption of fixed margins, the market retail price will stand as a proxy for prices received by farmers.
- Area planted to millet and sorghum (ASM_t): millet and sorghum are the most dominant crops in the current farming system and are the staple grains in the countryside. As a result, rice competes with these crops, especially with respect to labor time. The decision to plant rice is dependent on how much acreage should be planted to millet and sorghum for family consumption needs. Because millet and sorghum are produced primarily for home consumption rather than for market, the areas of these crops rather than prices may be the best variable in our model. Other competitors of rice are cotton and groundnuts. However, they do not appear in any equation. Given the short time series available, an attempt to include all these variables may lead to statistical problems, as discussed above.

- The level of rainfall is included in the yield equation to measure the effect of weather on yield. The problem with rainfall as a proxy for weather is the aggregation it embodies. This variable measures the average annual rainfall in the country. Consequently, rainfall distribution through time and space is not taken into account. Also the notions of temperature, humidity, and daylight time are ignored by such proxy. Despite these problems, rainfall can't be ignored in modeling agricultural production in Burkina Faso, for its effect on production has been important throughout the last two decades. However, to handle adequately the rainfall variable even in an agronomic study is a very complex task. In a quantitative analysis of the effects of rainfall on crop yield, for example, it is difficult to ascertain how much of an increase (or decrease) in yield is due to the effect of rainfall alone, given its interaction with some important variables explaining yield levels such as the soil quality, the biological and physiological characteristics of the plant, the cultural practices, and other variables. In other words, the coefficients attached to the rainfall variable in a regression analysis (as is commonly found in current studies on Sahelian crop production) provide only a partial explanation of what is intended to be explained. They are only gross estimates of the impact of several factors on production (or yields). Some of these factors may be known and can be measurable, while others may be completely unknown or be known but are unmeasurable. In this study, the rainfall variable is used only as a gross proxy for weather and its related variables. Consequently, we do not have high expectations about the statistical properties of the coefficient to be estimated.

- The consumer price index (CPI) is used to measure the effect of the general price level. It is used as a deflator for all monetary values.
- The dummy variable (DV) is included to measure the effect of the government land improvement and expansion program. This dummy variable will be combined with the time trend variable (T) to give an interaction variable (DV*T). This interaction term is used to test whether the government program had the effect of continuously increasing rice acreage through time. In other words, we want to test whether the acreage function has continuously shifted upward since 1968 as a result of the government intervention.
- Finally, a time variable is included in both the supply and demand models. Changes in the independent variables cannot explain all the variation in the dependent variable. For example, changes in technology, taste, urbanization, income distribution, etc., may all give rise to changes in the pattern of production or consumption. However, some of the variables are difficult to measure and can't be isolated. So, assuming that changes in these variables occur gradually through time, a common practice has been to include a time trend as a proxy for these variables. This practice is followed here. In certain cases, however, it might not be possible to include trend with other explanatory variables because of high intercorrelation. In such situations, a lagged endogenous variable may be included as a predetermined variable. In any case, either time or the lagged endogenous variable serves as a "gross" estimate for other relevant but excluded variables.

In the demand equation, the following variables are included beside the market retail price:

- Per capita gross national product is included as a proxy for per capita disposable income.
- Population = the demand is estimated on a per capita basis.
- The market retail price of millet and sorghum is included under the belief that these crops are substitutes for rice in consumption. They are, however, not close substitutes. Alternatively, the price of maize can be used.
- The dummy variable (DVI) attempts to capture changes that occurred in the cereal market during the post-drought period (1974-81). These changes relate to changes in government policies affecting both commercial food imports and food aid as well as to the shortage in the supply of other cereals (the total effect of which may not be captured by their price movements during this period). A description of these phenomena has already been provided in Chapter II.

In both the supply and demand models, the inclusion of any variable is done primarily on economic grounds and knowledge of the rice subsector; data availability was also an important consideration.

3. The Methodology

All the equations in the models will be estimated by linear regression techniques and different functional forms will be tried for each equation.

The right-hand side variables in the acreage and yield equations are all predetermined. So there is little evidence that any one of them might be correlated with the error term on this ground. The respective equations may be estimated by the ordinary least squares (OLS) techniques assuming that the other classical assumptions are met. The estimated parameters will be unbiased and consistent. Domestic production (QD_t) and total supply (QS_t) can

be obtained by simple algebraic manipulations. QS_t is calculated in the following way: subtract from domestic production 10 percent for losses and 10 percent for seeds; convert the remainder into milled equivalent by a factor of .65; and add imports. The estimation procedure is a simplified version of the one used by WARDA.[1/]

A major methodological problem with the demand model was the choice between (1) the simultaneous approach, which emphasizes the simultaneous determination of prices and quantities and (2) the single equation estimation by OLS under the assumption that either price or quantity is predetermined. In this analysis, it is difficult to ascertain whether price or quantity is exogenous. Government authorities have attempted to control prices by various means but have not been very successful. Consequently, a difference exists between official prices and market prices. Another problem is the one related to imports, including commercial imports as well as food aid. Starting from 1974, the inflow of rice into the country has been relatively important and domestically produced rice accounted in some years for only 40 to 60 percent of total supply. Without any government action, one would expect price and quantity to be endogenously determined in a regression model under such circumstances, assuming that a fair degree of competition exists. In other words, both variables are likely to be correlated with the error term in the equation. This implies that using OLS to estimate the structural parameters will result in biased and inconsistent estimates.

In Burkina Faso, however, the rice market is probably not a highly competitive one. The government attempts by various means to keep prices at a

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[1/] For the complete WARDA calculation version, see: WARDA, Statistics Yearbook, 1975, (Table 17), Monrovia, Liberia. For our analysis, QS_t is as follows: $QS_t = (.80\ QD_t) \times .65 = .52\ QD_t$.

desired level each year in order to protect consumers. Each year, the official consumer prices for cereals are released after the parastatals' buying campaign ends. An indication of the quantity available for consumption thus helps to set the level of price and the amount to be imported. However, a major problem remains after the amount to be imported is defined, that is how to allocate reported imports between commercial imports and food aid. Attempting to answer this question leads one, in turn, to ask another question: how are commercial imports allocated between parastatals and private traders? In general, there are no major restrictions on grain imports, especially in years of shortfall. But profit margins are squeezed by the ceiling imposed by the official consumer price, which is sporadically enforced, especially in cities. This may partly explain why Haggblade reports that commercial imports are less responsive to shortfalls in domestic production than is food aid. He estimated correlation coefficients of .56 and .67 for, respectively, commercial imports and food aid, with respect to shortfalls in domestic production from 1970/71 to 1982/83. Another possible explanation of this phenomenon is the selling of both commercial imports and food aid by parastatals (OFNACER and SOVOLCOM) through their retail stores at the official consumer price. Finally, in the face of rising prices, the government may subsidize rice prices to protect urban residents, who not only are high rice consumers but also have considerable political power. All these actions contribute to reduce the differences between the official consumer price and the market price.

Given these considerations, it is not unrealistic to assume that quantity supplied in any year determines the level of prices but the reverse is not true. It is under this assumption that a recursive model appears the best to describe the Burkinabé rice market. This implies that price will be the

dependent variable in the demand equation. The proposed econometric model is thus as follows:

$$(1)\quad SR_t = a_1 + a_2\, DMPR_{t-1} + a_3\, ASM_t + a_4\, DV + a_5\, T + U_{t1}$$

$$(2)\quad Y_t = b_1 + b_2\, DMPR_{t-1} + b_3\, RF_t + b_4\, T + U_{t2}$$

$$(a)\quad QD_t = \hat{SR}_t \times \hat{Y}_t$$

$$(b)\quad QS_t = .52\, \hat{QD}_t + QI_t$$

$$(3)\quad DMPR_t = c_1 + c_2\, \hat{QS}_t/POP_t + c_3\, PCINC_t + c_4\, PQMS_t + c_5\, DV1 + c_6\, T + U_{t3}$$

Most of the variables are already defined in previous sections. $DMPR_t$ and $PCINC_t$ represent the market retail price of rice and the per capita income, all deflated by the CPI. $PQMS_t$ is per capita millet and sorghum production, used as a proxy for the per capita millet and sorghum consumption. Alternatively, the per capita maize consumption (PQZ) can be included as a substitute for rice. The hat on any variable indicates that the estimated value from previous equations is used instead of the actual value. $\hat{QS}_t/POP_t$ is the estimated total quantity of rice available for consumption in any year divided by total population (POP_t) in the corresponding year. This variable is the estimated per capita rice consumption and will be denoted for convenience as $\hat{PRC}_t$ in subsequent sections. It is measured in kg/person/year.

The model is recursive and can be estimated by OLS. It is assumed that all the classical assumptions of OLS are met and that the error terms (the U's) across equations are not correlated with one another. Equations a and b are identities, the determination of which requires only algebraic manipulations. The empirical results are presented and discussed in the next chapter.

CHAPTER IV

EMPIRICAL RESULTS

In this chapter, the econometric model developed in Chapter III is estimated using OLS for all the equations. It is assumed that the equation errors are normally distributed with zero mean and finite variance. Moreover, we assume that the errors across equations are uncorrelated with one another and with any of the independent variables. Finally, the model is assumed to be correctly specified. Under these assumptions, the estimated coefficients will be consistent and assymptotically efficient and will have approximately a normal distribution. This makes possible the use of the t-test for statistical inference.

Alternative functional forms were used for the specification of each equation. In each case, the choice between alternative forms was generally made on the grounds of the magnitude of the standard error of the regression, provided that the coefficients had the "correct" signs. The standard error of the regression was used as the choice criterion because of our desire for the model to be useful in forecasting.

Another specification problem to be dealt with was the choice of the explanatory variables in each equation. As already mentioned, the inclusion of any variable in a given equation is primarily grounded on economic theory and knowledge of the Burkinabé rice subsector. However, in an econometric analysis, problems often arise when a certain set of variables are included in an equation or some assumptions are violated. Some of these problems are multicollinearity and serial correlation, which affect our confidence in the estimated parameters. Among other things, a high variance of the estimated parameters and a sign contrary to expectations may result from

multicollinearity. With serial correlation, the estimates of the standard errors obtained from OLS regression may be smaller or larger than the true standard errors, depending on whether we have positive or negative serial correlation. Throughout the estimation process, the Cochrane-Orcutt procedure was used to correct for first-order serial correlation when evidence of such correlation was indicated by the Durbin-Watson test at the 5 percent significance level.

In any selected equation, the explanatory variables appearing do so primarily because of the theoretical concern and knowledge of the Burkinabé rice subsector and additionally because their separate and/or joint effect helps explain the variation of the dependent variable. With this in mind, the empirical results are presented below. Standard errors are given in parentheses under the estimated coefficients. Equation (4) is obtained from equation (3) by a simple algebraic manipulation and shows per capita rice consumption as the dependent variable in the demand equation. The L's represent natural logarithms. The raw data are given in Appendix 1.

(1) $LSR_t = 4.557 + 0.032\ LDMPR_{t-1} - 0.149\ LASM_t + 0.144\ DV$
$\qquad\qquad (0.615)\ (0.052)\qquad\quad (0.086)\qquad (0.025)$

$R^2 = 0.848$; S.E. of regression = 0.032
D.W. = 1.557 ; F(3,14) = 26.044

(2) $Y_t = 944.567 + 0.165\ DMPR_{t-1} + 0.049\ RF_t - 13.393\ T$
$\qquad\quad (195.747)\ (1.173)\qquad\quad (0.195)\qquad (3.960)$

$R^2 = 0.672$; S.E. of regression = 55.525
D.W. = 1.52 ; F(3,14) = 9.578

(3)* $LDMPR_t = -3.9 - 0.152\ \hat{LPRC}_t + 0.856\ LPCINC_t + 0.215\ DVI$
$\qquad\qquad (3.941)\ (0.220)\qquad\quad (0.402)\qquad (0.140)$

$R^2 = 0.727$; S.E. of regression = 0.113
D.W. = 1.71 ; F(3,14) = 8.69

*The Cochrane-Orcutt procedure was used to correct for first-order serial correlation. The value of the rho estimate ($\hat{e}$) and its statistical features are as follows:

$\hat{\rho}$ = .529; S.E. of $\hat{\rho}$ = 0.217; t statistic = 2.42

(4) $\hat{LPRC}_t = -25.59 - 6.5\ LDMPR_t + 5.6\ LPCINC_t + 1.4\ DVI$

where the variables are as defined in Chapter III.

A. Statistical Features of the Model

For each equation, the R^2 indicates the proportion of the variation in the dependent variables explained by the set of explanatory variables. In the first equation, about 85 percent of the variation in acreage planted to rice is explained by the variation in the lagged real price of rice, the area planted to millet and sorghum, and the dummy variable. Similar interpretations can be made with respect to the variation in yields and real prices of rice in equations (2) and (3). The proportions of explained variation of these variables are about 67 and 72 percent, respectively. The F-statistics of the estimated equations indicate that the joint hypothesis that all the coefficients of the explanatory variables in the respective equations are equal to zero can be rejected at the one percent significance level.

Because we have a priori expectations about the sign of each coefficient except the trend variable in the yield equation, a one-tailed t-test is applied to check on the significance of these coefficients (a two-tailed test is used for the trend variable in the yield equation). The coefficient of lagged real price in the area equation, for example, is expected to be positive. Thus, we test the null hypothesis that the coefficient is less than or equal to zero against the alternative that it is positive at a given significance level. Applying the test to each coefficient yields the following conclusions.

- At even the 25 percent significance level, there is no evidence that the coefficients of the lagged real price variable in both the area and

the yield equations are positive. A similar conclusion emerges for the rainfall variable in the yield equation.

- In the area equation, the coefficient of the area planted to millet and sorghum is significantly negative at about the 5 percent significance level. The coefficient on the dummy variable is significantly positive at the one percent level.
- At the one percent significance level, there is evidence that the coefficient of the time trend variable in the yield equation is negative.
- In the demand equation (equation 3), the hypothesis that the coefficient of the per capita consumption is negative is sustained at the 25 percent level. The coefficients of per capita income and the dummy variable (DVI) are significantly positive at the 5 percent and 10 percent significance levels, respectively.

The Durbin-Watson test for serial correlation is inconclusive in the case of equations (1) and (2). In equation (3), however, correction for first-order serial correlation was made since the hypothesis of no serial correlation was rejected at the 5 percent level. The calculated t-statistic of 2.43 for the rho estimate after correction confirms this situation.

Finally, with respect to the magnitude of the standard errors of the regression, it is difficult to draw a conclusion. As Pindyck and Rubinfeld state: "Since there is no useful test for evaluating the magnitude of the standard error, we must rely on qualitative judgments about how low a percentage standard error is desirable." Given this, we will assume that under the current model specification, the OLS estimation techniques, and the data used, the standard errors of the regression obtained are assymptotically efficient. In equation (1), the S.E. of the regression is about .87 percent

of the mean of the dependent variable; in equations (2) and (3), this figure is about 6.5 percent and 2.6 percent, respectively. All other things held constant, these figures indicate that in forecasting, the performance of equation (1) is relatively higher than that of equations (2) and (3). Also, it should be noticed that since the estimation of equation (3) makes use of the estimated rather than the actual yield, once the model has failed to perform well in estimating the yield (equation 2), it could not be expected to be very successful in estimating the demand (equation 3). Figures 4, 5, and 6 give plots of the actual values and of the estimated values against time.

B. Interpretation of the Results

1. The Acreage Equation

As with the other equations, different specifications of the acreage equation were attempted. A major concern was how to handle the effect of the government rice production programs. Because of their ongoing nature, an attempt was made to take the effect of these programs into account by using an interaction term between the dummy variable and trend (DV*T). This, in essence, created a trend variable whose value was zero prior to 1968 (the first year of the government programs), 1 in 1968, 2 in 1969, and so on. The result of the regression, when this variable was included, indicated a poor fit compared to the one obtained when only the DV variable was used. The inclusion of DV*T led the adjusted R^2 to drop from .82 to .5 and the F-statistic to drop from 26 to 5.11 after correction for first-order serial correlation, which was also introduced. The result of this regression is given in Appendix 2. In another regression, both DV and DV*T were included. Under this specification, we did not obtain a better fit and the sign of the coefficient of DV*T was negative, which was contrary to what we expected. Consequently, the interaction term does not appear in the final model.

FIGURE 4 : RICE AREA ; ACTUAL AND FITTED VALUES.
1963–1981

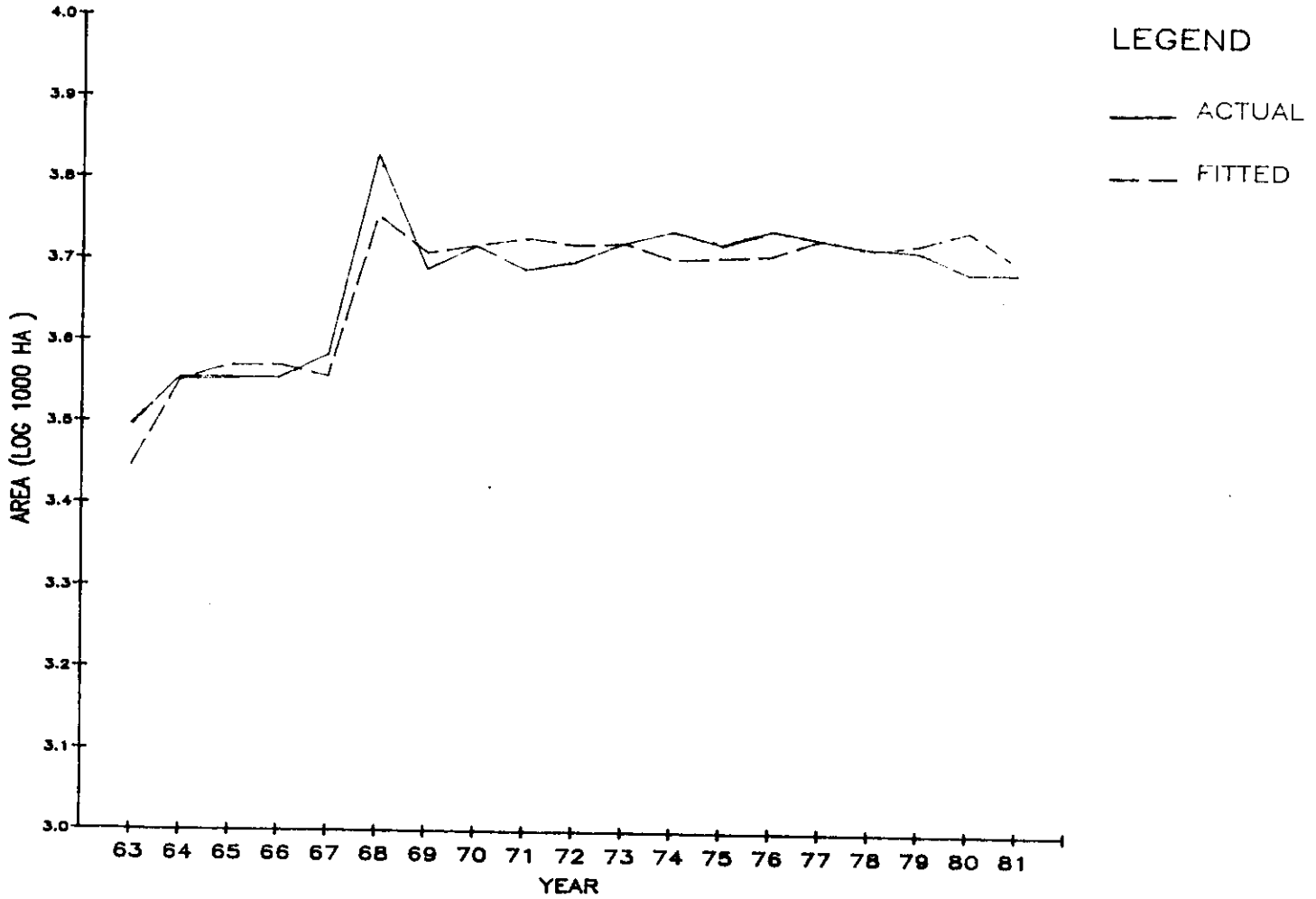
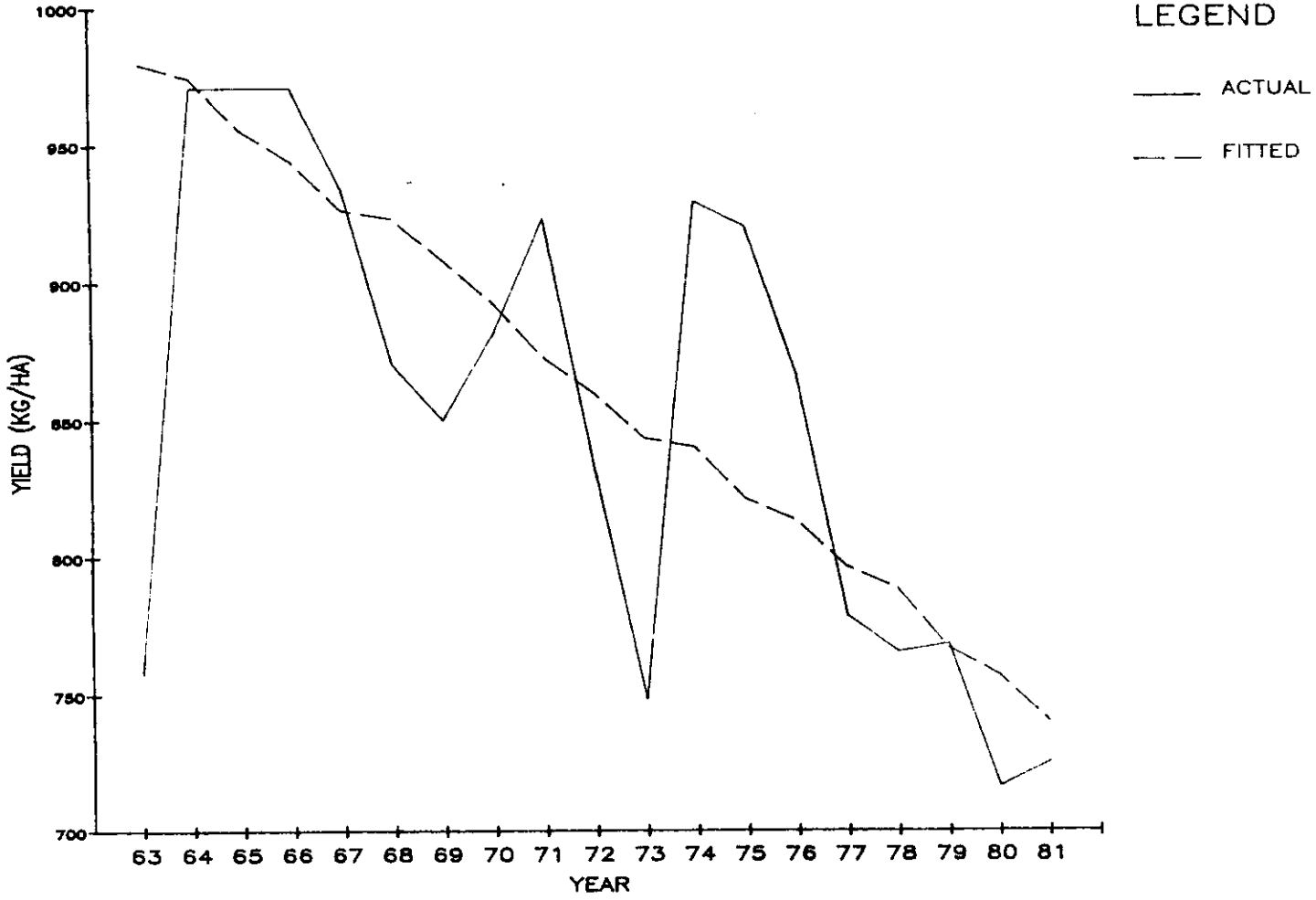


FIGURE 5 : RICE YIELD ; ACTUAL AND FITTED VALUES.
1963–1981.



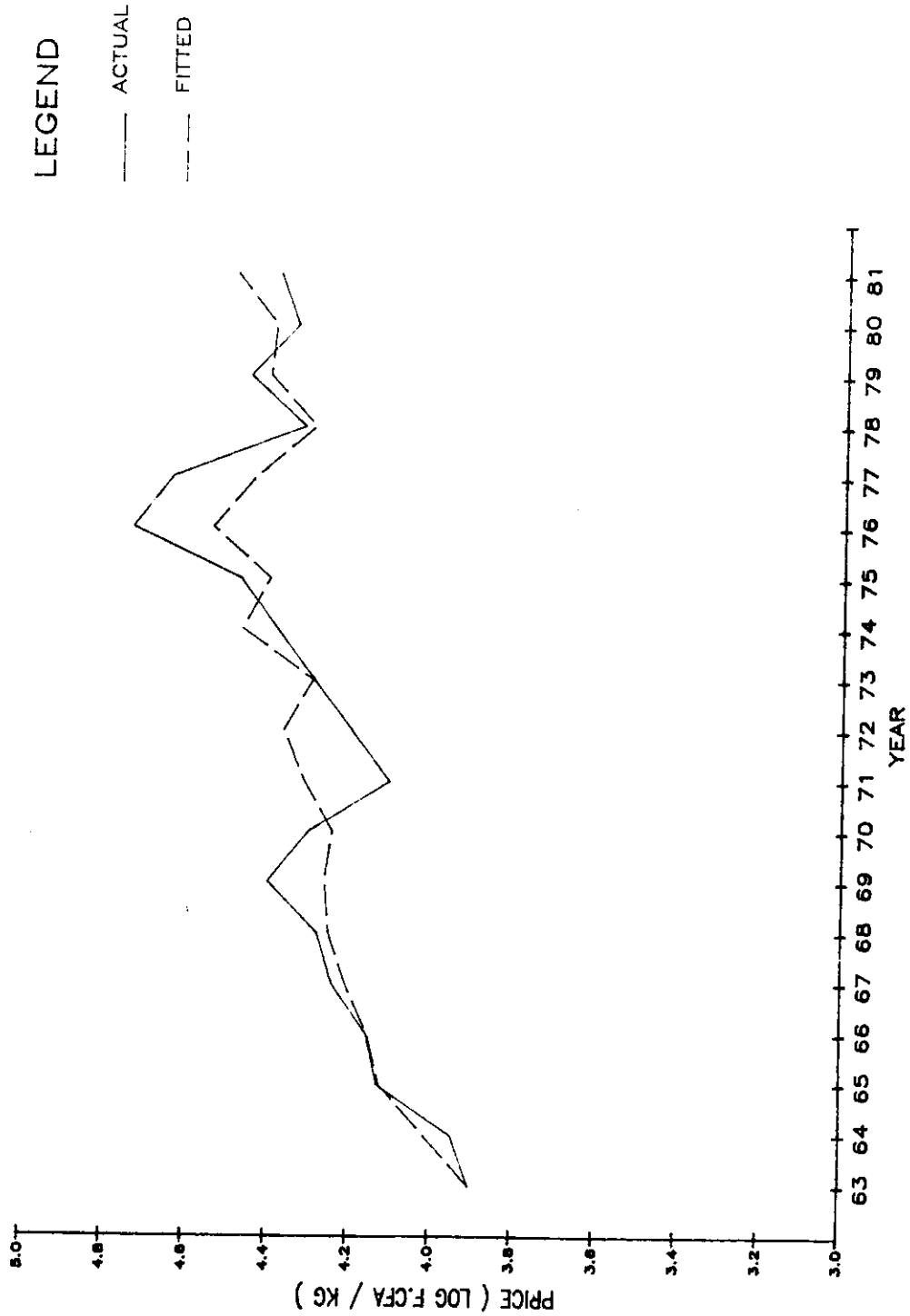


FIGURE 6 : DEMAND PRICE ; ACTUAL AND FITTED
1964 – 1981.

All the signs in the acreage equation conform to our expectations. The lagged real price and the dummy variable are positively related to acreage. The expected inverse relationship between the area planted to rice and that planted to millet and sorghum is also confirmed. Given the functional form of the equation, the estimated coefficients are interpreted in the following way: every percentage change in the exogenous variable changes the endogenous variable by the percentage indicated by the coefficient. So, a one percent increase (decrease) in the lagged real price of rice will induce a .032 percent increase (decrease) in area planted to rice, holding all other variables constant. Similarly, a one percent increase (decrease) in the area planted to millet and sorghum leads to a .149 percent decrease (increase) in the area planted to rice, ceteris paribus. Other things being equal, the coefficient of the dummy variable indicates that rice area was about 14.4 percent higher in the 1968-81 period than it was in previous periods.

In general, the limitations imposed by the quality of the data and the simple model developed here to describe a complex system probably affect the magnitude of the estimated coefficients. Consequently, care is recommended in their interpretation. With this in mind, the following can be said with respect to the regression results.

- The government land development programs appear to have influenced farmers' decisions to plant rice. In general, these programs, as described in Chapter II, are primarily aimed at providing a water control system to help ensure the crop harvest. So, given the high risk involved in upland cropping, farmers are--other things being equal--likely to shift into lowland production activities if they are given the opportunity to do so.

- Another explanation for the effect of these programs in expanding acreage is grounded on their alleviation of some constraints faced by farmers in preparing fields in the bas-fonds. In general, the bas-fonds (or lowland) soils are hydromorphic and contain a high proportion of clay. Working them with hand tools is hard and time-consuming. Under government programs, either free land preparation with tractors is offered for the first cropping season or access to credit to purchase animal traction equipment is provided. In other words, the programs provide a way to free labor for other farming activities and more importantly to break the technological constraint resulting from the rudimentary nature of the traditional farm tools.
- Another potential explanation for the important effect of government programs on acreage can be found in the scarcity of land in the north-central plateau region. Throughout the period covered by the study, increases in total crop output resulted mostly from increases in cultivated area and not from an increase in yields. The lack of an appropriate technological package to raise yield levels and the insufficiency and irregularity of rainfall explain to a large extent the reliance of farmers on raising the output level by expanding planted area. In the north-central plateau, the availability of arable land is decreasing from year to year due to population pressure and soil erosion. This creates a bottleneck for augmenting production to keep pace with the growing consumption demand. Thus, the opening of lowlands (which remain idle most of the time) for cultivation and the improvement of their productive capacity provide incentives to farmers to include more rice cultivation into their farming activities. We recall that lowlands are suitable only for growing rice during the rainy season.

- The area planted to millet and sorghum is also an important factor in explaining the variation in rice acreage. The sign of its coefficient is negative as expected. This indicates that the two crops compete for production resources. Increasing millet and sorghum acreage by one percent will lead to a .15 percent decrease in area planted to rice ceteris paribus. This percentage change probably overestimates the true substitution elasticity between the two crops. It, however, gives an idea of how labor-intensive rice cultivation is relative to millet and sorghum cultivation, and more generally it may indicate the high weight given to millet and sorghum by farmers when the decision regarding what to plant has to be made. This is not a surprise, given the subsistence nature of the agricultural sector, where millet and sorghum dominate the consumption patterns. Thus, unless changes occur in the consumption habits or an improvement in the cereal market is made, increasing the size of rice acreage will require, among other things, that the productivity in the millet and sorghum sector be increased.
- The responsiveness of acreage to price is very low. A one percent increase in the lagged price will induce rice acreage to increase by only .03 percent. A tentative explanation for the low responsiveness of rice acreage to price changes lies in the low technological level in rice production. Prices can be raised to levels higher than current price levels but farmers will still lack the necessary means to translate that into a corresponding quantity of acreage. The low price responsiveness is also a function of the market system conditions. The poor transportation network in the country, the lack of adequate milling facilities, and the difficulty faced by farmers in finding buyers

for their produce at remunerative prices are, among other elements, characteristic of the current market network. The cereal market is, in general, poorly organized, which limits the effect of price on resource allocation decisions. To conclude, it is worth noting that, given the current technical constraints and market network, price policy alone will have little impact on increasing rice acreage.

2. The Yield Equation

The yield equation is presented in a simple linear form. About 67 percent of the variation in yields from 1963 to 1981 is explained by the regression. The time trend variable, used as a proxy for technology and other excluded but relevant variables, is by far the most significant variable in this equation. It accounts for the bulk of the explanatory power of the regression. Both the lagged price and rainfall variables contribute little to explain the behavior of yields. The sign of their coefficients is as expected; that is, both variables are positively correlated with yield. The analysis carried out in Chapter II, section 5, indicated that yields had declined through time. The negative sign of the time trend coefficient confirms that this has been the case.

The coefficients are interpreted in the following way: a unit change in any exogenous variable will change the dependent variable by the value of the coefficient, ceteris paribus. For example, if average rainfall increased by one millimeter, yields would increase by .049 kg (49 grams), other variables held constant. The coefficient on the time trend variable indicates that, on average, yields have declined by 13.4 kg each year from their mean value during the study period.

Under current conditions, the insignificance of the coefficient of the price variable is understandable. The same arguments presented in the above section, with respect to acreage responsiveness to price, apply here as well.

The rainfall variable also provides little help in understanding the behavior of yields. Alternative explanations for this are numerous and only two of them are offered here. The first one is related to the form in which we included the variable. In the model, we have used the country's annual average rainfall as a proxy for weather. In this form, the distribution of rainfall through space and time is ignored despite its importance in explaining yield differentials between regions and years. We also implicitly ignored the effect of temperature and humidity on yield. The inability of the aggregate rainfall variable to capture these quantitative and qualitative phenomena largely explains why its coefficient is low. The second reason is probably related to the way the average yield variable is constructed. Yield levels vary by the type of production technique used. Yield levels also vary from one region to another, depending on soils and rainfall. In the process of calculating average yield in the country, if a high weight is given to yields obtained under irrigation conditions or to yields obtained in areas of normal rainfall and good soils, then the country's annual average rainfall quantity will do little to explain yield variation. Given the above discussion, the magnitude of the coefficient on rainfall should be interpreted cautiously. Its low statistical significance in this model does not imply that rainfall is not a decisive factor in yield levels. Throughout the period covered by the analysis, rainfall has, among other factors, been very influential on the crop output level in the country. So, in future model building, one may not find it difficult to decide on whether or not to include a rainfall variable. The major problems are likely to be how to include it and how much confidence should be given to the magnitude of the estimated coefficient.

The negative trend observed on yield is possibly a consequence of the lack of technology and the declining soil fertility observed in the country. Except in the Vallée du Kou, the production process makes little use of modern inputs (i.e., fertilizer or high yielding varieties). Also, in all cases, there is no crop rotation system in place, reflecting the fact that under current conditions, rice is the only crop grown in the lowlands during the wet season. Producing rice from year to year on the same soils without adequate inputs leads to the degradation of soil quality, which in turn leads to declining crop yields. Another reason for the declining rice yields may have to do with how labor time is allocated in the traditional farming system. The need to satisfy home consumption leads farmers to devote their work force primarily to the production of those goods they consume. In rural Burkina Faso, rice is the least-consumed cereal, with millet, sorghum, and maize being the most widely consumed. However, throughout the study period, the production of these last three crops has steadily declined, and as a consequence, their prices have been rising. These problems have probably induced farmers to devote less and less time to their rice fields. Even in normal situations, peasants in the country give higher priority to securing their millet and sorghum harvests than they do to securing the rice harvest. In the Yatenga ORD, for example, the author observed that peasants worked on their rice fields only when they had finished doing so on their millet and sorghum fields in any given period of activities (planting, weeding, etc.).

Finally, it is worth noting that the significance of the trend variable probably is explained by other elements in addition to the ones discussed above. In general, the trend variable may stand for variables we cannot include in a model because of lack of measurement or knowledge. So, understanding why the coefficient of the trend variable bears a given sign or has a certain magnitude may be difficult.

3. The Demand Equation

Equation (3) is the original estimate of the demand equation. About 73 percent of the variation in prices is explained by the set of independent variables (R^2 = .727). The bulk of the explanatory power of this regression lies probably on the variation in per capita income and the dummy variable. The variation in per capita consumption helps to explain very little the variation in prices. Because of our interest in consumption behavior, we derived equation (4) from equation (3). In equation (4), per capita consumption is shown as the dependent variable; the rest of our analysis will make use of equation (4). Under the log-log functional form, the estimated coefficients in the equation are interpreted as follows: a one percent change in the independent variable, ceteris paribus, will change the dependent variable by the percentage indicated by the coefficient.

Rice, in general, is not classified as a subsistence crop in the country. In rural Burkina Faso, for example, it is usually considered as a luxury good. As such, it is consumed only in rare occasions by many communities. In cities, however, its proportion in the diet of high- and middle-income groups (usually referred to as functionaries) is relatively important. For these groups, it is possible that one out of three to five meals is made of rice. Consumption patterns in the lower income groups are similar to those in the countryside, in which millet and sorghum remain dominant. The coefficient of the per capita income variable reflects these income-related changes in consumption. Other things being equal, a rise in per capita income will lead to more rice consumption. However, the income elasticity of 5.6 implied by the coefficient of the income variable is relatively high. Consequently, it should be interpreted cautiously, especially by food policy analysts. A global attempt to understand why the income elasticity of the demand for rice

in the country may have been high from 1963 to 1981 is provided below. There is, however, no intention to demonstrate or to prove from this exercise that the true income elasticity is 5.6.

The coefficient of the dummy variable (DVI) is also statistically significant in the demand equation and its sign is positive as expected. This confirms that the changes in import policy and more generally in the cereal market that took place after the drought have induced people to consume more rice than they would have otherwise.

C. Elasticities

The lagged-price elasticities of acreage, yield, and domestic production are calculated from equations (1) and (2). The price elasticity and the income elasticity of demand can be approximated by using equation (4).

The acreage equation is estimated in a log-log functional form. Thus, elasticities derived from such a function are constant throughout the period covered by the data and are equal to the estimated coefficient of the variable for which they apply. Consequently, the lagged-price elasticity of acreage is equal to .032.

From the linear equation describing yields, the lagged-price elasticity of yield is computed at the mean value of yield and price during the study period. The calculation yields a lagged-price elasticity of 0.014. This elasticity will increase with an increase in prices and decrease with an increase in yields.

Because production is equal to area multiplied by yield (both of which are functions of prices), the price elasticity of production is equal to the sum of the price elasticity of the two variables. Thus, the lagged-price elasticity of domestic production is estimated at about .046.

Like the acreage equation, the demand equation (4) is in log-log functional form. The own-price elasticity of demand is thus -6.56 and the income elasticity is 5.6.[1/] These elasticities are constant throughout the price range covered by the study.

The computed elasticities are presented in Table 10.

Table 10. Elasticity Estimates

Type	Elasticity
Lagged-Price Elasticity of Acreage	.032
Lagged-Price Elasticity of Yield	.014
Lagged-Price Elasticity of Production	.046
Own-Price Elasticity of Demand	-6.56
Income Elasticity of Demand	5.6

Comparison of the elasticity estimates in this study with those in other studies was not possible. Despite an extensive review of the literature on cereal price policy in Burkina Faso, no elasticity estimates have been found. Most of the elasticities referred to and used by price analysts are derived from regional studies (i.e., the Sahel). Moreover, these elasticities are seldom presented on a single-commodity basis; they refer instead to cereals in general. In fact, even if such elasticity estimates were available, there

[1/] The use of equation (4) to derive the price and income elasticities assumes that these elasticities are the inverse of the price flexibilities. This assumption may not strictly hold in general. The derived elasticities may, however, be taken as lower bounds of the true elasticities (Tomek and Robinson, p. 351).

would still be problems in comparing them with those estimates in our model. Differences in magnitude (and even in sign) can exist. Elasticity estimates are bound to the type of study (i.e., cross-section or time-series studies), the period covered by the study, the data used, the model specification, and the technique used in their derivation. So, collecting elasticity estimates from previous studies for the sake of comparison may be viewed as an exercise to provide only an approximate range of values in which a given elasticity estimate for a commodity may be expected to fall. Comparing different elasticity estimates does not tell which one is a good or a bad estimate; it may only tell how high or how low they are with respect to each other. It is with these caveats in mind that the following attempt is made to check the magnitude of the elasticities derived in this study with those obtained elsewhere.

On the basis of empirical evidence (and assuming other things to be equal), it is widely accepted that African farmers can be expected to respond positively to price incentives in making their decisions about production of food crops. This price responsiveness, however, is viewed as being relatively low. Reasons behind the low price responsiveness of food crop production are numerous and vary from country to country and, within the same country, from region to region and from one commodity to another. However, the most widely advocated reasons for low supply elasticities are the low technological level, which limits production increases beyond a certain level; and the underdeveloped nature of the marketing system, which results in a poor functioning of the price transmission mechanism. Rice producers in Burkina Faso face these two constraints. Besides problems related to land availability, land tenure, and human capital constraints, the expansion of rice acreage is constrained by the lack of adequate working capital. The relatively low yields observed reflect a combined effect of physical, technological, human,

and institutional factors. On the market side, getting a buyer for the produce at a remunerative price may not be an easy task for many farmers. Access to many producing areas is difficult, and as a result, transport costs are probably high. Because of the above problems and others, one may not expect the domestic rice production to be price elastic. So, the .05 elasticity estimate obtained under this study is not unreasonable.

On the consumption side, we derived a price elasticity of demand of -6.56 and an income elasticity of 5.6. Many analysts argue that both the price and the income elasticities of cereals (including rice to a certain extent) are low in general. This strongly suggests that the above elasticity estimates may be too high. WARDA, for example, in its 1977 study, "Prospects of Intraregional Trade of Rice in West Africa," uses an income elasticity of the demand for rice in Burkina Faso of 0.5 for the urban population and 0.2 for the rural population to project rice consumption from 1975 to 1980 and 1990. These elasticities were based on studies in West Africa and elsewhere. Using aggregate income and food consumption data, USDA (1981) estimated an income elasticity of the demand for rice in the Sahel of .93 and an own-price elasticity of -.35. The authors of the study concluded that these estimates were indicative of the relative luxury status of rice in the Sahel. The consumption patterns described previously in this paper tend to support this view.

Income growth of wage earners in particular and of groups in related occupational activities (i.e., traders) in cities may generate high demand for rice. We also mentioned that parastatals sell rice at the lower official price and that imports of rice (including food aid) were relatively important in the country starting from 1974. Because of these factors, the consumer price of rice has been kept probably lower than otherwise, which translated

into an increase in the purchasing power of consumers. This phenomenon has possibly contributed to increase rice consumption. Efforts made by rural families and the poor in cities to buy rice during festivities imply that (other things being equal) a rise in their income is likely to generate more demand for rice. The difference in absolute value between our estimated income elasticity and our estimated own-price elasticity of demand equals .95. This indicates possibly the existence of substitutes for rice. Potential substitutes we attempted to include in the model were millet, sorghum, and maize. Unfortunately, the unsatisfactory performance of these values (the per capita consumption of these cereals, or their prices) led us to drop them from the final model. The signs on their coefficients implied a complementary relationship, which is contrary to our expectation. T-tests applied to their coefficients indicated that at even the 20 percent level they were not significantly different from zero. Finally, when dropped out of the model, the performance of the regression improved. Thus, the hypothesis of possible substitutes for rice remains to be tested if better statistical data become available.

The above arguments do not necessarily lead to the conclusion that the magnitudes of the elasticity estimates from the demand model are correct. It is thus important to mention that these estimates depend on the period under study, the specifications of the model, and the quality of the data used, the limitations of which have already been mentioned. During the period covered by the analysis, the rice market and the cereal market in general in the country experienced several changes. Thus, the high income elasticity of the demand for rice during this period has been probably influenced by these phenomena which led to the rapid growth in consumption that took place when imports were available at relatively cheap prices.

Before we concern ourselves in the next chapter with some of the implications that can be derived from the results of the analysis, two general points should be emphasized:

- The domestic rice production responds positively to price changes but its responsiveness is relatively low. Consequently, price policy alone won't be enough to increase domestic production by a substantial amount.
- On the demand side, rice appears to be a luxury commodity; the demand for it is price responsive. Other things being equal, if the government wants to reduce rice consumption in order to improve its cereal trade balance, changes in the domestic price policy or in its trade policy may be alternatives to help achieve this goal.

CHAPTER V

IMPLICATIONS OF THE RESULTS

This chapter is concerned with the application of the results of the analysis to studying crucial problems in the rice subsector. An attempt will be made to project domestic rice production and consumption for the years 1985 and 1990. The instruments of projection include some of the estimated coefficients from our model, some assumptions concerning the levels of the exogenous variables in the future, and the FAO consumption projection methodology. It is hoped that this exercise will shed light on what the subsector will resemble in the future. Whether this picture will approach the true one, however, will depend on the assumptions underlying the projection. Assuming, for example, that yields or rainfall will be at X level or that per capita income growth will be Y percent on average from 1981 to 1990 may turn out to be wrong. Prediction of the future behavior of an underdeveloped agricultural economy such as the Burkinabé one, which in the past has been characterized by instability, is very difficult. Thus, the validity of the projected figures will depend, among other things, on whether or not the assumptions are realistic and hold in the future.

Finally, some policy implications will be drawn on the basis of the findings from the entire analysis. The centerpiece of this section will be a discussion of the major factors that have been identified as leading forces in the performance of the rice subsector from 1963 to 1981. It is our belief that the gap in our knowledge of the subsector is still wide because of both its complexity and the lack of reliable data on several aspects of the subsector's performance. Nonetheless, the identified forces affecting the rice subsector and their directions and relative magnitudes should be of central

concern for policy makers. These forces affect the capacity of the rice subsector to play an effective role in achieving the country's food security goals.

A. Projections of Domestic Rice Production and Demand

1. Projection of Domestic Production

Projecting the level of domestic production for the years 1985 and 1990 requires estimates of both acreage and yield for these years. On the basis of the estimated area equation, projection of total rice area for 1985 and 1990 will be provided. Yield levels will be simply assumed, because of the poor performance of the yield equation to fit the data. Also, using the estimated yield equation for projection is likely to result in very low yields by 1990, given the strong declining trend observed. Thus, prediction of yield levels using the equation implies a very pessimistic view of the future. In this analysis, we will assume that by the year 1990 the yield trend will be reversed.

Given the above qualifications, the projection of domestic production for 1985 and 1990 is done using the following values for the variables entering the production model:

- Prices: During the 1974-81 period (the period in which changes occurred in the domestic cereal market), real rice prices have fluctuated, with some weak indication of a downward trend, as indicated by the following simple trend equation:

$$DMPR_t = 97.0 - 1.98\ T \quad (R^2 = .12)$$

Given the budgetary costs to the government of maintaining through imports a continuous decline in the real price of rice, we will assume that the government will adopt policies that will hold real rice prices

at their 1981 levels of 80.4 FCFA/kg. Later in the study, we will discuss the implications of alternative price policies on production and consumption.

- Millet and sorghum areas: The data on millet and sorghum area suggest that there has been a tendency to cultivate more of these crops starting from 1974 than was the pattern from 1963 to 1973. This is certainly a consequence of the 1969-73 drought. Farmers were induced to plant more millet and sorghum to replenish their granaries and to assure their home consumption. Because the food situation in the country is still unsatisfactory, we will assume that in the future, peasants will behave like they have from 1974 to 1981. Thus, the total area planted to millet and sorghum will increase on average by one percent per year as it did from 1974 to 1981. This rate of increase is probably low but remains realistic if we take into account the limited availability of arable land in the most populated regions of the country and the cost of migrating to the south where more land is still available. Also, the labor force in agriculture, especially young people, is growing only slowly from year to year due to migration to cities and to areas outside the country. FAO (1976) projected, for example, an annual growth rate of the rural labor force of only one percent from 1975 to 1990. The same source estimated a yearly outmigration to Ivory Coast of some 500,000 young Mossis (an ethnic group living in the North and Central plateau regions of the country). Applying this rate of increase (one percent per year) and using 1981 as a base year, the total area planted to millet and sorghum is projected to be 2,185,000 ha in 1985 and 2,297,000 ha in 1990.

- The dummy variable is assumed to take the value of one in both 1985 and 1990. This is so because of our belief that the government land improvement program will still be in effect. Unexploited lowlands are still available in the country. Thus, except in case of funding limitations or other reasons such as the unprofitability of the investment or major policy changes in the agricultural sector, the programs will be continued in the near future.

Since we do not intend to use the yield equation for forecasting, prediction of rainfall level is unnecessary. We will use the 1974-81 yield levels as a basis to approximate the yield for 1985. This is so because it is during this period that the trend is really pronounced. Also, 1985 is not far enough from 1981 to allow a profound reversal of the trend so that yields can be brought above their 1974-81 levels. The transformation of the agricultural sector is too slow and surrounded by many uncertainties to permit too highly optimistic predictions of this kind. We may, however, expect yields to approximate the 1974-81 average level in 1985. That is, the situation will not have worsened by this time. From 1985 to 1990, we expect an improvement to take place and bring yields at least to their 1964-66 level, which was the highest level achieved during the 19-year period under study. Thus, the assumed yields for 1985 and 1990 are 810 kg/ha and 971 kg/ha, respectively.

The results of the projection are presented in Table 11. The quantity of domestically produced milled rice available for consumption is obtained by converting domestic paddy production by a factor of .52. The resulting amount is considered as the domestic supply.

Table 11. Domestic Supply Projection

Year	Area (1000 ha)	Yield (kg/ha)	Paddy Production (MT)	Domestic Supply (MT)[a/] (Milled Equivalent)
1985	40.3	810	32,643	16,974
1990	40.0	971	38,840	20,197

[a/] Estimates rounded; MT = metric ton.

2. Demand Projection

The projection of consumption demand for 1985 and 1990 is done by using the FAO projection methodology. This method assumes that population and income are the chief determinants of demand and that relative food prices remain unchanged. If population and income parameters are available, projections are then based on the following equation:

$$D_t = D_o (1 + d)^t$$

where: D_t = projected total consumption in year t

D_o = base year consumption

d = rate of growth of consumption

t = time in years from base year to the desired year of projection

The rates of growth of consumption are defined as follows:

$$d = r_{pop} + r_y \times n_y$$

where: r_{pop} = rate of growth of population

r_y = rate of growth of per capita income

n_y = income elasticity of demand

The value for d will depend on the assumptions made regarding r_{pop} and r_y. This paper will assume a rate of growth of 2 percent for the population up to 1990, its value for the last two decades. This rate is also the same used by

development planners in the country and by FAO in its "Long-term Agricultural Development Strategy for Upper Volta, 1976." The per capita real income in the country grew only by .4 percent on average from 1961 to 1979 according to the World Bank's 1982 study, a very small growth rate resulting primarily from the performance of the agricultural sector, the major contributor to the country's GNP. This analysis uses GNP data from the World Bank study. Because we do not expect too much from the agricultural sector for the coming years due to the current weather trend, we will assume moderate growth rates for the next decade. We also expect the performance of the country's economy to be limited during the next decade because of the political instability in the country since 1978. Given the above considerations, we will assume a .5 percent growth rate of per capita real income from 1979 to 1985 and a .8 percent rate from 1985 to 1990.

Two estimates of the income elasticity of demand will be used. The first is the .5 urban income elasticity of demand used by WARDA in its 1977 study and the second is the one derived from our analysis. The latter was estimated to be 5.6. Finally, our base year consumption is that of 1981. It is obtained from our estimated model. For 1981, the estimated per capita rice consumption from the analysis is 5.81 kg. In that year, total population was 6,294,000. Thus, the base year consumption is given to be 36,945,780 kg or 36,945.78 metric tons.

The results of the demand projection are given in Table 12 accompanied by the assumed values for the total consumption growth rates (d) and the income elasticities (n_y). In its 1976 study, the FAO projects a total demand for rice of 64,000 metric tons in 1985 and 74.5 thousand metric tons in 1990 on the basis of the 1975 consumption level. From the same base year, WARDA (1977) projects for 1990 a total consumption of 54.3 thousand metric tons. In

Table 12. Demand Projection (MT)

Year	d (%)		Demand	
	$n_y = .5$	$n_y = 5.6$	$n_y = .5$	$n_y = 5.6$
1985	2.25	4.8	40,385	44,567
1990	2.4	6.8	45,737	65,010

both studies, the population growth rate is assumed to be 2 percent as in our analysis. WARDA uses an income elasticity of .5 for urban residents and .2 for rural residents and a per capita real income growth rate of one percent. The FAO study does not provide either an income elasticity or a per capita income growth rate. Comparison of the above projected figures with those of our analysis leads to the following conclusions:

- Our estimate is lower than the FAO's even when we assume a 5.6 income elasticity of demand. For our estimate to approach the FAO's, we have to assume in addition to the 5.6 income elasticity a per capita income growth rate of at least one percent for the 1981-90 period.
- WARDA's estimate is lower than ours, made under the 5.6 income elasticity assumption.

3. Implied Import Requirements for 1985 and 1990

On the basis of the projected figures, an attempt is made to derive the import requirements to meet consumption demand in each of these two years. Quantities to be imported are simply the differences between the domestic supply and the demand. The results of these calculations are shown in Table 13. These figures take into account what the demand is under each of the two income elasticity assumptions.

Table 13. Import Requirements (MT)

Year	Domestic Supply	Demand		Imports	
		$n_y = .5$	$n_y = 5.6$	$n_y = .5$	$n_y = 5.6$
1985	16,974	40,385	44,567	23,411	27,593
1990	20,197	45,737	65,010	25,540	44,813

The projected values indicate that even with a low income elasticity of demand, production will still lag behind demand, as it has in the past. In general, if total consumption continues to increase rapidly as it has in the past, then it will grow to a level more than double that of domestic supply. The cost of this growth in demand will be a rising import bill unless actions are taken to either increase drastically domestic production or to reverse the trend in total consumption.

Although increasing domestic production may appear desirable, it may also be very costly and its results may be slow in coming. By setting self-sufficiency in rice as one of its major food policy objectives, the government seems to have chosen the production alternative as the way of closing the import gap.

The second alternative, reducing rice consumption, can be quickly realized by cutting imports. This could be done by simultaneously raising the domestic consumer price and controlling imports. However, this may have severe consequences both in terms of the nutritional status of the people and in terms of political stability in the country. So, before any action aimed at reducing rice consumption is undertaken, a careful assessment of some of the following may be necessary: (1) the possibility of having substitutes for rice; is there enough millet, sorghum, or maize to supply consumers at

affordable prices so that their nutritional status can stay the same or be improved when they forego part of their rice consumption? The majority of the population will be hurt if a rise in the price of rice should lead to a rise in the prices of the cereals they consume. (2) The political power of rice consumers, who may strongly oppose any policy aimed at cutting rice consumption.

From the above discussion, it appears clearly that it will be difficult to balance the supply and demand for rice in the country in the next decade and that it will be almost impossible to achieve this balance through only a supply-side policy as the food self-sufficiency goal of the government tends to imply. This supply-side policy appears to be also at the heart of various international agencies' documents. Although it seems agreed upon that rice is not a staple grain for the majority of Burkinabés and is costly to produce domestically, there is little interest in examining ways of reducing its consumption. Through various optimistic scenarios with respect to production, planners have mostly attempted to push domestic production to approach demand so that imports can be reduced and a high consumption level be maintained. By making various assumptions about yields and areas under the different production techniques in the country, WARDA (1977) projected that rice production and consumption would almost be balanced by 1990. (The projected figures are a domestic production of 53.7 thousand tons of milled rice and a domestic consumption of 54.3 thousand tons.) For 1980, WARDA projected a production level of 26.3 thousand tons and a consumption of 33.8 thousand tons. Yet, its 1981 Statistics Yearbook records a domestic production of only 16.6 thousand tons and 40.6 thousand tons of consumption. A similar projection scenario is offered by the FAO (1976) agricultural development plan. It projects for the years 1980, 1985, and 1990 a domestic rice

production (paddy) of 60,000, 80,000, and 120,000 tons, respectively. These figures translate into 31,200, 41,200, and 62,400 tons of milled rice equivalent available for consumption, if adjusted by our .52 conversion factor.

It appears then that even under optimistic scenarios the goal of reaching self-sufficiency in rice as conceived at the national level is not likely to be reached in the near future. This is probably an unfortunate prediction for Burkina Faso, given that it is a land-locked country with a poor economic base and, as such, has little trade opportunity. Thus, its being self-sufficient (in a narrow sense: domestic production covering demand) in a commodity its citizens consume is desirable. However, the question is at what cost can such a country reach self-sufficiency. In the case of Burkina Faso, this cost is likely to be high if self-sufficiency in rice as commonly understood is the targeted goal. A move toward a global view of the food system before setting goals with respect to food security in the country may offer other alternatives. Taking a more global view permits, among other things, an assessment of the potential contribution of each commodity to the nutritional well-being of the population; the relationships of that commodity with other commodities, both at the production and consumption levels; and the trade-offs that may exist among commodities. This implies that both the supply side and the demand side of a commodity, including their related variables, should be carefully analyzed before actions are taken to implement specific commodity policies. Unfortunately, given the weakness of the data, we are not yet in a position to develop a detailed framework of analysis useful in designing policies affecting rice production and consumption in Burkina Faso. Rather, only some broad implications for rice policy will be drawn from the results of our analysis. It is our belief that more research is still needed if detailed prescriptions aimed at improving the contribution of the rice subsector to food security objectives of the country are to be made.

B. Policy Implications

The quality of the data used in the econometric analysis has been generally described as dubious. This is not a surprise when dealing with data on a country like Burkina Faso, given its current state of economic development. There is a lack of both qualified personnel and capital to devote to an adequate data collection system. However, despite the quality of the data used, the results of the econometric analysis do not considerably diverge from economic theory and our knowledge of the rice subsector in the country and more generally from what could be expected after an overview of the subsector was made. While rice acreage expanded from 1963 to 1981, yields, in contrast, declined substantially. Consequently, the gain in total production was almost nil during the whole period. Rice consumption, however, increased considerably and was satisfied mostly through imports. The government rice policies during this period can be summarized as follows: increasing domestic production by investing in land development programs; supporting producer earnings by subsidizing farm inputs; fixing ceiling consumer prices, which are sporadically enforced in cities; and allowing imports to fill the gap between consumption demand and domestic production. Thus, the general objectives of the policies are to encourage domestic rice production and to protect consumers from paying high food prices. In light of the results of the analysis, we may draw the following conclusions with respect to these policies.

- Production: Rice production in Burkina Faso is probably not constrained by what is usually conceived as low producer prices. Thus, policies designed to increase domestic rice production through higher producer prices are likely to yield small benefits. From 1963 to 1981, the official agricultural price movements have largely turned in favor

of cereal growers in the country and more specifically in favor of rice growers. Also, in certain years, the official producer price of rice was even higher than the world price because of the government's attempt to stimulate domestic production. Yet, rice output did not increase as expected in the country. Increase in rice production is constrained by a lack of appropriate technological packages rather than by low producer prices. It should, however, be mentioned that fixing a producer price higher than the world price does not necessarily mean that farmers get paid this price. Experience indicates that in years of high domestic producer prices, imports rather than domestic production, supply consumers. Therefore, caution is required when interpreting the low price responsiveness of the domestic production.

- The implementation of the government land development programs appears to be a significant move toward the breaking of this constraint. However, the declining trend in yield more than offsets the gains from the programs. This implies that the policy alone is an ineffective way of increasing domestic production. At the present state, more investment in the development of high-yielding and short-duration-growing-cycle varieties is needed for the various rice projects to be successful. Making such varieties available to farmers at economical cost would benefit not only farmers working on existing perimeters but also those working under the traditional system of production. The low returns observed under most cultivation techniques by various studies is basically a question of low productivity, which implies a high unit production cost.
- Another related input problem to be concerned with is the low rate of fertilizer utilization by farmers (except in the Vallée du Kou).

Despite the high subsidy rate on fertilizer, use of fertilizer by farmers is very small and unevenly distributed between groups of producers. This raises basically two questions: the profitability of fertilizers despite their low prices and their availability to farmers. To answer the first question would require more research on the responsiveness of rice to fertilizer under the present conditions. The answer to the second question is that on the basis of past experience, many farmers have not been able to get either the amount of fertilizer they wanted or to get it when they needed it. The same observation is valid for other inputs as well (i.e., improved seeds and animal traction equipment). These problems constrain the success of the government policies. Increasing domestic rice production through land development will only result in waste of resources if the strategy is not supplemented by investment in programs aimed at improving yields.

- Besides the above shortcomings of the government policies, the results of the analysis also point out the need to move toward an integration of rice policies into a broader agricultural development strategy. Doing so would offer alternative agricultural investment opportunities to choose from. The results indicate that rice competes effectively with millet and sorghum for production resources. Unfortunately, it is difficult to approximate from our regression coefficient the true opportunity cost of the actual self-sufficiency objective in rice in terms of losses in millet and sorghum output. This is so because of the limitations put on the regression by the quality of the data. However, it is worth mentioning that this opportunity cost is probably far from being negligible, given the relatively low productivity in the rice sector.

- Given the above, one may argue that there is a trade-off between the two crops if the real objective of the country is to achieve food security. However, if self-sufficiency in rice appears to be a priority for other reasons, then increasing rice production could come through measures designed to do the following: (1) increase by a substantial amount the current rice yields; and (2) improve the productivity in the millet and sorghum sector to free more labor for rice cultivation. This assumes that labor is the most constraining factor of production. Other things being equal, increasing the per unit production of land would lead to less hectarage being needed to grow millet and sorghum to feed farm family members, freeing the work force for the cultivation of more rice land.
- Finally, we previously raised the question of the lack of enough milling facilities and the relatively high proportion of broken rice resulting from the operation of the few existing mills. Reducing the proportion of brokens would certainly improve the quality of the domestic rice, making it more competitive with the imported rice.[1/] Unfortunately, there is not enough information on milling activities in Burkina Faso to address this issue seriously in this paper. The problem may consequently be left as a research issue.
- Consumption: The results from the demand equation are relatively less satisfactory than those obtained from the supply model. The estimated elasticities appear higher than expected. Consequently, they do not lend themselves to easy application and may even be misleading. Any

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[1/] Improving the quality of domestic rice to make it more competitive with the imported one will have a limited effect if the imported rice is mostly made of brokens. Under this condition, only relative price of the two types of rice matters.

attempt to use them in a policy analysis framework should therefore be done cautiously. Generally, they tend to support the common belief that rice is a luxury commodity for Burkinabés. A micro study of the consumption patterns of the different income classes in the country is probably needed to shed light on this problem.

- Actually, we seem inclined to accept the view that rice is a luxury cereal for Burkinabés and consequently needs different treatment from millet, sorghum, or maize (the most widely consumed cereals) when we address food security problems in the country. With respect to rice import policy, for example, the government does not make a distinction between rice and the three other cereals. Up to now, the same import tax is applied to all cereals (including wheat).[1/] The consumer price ceiling policy covering all market participants also applies to rice. So, part of the losses incurred by parastatals from their market transactions may result from their activities in the rice market as well as their activities handling other cereals. Since these losses are paid by the government budget, they represent an indirect subsidy on rice production and consumption in addition to the periodic direct subsidy financed by the Caisse de Péréquation (a government marketing board). The relative luxury status of rice, consumed by only a few citizens, suggests that both the trade and the pricing policies of cereals be revised. Taxing rice imports at a higher rate rather than subsidizing it should probably be a rule rather than an exception. Also, the fact that rice donated as food aid or obtained under a concessional sale

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[1/] The government lowered its import tariff on cereals from 18 percent to 12 percent in 1983/84 (see Haggblade, 1984, p. 31).

program does not necessarily go to the poor because it is usually sold in cities by the parastatals to those who have high purchasing power, suggests that it should be sold at the market price rather than at the low official consumer price. Under the present system, poor consumers are relatively more highly taxed than are rich consumers. The grain policies also result in a transfer of income from cereal producers to consumers in general but more specifically to rice consumers. The reason is that cheap rice prices shift away consumption from other locally produced cereals, thereby depressing their prices to producers. Consequently, any change aimed at raising the consumer price of rice relative to that of other widely consumed cereals (millet, sorghum, and maize) is likely to be beneficial to both the government and millet and sorghum producers. Government benefits would include a reduction in imports, which would save on foreign exchange, and an increase in import tax revenues from rice if import levels did not fall greatly. These funds could be invested in other much needed areas such as the millet and sorghum subsector, which feeds the majority of the population. With respect to domestic rice production, we previously raised the need for investment in research to develop appropriate technology to help solve the problem of low yields. The proposed policy change offers an opportunity for the government to make consumers pay part of the research bill. Rice producers and ultimately consumers will benefit from high productivity.

- Although it seems reasonable to oppose a subsidy program on rice in the country, there might be reasons behind its implementation by the government. The most obvious one is the political power held by trade unions, the members of which are mostly from the public sector. They

participate in the price setting process through their representatives. This frequently gives them the opportunity to oppose food price increases unless they are accompanied by corresponding increases in wages. In order to avoid wage increases and also potential food riots (not infrequent in developing countries), the government finds itself constrained to accept low consumer prices supported through a subsidy program. Besides this, the government runs social institutions such as hospitals, schools, and the army. Because rice is easier to cook than millet or sorghum, especially for collective meals, there is an advantage to feed the members of these institutions with rice. These public programs contribute largely to increase the size of the subsidy on rice each year.

- In light of the above, there is reason to believe that any attempt to bring changes like the ones suggested by this paper are likely to be opposed. It is, however, our belief that the current rice policies are likely to be too costly to sustain in the long run and will probably do little to improve the country's food situation. Although we usually accept and even encourage food subsidy programs for the poor despite the fact that such programs introduce inefficiencies in the resource allocation process, it is difficult to accept a subsidy program for the rich. Finally, it should be recalled that the above suggestions are mostly derived from the results of our analysis, which are not exempt from criticisms. We therefore believe that more indepth study is required before detailed policies can be formulated to improve the present food system in the country.

CHAPTER VI

SUMMARY AND CONCLUSIONS

A. Summary

One of the most pressing concerns for the Burkinabé government is how to feed the growing population of the country adequately. Over the past 20 years, total food production in the country fluctuated widely from year to year, mostly as a result of inadequate rainfall during this period. Shortfalls in production of cereals, the basic staples of the country, became the rule rather than the exception. Consequently, to maintain an adequate diet for the population has been very difficult. The country is landlocked with a poor economic resource base, which limits its ability to rely on the world market for its food supply. The fact that a large proportion of food imports (which have been flowing massively into the country since the 1969-73 Sahelian drought) is made of food aid is testimony to this lack of resources. Nevertheless, the country is described by some analysts as being potentially self-sufficient in food production in years of normal rainfall. Thus, the lack of adequate investment in the agricultural sector to minimize the effect of weather is usually pointed out as a major constraint to food production. Another constraint facing the development of food production is the underdeveloped nature of the marketing system. With respect to this, the domestic food pricing policy has been of concern for food system analysts, for it has been usually termed "consumer biased" and therefore as not providing enough incentives to farmers to increase production.

The awareness of the importance of these problems led the government to undertake various steps toward the transformation of the agricultural sector with the objective of moving the country to self-sufficiency in food. Changes

in price policies took the form of the government fixing producer and consumer prices and of the participation of parastatals in buying and selling grains. A licensing system was put into effect to regulate private grain trading. On the production side, steps were taken to provide extension services to farmers and an input subsidy program was introduced to encourage greater input use. Also of concern to the government was the diversification of cereal production, heavily dominated by rainfed production of millet and sorghum, which remains sensitive to shortfalls in rainfall. It is on this ground that the expansion of rice cultivation under modern production techniques became an important goal for the government starting from the early 1970s. Rice consumption was also known to be growing in the country, especially in cities, which implied that more rice would have to be imported if steps were not taken to increase domestic production or curb domestic consumption. Despite efforts ranging from land development projects (mainly small-scale irrigation projects) to input subsidy programs and producer price supports, rice production barely increased during the last decade. Consumption, on the other hand, substantially increased during the same period, widening the import gap. It is on this issue of lagging domestic production and increasing demand that this paper was centered. More generally, the paper was concerned with the identification of the factors affecting the supply and the demand for rice in Burkina Faso. The supply and demand responsiveness to changes in these factors was of particular interest. The specific objectives of the paper were as follows:

(1) to provide a detailed description of the rice subsector in Burkina Faso;

(2) to develop an econometric model based on theory and knowledge of the economic relationship in the Burkinabé rice subsector;

(3) to formulate and estimate the statistical model of the supply and demand relationships and to see if the estimated relationships conform to our economic model;

(4) to interpret and apply the model to current conditions;

(5) to use the model in forecasting demand and supply of rice in Burkina Faso; and

(6) on the basis of the findings, to draw some policy implications that would help formulate actions to improve the present situation.

Several factors that influence the amount of rice supplied (more specifically the amount of domestic production) and demanded were identified. Models were specified and tested using time series data compiled from secondary sources for the period of 1963 to 1981. The selection of explanatory factors was based on economic theory, knowledge of the Burkinabe rice subsector, and data availability. The major findings of the paper are:

(1) Domestic rice production responds positively to price incentives but its responsiveness is low. The estimated price elasticity is about .046. The government land development programs have contributed to expansion of acreage during the 1968-81 period, as expected. Their effect, however, on increasing rice production has probably been low given the general low productivity observed in the subsector. Rice competes effectively with other cereals (millet, sorghum, and maize) for production resources. As a result, production policies aimed at integrating rice into a broader farm production policy will be a better approach to achieve food security for the country than the usual approach of self-sufficiency in rice. Yields have substantially declined through time, resulting mostly from the lack of an appropriate technological package.

(2) The demand for rice is price elastic; hence, demand will decrease rather sharply with an increase in price.

(3) The income elasticity derived suggests that rice is a luxury commodity for Burkinabés. As such, its contribution to the nutritional well-being of the majority of the population should not be overemphasized. Changes in conditions in the domestic cereals market and in trade policy, which were translated into massive rice imports (including food aid) in the 1974-81 period, have contributed to increased rice consumption. The results indicate that per capita rice consumption was twice as high during this period as it was in previous years.

B. Conclusions

Despite the limitations put on the study by the lack of reliable statistical information, the analysis has provided some insight into the rice subsector in Burkina Faso. In general, the results tend to point out that the self-sufficiency goal in rice as usually put on the agenda of policy makers is not likely to be met in the near future. If the current domestic rice policies are continued in the future, the gap between domestic production and consumption demand will continue to widen as it did in the past. The cost of this widening gap will be rising import bills. Currently, the domestic food pricing and trade policy in general tend to work in favor of an increase in rice consumption, a commodity still considered in many Burkinabé circles as a luxury. This aspect of the domestic price policy should not be overlooked. Finally, domestic production appears to be constrained above all by a lack of high-yield technology. The fact that farmers' responsiveness to prices is positive but low is partly a result of this phenomenon. Even with high producer prices, this technical constraint will make it impossible to increase production by a substantial amount.

APPENDIX 1:

Data Used in the Study

Year	Area Under Rice (1,000 ha)[a/]	Area Under Millet/Sorghum (1,000 ha)[b/]	Rice Yields (kg/hg)[a/]	Rainfall (mm)[c/]
1963	33	1,731	758	984.5
1964	35	1,980	971	981.7
1965	35	1,764	971	865.2
1966	35	1,818	971	869.7
1967	36	7,012	934*	771.5
1968	46	1,443	870	961
1969	40	1,961	850	923
1970	41.2	1,891	881	844.2
1971	40	1,742	923	736.7
1972	40.4	1,762	832	787.7
1973	41.4	1,757	748	709.2
1974	42	2,050	929	892.5
1975	41.3	2,050	920	752.1
1976	42.1	2,049	867	839.2
1977	41.6	1,900	778	679.5
1978	41.2	2,010	765	823.7
1979	41	1,800	768	753
1980	40	1,650	716	788
1981	40[b/]	2,100	725	751.6

Sources:

[a/] WARDA, Rice Statistics Yearbook, 4th ed., June 1981.

[b/] "Rapport Mission Conjointe Banque Mondiale/FAO/ISNAR sur la Recherche Agronomique en Haute-Volta, 1983."

[c/] FAO/PAM (1980), WMO (various issues), and ASECNA.

* Estimates.

N.B. Data are presented on a calendar year basis.

Year	Nominal Market Price of Rice (F.CFA/kg)[a/]	Consumer Price Index (1970=100)[b/]	Imports of Rice (1,000 MT)[c/]
1963	45	90.8	2.184*
1964	48	92.6	4.765
1965	57	91.8	3.222
1966	60	93.9	4.084
1967	63	90.4	7.459
1968	65	89.9	1.327
1969	79	96.8	1.475
1970	74	100.0	2.546
1971	62	102.1	1.127
1972	66	99.1	1.598
1973	78	106.6	1.000
1974	93	115.9	18.7
1975	121	137.7	16.2
1976	144	126.1	15.4
1977	174	167.6	18.382
1978	165	218.7	17.9*
1979	176	204.1	25.455
1980	176	229.0	29.0
1981	198	246.3	15.079**

Sources:

[a/] 1963-67: WARDA, 1978, Statistics Yearbook.
1968-81: Steve Haggblade (1984), "An Overview of Food Security in Upper Volta."

[b/] Data presented are a result of a transformation to the base 1970 of original data from BCEAO.

[c/] 1964-77 and 1978-79: P.T. Fotzo, 1983.

*WARDA (1975 and 1981).

**Steve Haggblade (1984).

Year	Population (Millions)[a/]	Gross National Product (Millions of F.CFA)[b/]
1963	4.406	66,862*
1964	4.494	69,287*
1965	4.584	71,800
1966	4.678	74,300
1967	4.769	77,300
1968	4.865	79,500
1969	4.962	86,700
1970	5.061	89,400
1971	5.162	99,200
1972	5.266	103,600
1973	5.371	103,500
1974	5.478	122,100
1975	5.588	134,600
1976	5.700	146,900
1977	5.814	178,600
1978	5.930	199,400
1979	6.049	222,900
1980	6.170	254,106*
1981	6.294*	289,680*

Sources:

[a/] WARDA, 1981, Rice Statistics Yearbook.

[b/] World Bank, 1982: Upper Volta, Agricultural Issues Study.

* Estimates.

APPENDIX 2:

Results of the Regression Analysis Under the Alternative Specification of the Acreage Equation (standard error of coefficients in parentheses)

(1) $LSR_t = \underset{(0.876)}{5.69} + \underset{(0.104)}{0.024}\ LDMPR_{t-1} - \underset{(0.102)}{0.29}\ LASM_t + \underset{(0.004)}{0.0079}\ DV*T$

Statistical features for rho estimate ($\hat{\rho}$) after correction for first-order serial correlation:

$\hat{\rho} = 0.559$; S.E. of $\hat{\rho} = 0.255$; t-statistic = 2.18

$R^2 = .63$; S.E. of regression = 0.048

D.W. = 1.77; F(3,13) = 5.11

(2) $Yt = \underset{(195.74)}{944.56} + \underset{(1.17)}{0.165}\ DMPR_{t-1} + \underset{(0.195)}{0.049}\ RF_t - \underset{(3.96)}{13.39}\ T$

$R^2 = 0.67$; S.E. of regression = 55.52

D.W. = 1.52; F(4,14) = 9.57

(3) $LDMPR_t = \underset{(4.99)}{-4.13} - \underset{(0.246)}{0.195}\ LPRC_t + \underset{(0.495)}{0.88}\ LPCINC_t + \underset{(0.109)}{0.321}\ DV\ 1$

$R^2 = 0.64$; S.E. of regression = 0.12

D.W. = 1.16; F(4,14) = 8.41

All the variables are defined in the text.

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