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FACTORS AFFECTING DEMAND AND SUPPLY
OF RICE IN SIERRA LEONE

By

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CHAPTER 1

INTRODUCTION

Sierra Leone, like most developing countries, is primarily agricultural, with about 75 percent of its population getting its living from farming. The main characteristic of its farming is the large number of small holdings--averaging about two hectares per farm. Most of these farms are fragmented. Large-scale farming is a fairly recent development and the few large farms are either government or quasi-government institutions, confined to crops that require expensive machinery and timely processing.

Of the estimated total area of 7,232,434 hectares of land in the country, only 7.4 percent is under cultivation. A large variety of crops is grown, but only a few are for export, the majority being for local consumption. Rice is by far the most important single crop, cultivated on about 326,802 hectares, or 61.3 percent, of the total land area under cultivation (WARDA) by about 86 percent of the country's farmers (Spencer). These areas provide more than 94.7 percent of the total cereal and about 45 percent of the total agricultural output.

Before the early 1970s, the mining sector, especially the diamond industry, provided the major impetus for economic development in Sierra Leone. In recent years, however, the relative importance of the mining sector in income generation and employment declined. This development raised a serious threat to the orderly and sustained growth of the national economy. New sources of economic expansion had to be developed very quickly if the rates of growth in income, employment, and export earning were not to stagnate. Thus, a major challenge confronting the government at that time was to devise new policies which would prevent such stagnation.

In the country's search for new sources of economic expansion, agriculture assumed first priority. This was due, in part, to the fact that a large percentage of the population derived its living from agriculture. In addition, the development of agriculture has proven to be the safest and most stable avenue for increasing rural income and employment and improving the shortage of foreign exchange. In the early 1970s the government embarked on an ambitious five-year development plan which gave high priority to the development of agriculture. About 15.5 percent of the total investment, and about 26.5 percent of the public investment, was to be allocated to agriculture. This level of investment was expected to result in an agricultural Gross National Product growth rate of 4.6 percent per annum. Among the development

objectives for agriculture, the National Development Plan set out the following:

"1. rapid transition from subsistence to market agriculture

"2. achieving self sufficiency in staple food stuffs and other crops, and improving human nutrition

"3. increasing crop productivity and rural income and employment"

The means of meeting the above objectives with respect to rice production are varied and are contained in the National Development Plan 1974-75 to 1978-79. Most of the improvements in rice production are embodied in the more general and broad integrated agricultural projects located in each of the three major administrative provinces. Major emphasis was put on the development of inland valley swamps and mechanical cultivation of the boli-lands and the riverain grasslands. In addition, there was a proposal for seed multiplication and distribution centers to be located in strategic areas within the country. A central seed testing laboratory at Freetown was also envisaged. This program, coupled with changes in the pricing policy and improvements in harvest and post-harvest technology, was expected to substantially improve the Sierra Leone rice industry.

Until the mid-1950s, Sierra Leone had been a net exporter of rice. Since 1955, however, domestic production has fallen short of domestic demand. This lag in production has been blamed on insufficient attention to agriculture

coupled with unfavorable producer prices for most agriculture products. The generally-perceived result was a growing disparity between rural and urban per-capita income, leading to the excessive migration of young workers to urban centers and the diamond-mining areas in search of income-earning jobs. The final effects included a steady decline in the level of agricultural investment, an aging farm population, rising deficits in foodstuffs, and a slow growth in agricultural exports (FAO). Between 1970 and 1974, rice imports averaged 35,160 tons valued at Le 7,048,000 per annum, putting a squeeze on an already badly needed foreign exchange. In spite of government efforts to increase production through so-called price support and subsidization programs,¹ the need to import rice has continued.

The achievement of self sufficiency in rice has been an important politico-economic goal for policy makers of the government of Sierra Leone. While no firm target date is set, it is nonetheless clear that policy makers and the public believe that the sooner the goal is reached, the better. The political reasons for this objective include national pride and self-determination as well as domestic tranquility. A major economic reason for the policy objective is the desire to save foreign exchange.

¹More will be said on this later.

It is assumed that producing rice domestically by any means will use less foreign exchange than purchasing rice from abroad.²

Justification and Objectives

Despite its importance in the economy of Sierra Leone, the agricultural sector has until recently received very scanty attention from economists and statisticians. Agronomists, sociologists and anthropologists have examined in some detail the soils, cultural practices, land tenure systems, tools, and basic techniques used by Sierra Leonean farmers. Their efforts, however, have failed to produce much-needed basic information such as crop acreages, yields, prices, and other data most relevant for policy formation. Recent efforts to collect such information have only succeeded in getting rough approximations which are at best unreliable. However, in the context of a developing country, such information can be of extreme importance in the design of a development strategy. A number of scholars in developing countries have now come to recognize this fact and have directed their efforts toward measuring the price responsiveness of primary producers.

²While domestic production may save foreign exchange under some conditions, it is very doubtful whether these conditions exist in Sierra Leone. Under several rice-production alternatives examined, Due and Karr (1973) conclude that "the value of rice produced is lower than the costs of rice imports." However, current statistics indicate that the domestic prices (both retail and guaranteed producer prices) are higher than the world price, an indication that Sierra Leone may not have a comparative advantage in rice production.

Throughout the agricultural literature of Sierra Leone, one encounters various impressions about the responsiveness of primary producers to changes in prices of agricultural products. But no explicit study is yet available. The paucity and unavailability of relevant data may be one reason for such lack of study. Eicher et al. (1970), Byerlee (1974) and Todaro (1971) have indicated that various price distortions, such as high urban wage rates and low agricultural prices, act to increase rural-urban income differentials and increase migration. Due and Karr (1973) indicate that there is a direct correlation between rice production and prices, lagged by one year.

In the late 1950s it was generally believed that farmers in Sierra Leone reacted perversely to price changes. Such a viewpoint is implied in the Annual Report of the then Department of Agriculture in 1957. This report states that the majority of farmers had yet to regard oil palm as a crop. They exploited wild palms only if there was no other way of supplementing the budget, and as a result, efforts to distribute better, high-yielding types met with very disappointing results.³

Those who held this viewpoint attempted to justify their positions by stating that farmers had a fixed or target level of income. This viewpoint is no longer held, as is indicated in the opening speech of the President of

³Sierra Leone, Department of Agriculture, Annual Report, 1957, p. 2.

the Republic when he said that government has made a major change in the agricultural price policy and that it is hoped that the price incentive will now act as a powerful stimulus for agricultural expansion.⁴

The accelerated growth in Sierra Leone brought about by the partial implementation of the National Development Plan has important implications for rice-consumption requirements. Rice is being consumed in greater quantities with the increase in population and incomes. This in turn produces an increased demand for the inputs required in rice production. Reliable forecasts of rice consumption requirements are therefore crucial and constitute an indispensable tool to planners. They can help to reduce the margin of error in setting rice production goals, thus minimizing misallocation of resources resulting from over-production and also averting famine resulting from under-production. In commenting on the Rice Corporation, I. I. May-Parker (1972) stated a need for action to ensure that the forecasts of domestic crop and consumption requirements --from which estimates of importation are made--be fairly accurate.

Knowledge of demand and supply price elasticities is important if attempts are to be made to influence

⁴Sierra Leone, "Message by His Excellency, the President, Dr. S. P. Stevens, on the Occasion of the Launching of the National Development Plan," National Development Plan 1974-75 to 1978-79.

3

consumption patterns or if the effects of a particular configuration of supply and demand are to be known. Elasticity estimates used in demand and supply projections in the National Development Plan tend to be inaccurate because they are based on unreliable "general" estimates provided by international organizations such as the Food and Agriculture Organization of the United Nations. Estimates based on data from individual nations are often unavailable. Nevertheless, it is believed that such estimates, although themselves unreliable, can serve as a better guide for formulations than can the regional estimates which incorporate several nations. This paper attempts to look at the factors affecting the rice industry in Sierra Leone using data specifically compiled for Sierra Leone, and in the process, attempts to estimate, for rice, the price and income elasticities of demand and the price elasticity of supply. The specific objectives of this study are as follows:

1. To develop an econometric model based on theory and knowledge of the economic relationships in the Sierra Leone rice industry
2. To formulate and estimate the statistical model and to test this model for the supply and demand relationship of the economic model
3. To interpret and apply the model to current conditions
4. To use the model in forecasting demand and

supply for rice in Sierra Leone

5. To study the impact of government policy on the Sierra Leone rice industry

It is hoped that analysis of this nature will serve as a guide to policy makers in estimating the demand and supply for rice and in implementing strategies for self sufficiency in rice in Sierra Leone.

Plan of the Remaining Chapters

Chapter 2 takes a brief look at the current world rice economy before examining the rice situation in Sierra Leone. Chapter 3 sets the theoretical framework for the empirical analysis, the results of which are discussed in Chapter 4. The results obtained in Chapter 4 are used in Chapter 5 in projecting demand and supply. A discussion on the effects of government pricing policy is also included. This chapter is followed by a brief summary and conclusions in Chapter 6.

CHAPTER 2

RICE IN SIERRA LEONE

World Rice Economy

Rice is a storable and widely traded product. Export production is concentrated in the United States of America, Thailand, the People's Republic of China, Japan, Burma, Egypt, Italy, Pakistan, and Cambodia. Indonesia and South Korea top the list of importing countries. Table 1 shows world rice production, utilization, beginning stock and price index from 1970.

Because of favorable growing conditions, the 1979 crop was estimated at 253 million metric tons. This is above the estimated level of world utilization by 3 million metric tons. World ending stocks were expected to increase to a record level of 24.2 million metric tons (USDA).

Strong import demand and limited export supplies of rice, combined with tight supplies and high prices of other cereals, as well as general inflationary pressures, caused rice prices in the world market to sky-rocket to record highs in 1974, making rice much more expensive in relation to other cereals. Precautionary buying by some importing countries and the continuation of export restrictions by some exporting countries also contributed

TABLE 1

WORLD PRODUCTION AND UTILIZATION OF RICE

Year	Milled Production (a) *	Utilization (b) *	Beginning Stock (c) *	Price Index (d) **
1969-70	203.5	200.5	16.2	129.3
1970-71	210.7	210.7	18.8	103.6
1971-72	214.6	216.8	18.7	85.9
1972-73	208.2	212.7	16.0	99.4
1973-74	223.5	221.8	10.7	235.7
1974-75	227.3	227.2	12.1	377.2
1975-76	243.2	238.0	12.3	306.3
1976-77	235.4	234.2	15.8	. . .
1977-78	247.1	243.0	17.0	. . .
1978-79	253.4	250.3	24.2	. . .

SOURCE: a, b, and c: U. S. D. A., "Foreign Agriculture Circular: Grains," Sept. 1978. d: WARDA, Rice Statistics Year Book, 1974.

*a, b, and c are in millions of metric tons

**Base 1957-59 = 100

to the rise in world prices.

In response to this rice crisis, a number of countries made important policy changes affecting rice production, consumption and trade. This intervention contributed significantly to world market instability by insulating individual countries from the marked adjustments required to meet supply variability. Indeed, by 1976 the favorable weather conditions and the increasing stock of rice contributed to a fall in prices of nearly one-third of their 1974 peak.

Sierra Leone Rice Economy

Sierra Leone and her neighbor Liberia are conspicuous among West African countries for the importance of rice as their basic food staple. As Table 2 shows, Sierra Leone has the highest per-capita consumption of rice in West Africa and she is also the third largest rice producer in Africa, ranking behind the United Arab Republic (Egypt) and the Malagasy Republic. In the early 1950s⁶ Sierra Leone turned from a net exporter of rice to a net importer, and since then, domestic production has always had to be supplemented by imports.

Government concern about the rice situation is not a phenomenon of recent years. As far back as 1932

⁶Available literature as well as export-import statistics do not agree on the date when Sierra Leone became a net importer. However, it is certain that by 1955, Sierra Leone's rice production had to be supplemented by imports.

TABLE 2

RICE CONSUMPTION IN KILOS PER CAPITA (1972)

Country	Kilos/capita/annum
Sierra Leone	127.0
Liberia	119.0
The Gambia	86.0
Senegal	68.0
Mauritania	26.3
Mali	23.8
Ghana	8.6
Togo	5.8
Niger	5.3
Dahomey	4.8
Nigeria	3.8
Upper Volta	2.2

SOURCE: WARDA, Rice Year Book, 1974.

the then Department of Agriculture initiated programs which were meant to achieve self sufficiency in rice and exportation of surplus in good years. Emphasis at that time was placed on swamp rice cultivation. The Rokupr Rice Research Station was established for the explicit purpose of developing and testing improved varieties of swamp rice seeds. Revolving seed schemes were created, a cooperative marketing society for swamp rice was formed, and loans were advanced to farmers to finance the clearing of mangrove swamps. After World War II this program was extended to include inland swamps.

In the early 1950s, the government adopted three other complementary programs in addition to the clearance programs--subsidized fertilizer usage, subsidized mechanical cultivation, and pegging of prices.

Prior to 1952, the price of rice in Sierra Leone was determined solely through market forces. Following a report by a committee appointed to look into the production and marketing of rice in Sierra Leone, the government accepted the following recommendations:

"1. that in order to encourage the planting of rice a guaranteed price to producers should be fixed annually before the time for clearing farms

"2. that in order to implement the guarantee that producers will receive this price, the government must be prepared to buy a considerable portion of the crop offered for sale, up to the present storage capacity

"3. that government should hold adequate reserve stocks of rice not only in Freetown but also in larger urban centers in the protectorate (Provinces) and that

adequate storage accomodations should be provided where this is lacking."⁷

Strict control of rice imports was required in order to implement this program. The government prohibited importation of rice except under government license. When the Rice Corporation was formed in 1965, it assumed these responsibilities and until April 1979⁸ it had a sole monopoly on the export and import of rice. It was also responsible for buying domestically produced rice for resale to the general public, and for fixing the producer price of rice.

The so-called rice price subsidy (pegging of prices) posed two interesting problems. First, the amount of rice purchased from producers was limited by the amount of storage capacity available to the government. When existing facilities were filled to capacity, the overflow had to be sold in the free market.

The second important problem was whether a subsidy was actually being paid to producers who sold their crop to the Rice Corporation. Subsidization usually implies either a lump-sum transfer of income to producers or a pegging of price above relevant market prices. Neither

⁷R. G. Saylor, "Agriculture in Sierra Leone," The Economic System of Sierra Leone (1967), pp. 80-81.

⁸In April 1979, proposals were under way to scrap the Rice Corporation and transfer its activities to the Sierra Leone Produce Marketing Board. See, "Rice Corporation to Scrap," Sunday We Yone (April 15, 1979), pp. 1-2.

of these exists in Sierra Leone. Even when the fertilizer scheme is considered, the questions still remain unanswered, because only a fraction of the farmers utilizes these schemes. Mechanical cultivation is limited to boli-lands and riverain grasslands, which, in 1970-71, contributed a total of only 4 percent of the rice produced. Use of fertilizer is also known to be low.

Production. Rice is grown throughout Sierra Leone on small farms averaging between two and three hectares. Rainfall, which comes mainly between the months of May and October, is sufficient to produce at least one rain-fed crop of rice under various cultural practices. Figure 1 shows the major surplus rice producing areas in Sierra Leone. The Northern Province leads the other administrative regions in both total hectarage planted with rice and total production (Table 3).

There are five major types of rice culture in Sierra Leone. Their percentage distribution in terms of area under rice and paddy production is shown in Table 4. These rice cultures vary in their distributions and capital and labor requirements, as well as yield. Detailed descriptions of the cultural practices and production techniques have been discussed elsewhere.⁹

Upland rice is usually grown in a mixed-cropping system which often includes maize, sorghum, okra, millet,

⁹See J. M. Due and G. L. Karr, "Strategies for Increasing Rice Production in Sierra Leone," African Studies Review 16 (April 1973):23-71.

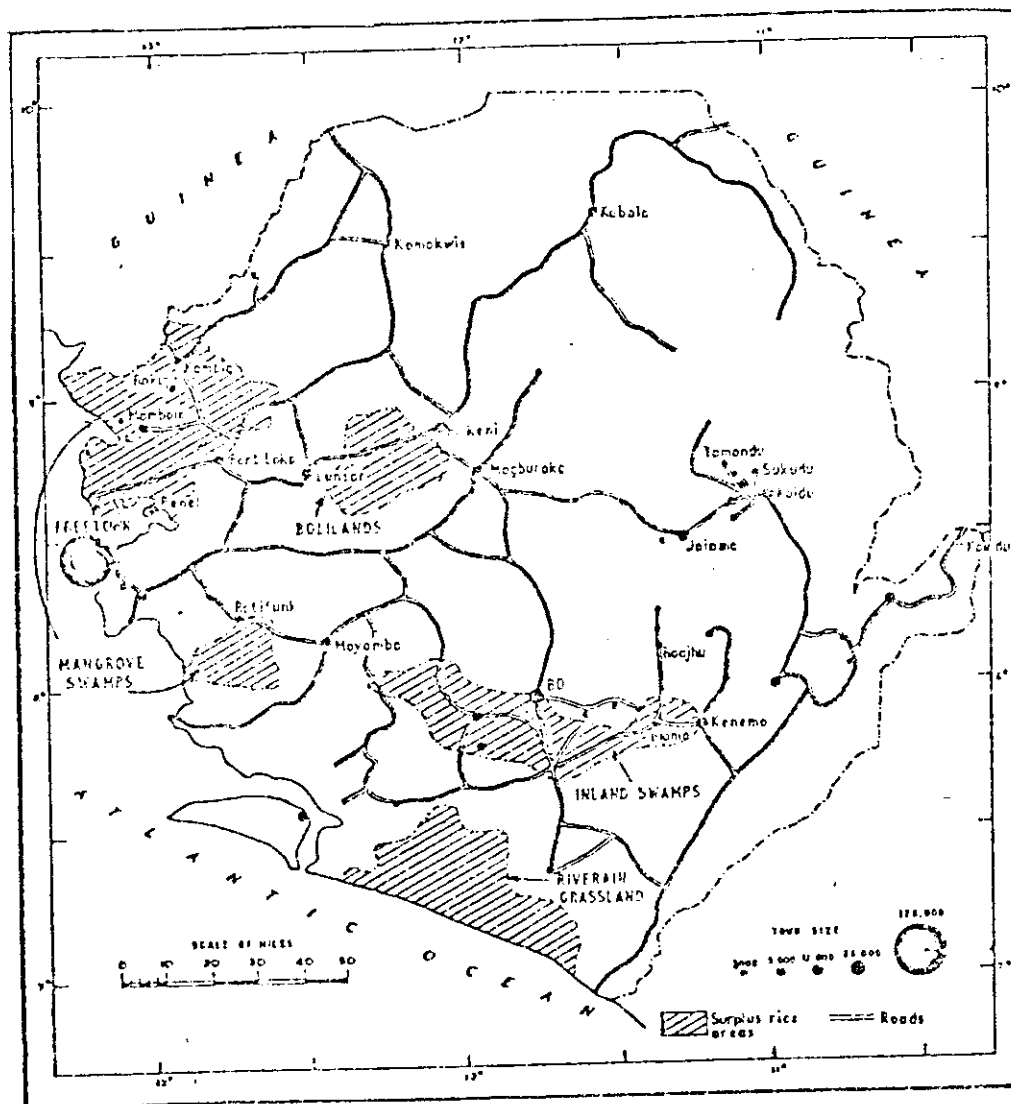


Figure 1. Urban And Major Surplus Rice Producing Areas in Sierra Leone.

Source: Spencer in Due and Karr

TABLE 3

REGIONAL DISTRIBUTION OF HECTARAGE AND PRODUCTION OF
PADDY IN SIERRA LEONE (1965-66)

	Area		Production	
	Hectares (000)	%	Metric Tons (000)	%
South	82.24 (203.2)	27	93.1	24
East	92.18 (227.8)	30	126.6	32
North	125.85 (311.0)	43	173.9	44
Sierra Leone . .	300.27 (742.0)	100	393.6	100

SOURCE: Due and Karr

NOTE: Figures in parentheses are in acres.

TABLE 4

AREA UNDER RICE AND PADDY PRODUCTION--PERCENTAGE
DISTRIBUTION BY TYPE OF RICE CULTIVATION
(1970-71)

Type of Cultivation	Area %	Production %
Upland	76	73
Inland Valley Swamps . . .	16	19
Tidal Swamps	4	4
Riverain Grassland	2	2
Bolilands	2	2
Total	100	100

SOURCE: Warda, "Sierra Leone," Table 10, Rice Statistics Year Book, 1974.

cassava, etc. Swamp rice is grown in pure stands and is distributed throughout the country, with greatest importance in the north. Boli-lands tend to be specific. The largest farms occur in the boli-lands, where mechanically cultivated farms are known to average about six hectares. Input-output information under five different technologies is shown in Tables 5 and 6. Although gross returns per hectare are highest under improved swamp cultivation, the gross margin per hour of family labor with unsubsidized costs is highest on hand-cultivated boli-lands, followed by traditionally cultivated swamp lands.

Recent increases in total production are mainly a result of increases in total area cultivated. Production averaged 334.2 metric tons from 1961 through 1965 and 577.8 metric tons from 1971 through 1975. For the same periods, the area cultivated averaged 287.2 hectares and 438.68 hectares respectively, while the yields were 1180.2 kg/hectare and 1340.8 kg/hectare respectively. It is believed that, even without further increase in total hectarage, Sierra Leone can substantially increase total production of rice through increases in yield per hectare.

Consumption. The rice consumption pattern in Sierra Leone is interesting. Estimates of the rates of increase in consumption and production vary with the source of data. Due and Karr indicate that imports (on husk basis) averaged 7 percent of total estimated consumption between 1960 and 1970, while consumption and production

TABLE 5

LABOR INPUTS AND YIELDS IN RICE PRODUCTION UNDER DIFFERING
TECHNOLOGIES IN SIERRA LEONE, 1974-75

	Labor Input Per Hectare ^a Person Hours Per Year ^b			Yield Per Hectare ^d
	Family	Hired	Total	
<u>IADP Area^c</u>				
Traditional upland	2184.4 (884)	148.3 (60)	2354.9 (953)	894.6 (798)
Traditional swamp	1722.3 (697)	96.4 (39)	1818.7 (736)	1424.5 (1260)
Improved swamp ^e	2780.0 (1125)	632.6 (256)	3442.2 (1393)	1943.8 (1734)
<u>Bolilands</u>				
Hand cultivation	667.2 (270)	116.1 (47)	783.3 (317)	961.8 (858)
Mechanical cultivation	378.1 (153)	98.8 (40)	476.9 (193)	1130.0 (1008)

SOURCE: Spencer and Byerlee, Table 2

^aPerson hour equivalents computed by applying weights of 1.0, 0.75, and 0.5 to men, women and children labor in the IADP area and weights of 1.0, 1.0, and 0.5 to men, women, and children labor respectively in the boliland areas. Weights reflect relative wage rates in those areas as discussed in Spencer and Byerlee (1976).

^bFigures in parentheses are labor input per acre.

^cIADP = Integrated Agricultural Development Project

^dFigures are kilograms per hectare; figures in parentheses are in pounds per acre.

^eIADP package of fertilizer, seed, and water control.

TABLE 6

ENTERPRISE BUDGETS FOR DIFFERENT SYSTEMS OF RICE
PRODUCTION IN SIERRA LEONE, 1974-75

	IADP Area ^a				
	Trad- itional Upland	Trad- itional Swamp	Im- proved Swamp ^h	Hand Culti- vation	Mech- anical Cult.
	Average per Hectare ^b				
Output Value (le) ^c	165.6 (67.0)	259.5 (105.0)	355.8 (144.0)	151.7 (61.4)	178.2 (72.1)
Variable Costs (le)					
Land Paymt. . . .	. . .	. . .	1.7 (0.7)	0.7 (0.3)	5.2 (2.1)
Seed	13.1 (5.3)	10.9 (4.4)	12.6 (5.1)	11.1 (4.5)	9.4 (3.8)
Fertilizer . . .	. . .	. . .	3.7 (1.5)	2.0 (0.8)	3.0 (1.2)
Mechanical Service . . .	. . .	. . .	. . .	. . .	16.8 (6.8)
Hired labor ^d	16.1 (6.5)	11.6 (4.7)	59.1 (23.9)	7.7 (3.1)	7.7 (3.1)
Others . . .	. . .	. . .	5.4 (2.2)	. . .	. . .
Total Variable Costs	29.2 (11.8)	22.5 (9.1)	82.5 (33.4)	21.3 (8.6)	41.8 (16.9)
Interest on Total Cost ^e	5.7 (2.3)	4.4 (1.8)	16.6 (6.7)	4.2 (1.7)	8.4 (3.4)
Enterprise ^f gross mar- gin per hectare	130.0 (52.6)	232.5 (94.1)	255.3 (103.3)	126.3 (51.1)	128.2 (51.9)
Enterprise ^f gross mar- gin per hour of family labor	0.06	0.13	0.10	0.18	0.34

TABLE 6--continued

	IADP Area ^a			Bolilands	
	Trad- itional Upland	Trad- itional Swamp	Im- proved Swamp	Hand Culti- vation	Mech- anical Cult.
	Average per Hectare ^b				
Gross margin ^g per hour family labor unsubsidized costs	0.06	0.13	0.09	0.18	0.06

SOURCE: Spencer and Byerlee, Table 12.

^aIADP = Integrated Agricultural Development Project

^bFigures in parentheses are average per acre.

^cLe 1.00 = \$1.10 U. S. in 1974-75

^dValued at wage rate specific to the area

^eAssumes 20 percent opportunity cost

^fOutput value less variable costs less interest on
variable cost

^gAssumes fertilizer subsidy of 67 percent and mech-
anical ploughing subsidy of 85 percent.

^hIADP package of seed, fertilizer, and water control.

increased at an annual average rate of 6.4 percent and 7.2 percent, respectively, between 1955 and 1970. Using more recent data (WARDA, 1974), imports averaged 10.7 percent of total consumption and consumption and production increased at an average annual rate of 4.9 percent and 3.6 percent, respectively, between 1964 and 1974 (based on milled rice). While no sweeping conclusions can be made from these figures, it is nevertheless clear that in recent years the annual rate of increase in production has fallen behind that of consumption. The reasons for the faster rate of consumption increase are difficult to isolate. It is often attributed to increases in population and income, but production increases can also increase per-capita consumption.

Demand projections have also varied with the assumptions, including rate of population growth and income elasticity estimate. Using the formula $D = p + n.g$,¹⁰ Due and Karr estimated the annual rate of increase in demand for rice in Sierra Leone as shown in Table 7.

The figures in Table 7 appear to be very conservative. The recent rate of population growth is estimated at 2.7 percent. Estimates by Robert King show that, on the average, expenditure elasticities for rice are very close to unity, and depending on the income group, they vary between 0.887 and 1.162. Thus, using a population

¹⁰ $D = p + n.g$ where D is the rate of increase in demand, p is the rate of population growth, and g is the rate of increase in per-capita real income.

growth rate of 2.7 percent, an increase in real income of 2.1 percent, and income elasticities of 0.887 and 1.162, the annual increases in the rate of demand will be 4.56 percent and 5.14 percent, respectively. This range includes the observed average annual rate of increase of 4.9 percent noted above.

TABLE 7
ESTIMATES OF RATES OF INCREASE IN DEMAND
USING DIFFERENT ASSUMPTIONS

p	n	g	D
1.3	0.9	1.5	2.7
1.3	0.6	1.5	2.2
1.5	0.9	2.1	2.8
1.5	0.6	2.1	3.5

Data from the household survey of the Western area in 1968 showed that the average consumption of rice per person increased slightly with income levels between Le 30 and Le 100 per month. The average consumption declined for the above-Le 100 income group (Table 8).

The average amount of rice consumed per person per week in the Freetown area is 3.62 lbs; the average monthly family income is Le 43. This compares to 4.4 lbs in the Northern province, with an average monthly family income of Le 38.90; and 2.9 lbs in the

Southern province, where the average monthly family income is Le 38.09. These figures cannot typically be used to reflect the effect of income on rice consumption, because other factors--such as population and production by province --will have to be considered.

TABLE 8
CONSUMPTION OF RICE BY FREETOWN HOUSEHOLDS

Household income per month	Quantity per week per person (lbs)	Average exp. per week
Under Le 20	3.85	Le 1.00
Le 20-30	4.18	.93
Le 30-40	3.49	1.20
Le 40-60	3.50	1.36
Le 60-80	3.80	1.68
Le 80-100	3.80	1.68
Le 100 and over	2.30	1.65
All households	3.62	1.23

SOURCE: Sierra Leone Central Statistics Office,
Household Survey of the Western Area, Nov. 1966-Jan. 1968
(Freetown, 1968), Table 7.

CHAPTER 3

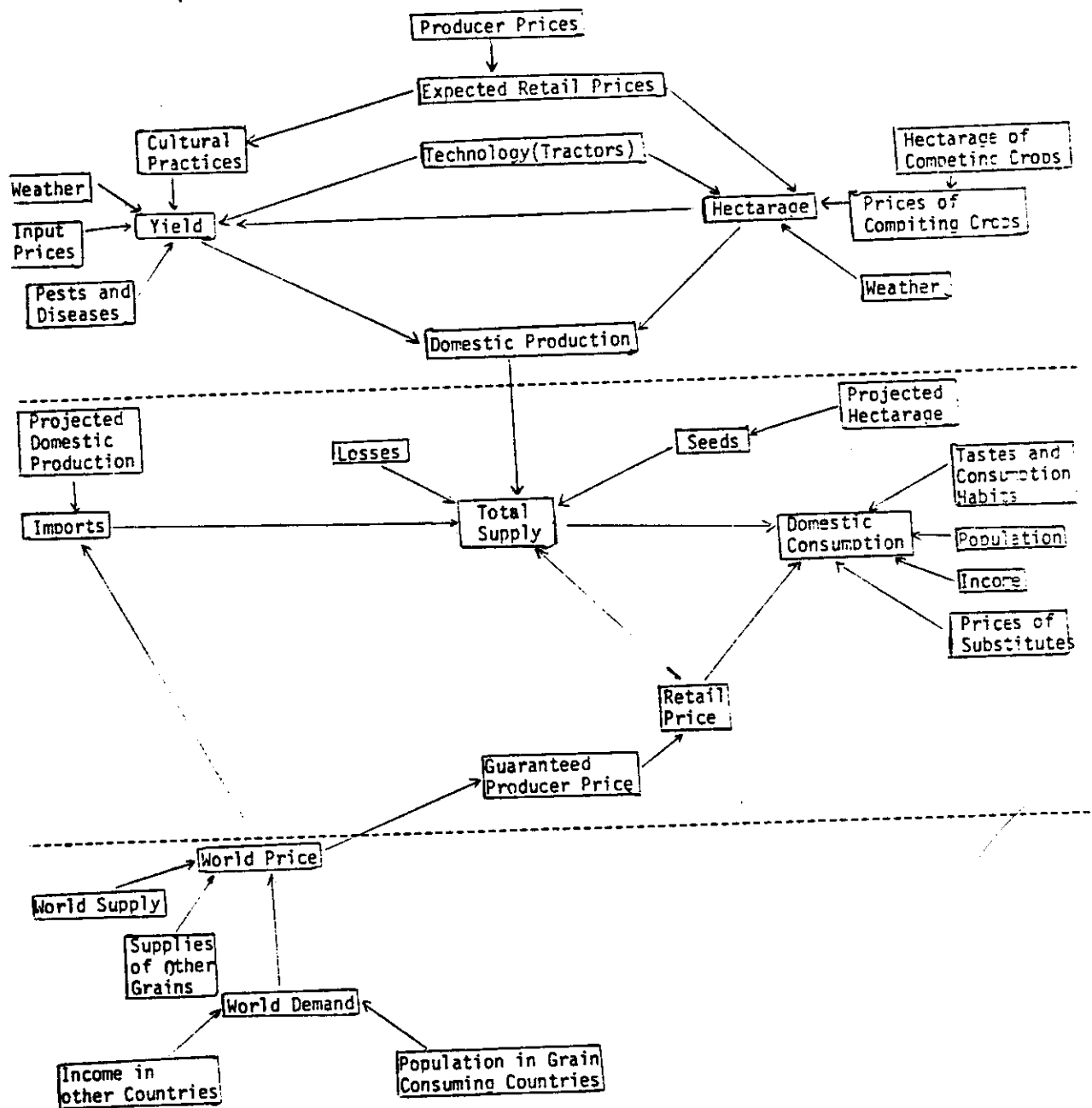
THEORETICAL FRAMEWORK

The supply-demand relationships for rice in Sierra Leone are complex. Prices and uses are determined simultaneously, not only by the supply of rice but also by certain factors outside the rice-market structure that affect demand. The different types of processed rice--white and parboiled--often have different demand relationships. This is further complicated by the different demand and supply relationships between locally-produced rice and imported rice. Unfortunately, these complexities cannot be modeled: available data do not disaggregate demand and supply of white from parboiled rice, nor between locally produced and imported rice.

The Economic Model

The principal economic relationships and variables involved in the Sierra Leone rice industry are shown in Figure 2. The upper part of the figure shows the pattern of forces affecting production, yield, and hectarage of rice. Assuming that expected prices are known with certainty (i.e., guaranteed producer prices are announced before the start of the growing season), the important determinants of both hectarage and yield are physical factors, such as weather, pests and diseases, and cultural practices.

Figure 2: Major Relationships in the Sierra Leone Rice Industry.
(the arrows indicate the principal direction of the causal effects)



Improved technology--i.e., the use of tractors and fertilizers--does affect total hectarage and yield per hectare, but its effect on total production is minimal because of the low percentage of farms using this technology.

The middle part of the figure shows factors affecting consumption and the retail price. The major factors affecting consumption appear to be total supply, population, income, and retail price. An additional consumption factor is the use by farmers of part of their production as seed (planting material) for the next farming year. Estimates for these seed requirements and for the post-harvest losses are not available, but these leakages do affect supply.

The lower left hand corner of the figure shows factors which affect the world price of rice. Since Sierra Leone imports about 7-10 percent of its domestic requirements, it is inevitable that world supply-demand relations will affect domestic supply and demand of rice.

Using two-dimensional graphs, the economic model can be represented as shown in Figure 3. These diagrams are based on economic theory and knowledge of the Sierra Leone rice industry. They give price-quantity relationships, assuming that all other factors are held constant at a given point in time. Diagrams A and B show the demand for imported rice and domestically produced rice, respectively. Diagram C is total demand--a horizontal summation of Diagrams A and B. The price of imported rice is lower than that of domestically produced rice, and this is

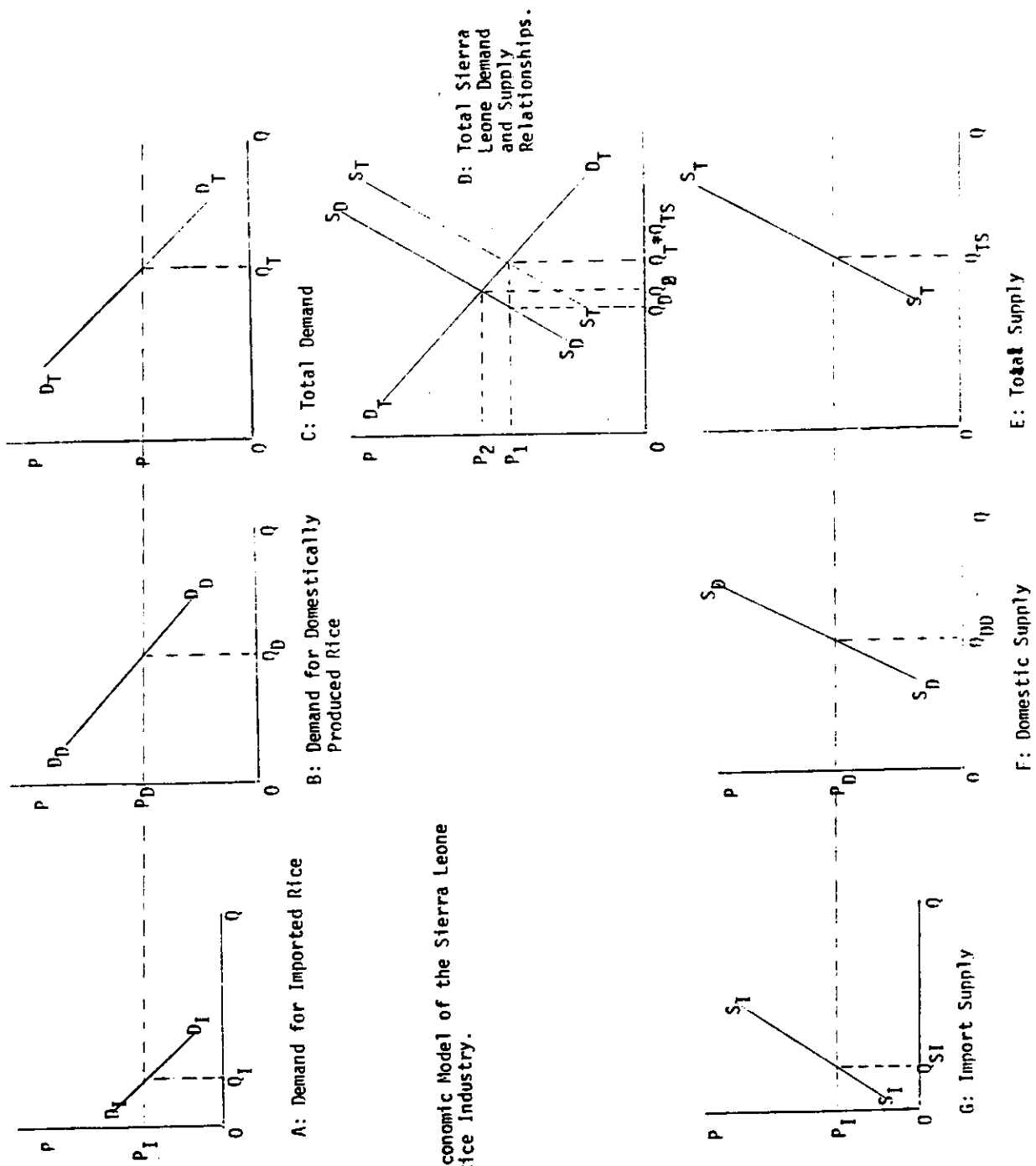


Figure 3: Economic Model of the Sierra Leone Rice Industry.

reflected in the diagrams. However, this price differential is not considered in the analysis, because of a lack of data on the different prices.

The total supply (Diagram E) is also derived via a horizontal summation of the domestic and import supply curves of Diagrams F and G, respectively. The two curves, total demand ($D_T D_T$) and total supply ($S_T S_T$) are combined in Diagram D. Their point of intersection gives the retail price P_1 . The domestic supply curve ($S_D S_D$) is also included in Diagram D to show the difference between domestic production (Q_D) and imports ($Q_T - Q_D$). Without imports, retail price would be expected to increase to P_2 and domestic production would increase to Q_2 .

The Statistical Model

The statistical model is a representation of the underlying economic relationships just discussed. These relationships, supplemented by theory, form the basis for the construction of the model and the classification of the variables. It is assumed that demand and supply are independent of each other and will be estimated separately.

Supply. Empirical studies of supply relationships in other countries indicate that changes in the price of agricultural commodities typically explain a relatively small proportion of the total variation in output over a period of years. Short-run changes in output are often influenced by weather variables and other unpredictable

natural hazards, while long-term changes in supply are attributable to such factors as technology, prices of inputs, and prices of other commodities. In Sierra Leone, the supply of rice is affected by complex and interrelated factors, most of which cannot be statistically measured--either because the factors are not quantifiable, or because there is a lack of data. In this study, only those variables for which data are available have been included, and an attempt has been made to use certain variables as proxies for others. For the total-supply section, a single equation model has been hypothesized with the following functional relationships:

$$(1) \quad QT_T = f(RP_{T-1}, R_T, M_T, T_T, CH_T, T)$$

where

- QT_T = total supply of milled rice in thousands of metric tons in year T
- RP_{T-1} = retail price of rice in leones per metric tons lagged by one year
- M_T = total imported milled rice in thousands of metric tons in year T
- T_T = number of operating tractors in year T
- CH_T = number of hectares planted with cassava in year T
- T = trend variable (1961 = 1)
- R_T = total rainfall between April and December in millimeters in year T

A single domestic supply equation is also hypothesized to have the following functional relationship:

$$(2) \quad QD_T = f(RP_{T-1}, R_T, T_T, CH_T, T)$$

where

RP_{T-1} , R_T , T_T , CH_T , and T are as defined above

QD_T = total domestic supply of milled rice in thousands of metric tons in year T

Demand. Many factors influence the quantity of a commodity that a consumer purchases or his expenditure on it. Some of them are not measurable statistically. Changes in tastes and consumption habits due to institutional and psychological factors cannot be statistically isolated. Others, such as quality considerations, can only 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 single equation model has been hypothesized for the demand section.

$$(3) \quad QT_T / POP_T = f(RP_T, Y_T / POP_T, CP_T / POP_T, T)$$

where

QT_T = total quantity of milled rice demanded in thousands of metric tons in year T

POP_T = population in thousands of persons in year T

RP_T = retail price in leones per metric ton of milled rice in year T

Y_T = national income in thousands of leones in year T

CP_T = total cassava consumption in thousands of metric tons in year T

T = time trend (1961 = 1)

A Note on Data and Methodology

In every economic study there are data limitations. This study is no exception. The level of aggregation upon which this study is based leaves much to be desired. The quality of the data is also suspect, since all of the data used to measure the variables are secondary data from various sources. In evaluating the West African rice economy, the USDA-AID team noted problems with all of the data available and indicated that the accuracy of the available data is often suspect. The figures collected are no more than orders of magnitude. Relevant data such as input costs and prices of competing commodities are not available. Even when data are available, the length of the period they cover is often so short that a limitation is imposed on the number of variables to be included.

This study uses data for the period 1961 through 1976. For time-series analysis, this period is relatively short: most studies draw upon more than 20 years (i.e., twenty observations if annual data are used). Because of degrees of freedom problems, it is rare to establish significant regression coefficients on more than three or four variables with fewer than twenty observations.

Moreover, as the number of independent variables increases, the problem of multicollinearity tends to arise, increasing the variance of the estimated coefficients. One possible solution is to increase the number of

observations. However, in a study like this, the possibility of getting additional data is remote. Besides, if the model will be used for forecasting, it is more reasonable to base it on as recent a time period as possible. This is because the future is more likely to be structured like the recent past than like the distant past.

The effect of the general price level is not included in the demand and supply equations for several reasons. First, the data available on the consumer price index (for a given weight) do not extend through the period used in this analysis. Secondly, it is assumed that producers and consumers are more sensitive to changing rice prices than to changing general price levels. Lastly, the use of the consumer price index either as a deflator or as a separate independent variable could have increased the problems of multicollinearity.

In the supply and demand functions, hectarage planted with cassava and per-capita consumption of cassava have respectively been used as proxies for the price of cassava. Cassava is believed to be the most important substitute crop for rice in Sierra Leone. Provided that other factors remain unchanged, it is assumed that a decrease in the price of rice will result in increased production of cassava, as farmers shift their resources from rice cultivation to cassava cultivation, and in a decreased consumption of cassava, as consumers substitute

rice for cassava.

Lagged retail price has been used in the supply equations instead of the producer prices guaranteed by the government. This is because farmers are believed to respond more to the retail price, since it is consistently higher than the producer price. Besides, out of the total amount of rice that enters the market, only a small proportion is sold through government agents, who pay the lower producer price.

A time-trend variable is included in both the supply and the demand functional equations. Changes in the independent variables included in the models per se cannot explain all the variation in supply and demand of rice. For instance, changes in tastes; in the composition of the population; in technology; and in the distribution of employment between agriculture, industry, and services may all give rise to changes in the patterns of production and consumption of rice. Most of these changes are gradual, however, and might be better explained by trend. Still, as discussed later, it may not be possible to introduce trend together with some of the other variables, because of strong intercorrelation. In such cases, 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.

A major methodological problem in the demand model

was the choice between (1) the simultaneous equations approach, which emphasizes a simultaneous determination of all interdependent relationships, and (2) single equation analysis, using only one equation for the analysis. The main question is whether the coefficients obtained will be unbiased and consistent estimates of the true parameters. The equation used in this study is:

$$y = a + b_i x_i + e$$

where

y = the dependent variable
 x_i = the independent variables
 a, b_i = the unknown parameters
 e = an unobserved error term

The main problem is whether the independent variables can be regarded as predetermined with respect to the demand equation. To be specific: in the demand functional relation, can retail price be regarded as predetermined? Price cannot be predetermined if supply depends to some extent on the price in the same time period. In a case like this, it will be necessary to have a separate equation describing the supply of rice. Otherwise, the random term could not be assumed to be independent of the independent variables, and the use of single equation least-squares analysis would therefore be invalidated.

In this analysis, it is difficult to determine whether the price of rice and the quantity of rice supplied are predetermined variables. Government authorities usually

increase the amount of imported rice available in the market when retail prices start to rise. By increasing supply, this action is believed to keep prices down. However, as prices go up or down, the amount of domestically produced rice in the market moves in sympathy with them. For a country like Sierra Leone, where the total domestic supply accounts for over 90 percent of the rice consumed, the effect of imported rice on total rice supply is minimal and can be considered negligible. For the most part, price, income, and population determine the quantity of rice consumed. Therefore, it seems reasonable to conclude that an analysis of the demand for rice can be based on a single equation least squares regression analysis, with price as a predetermined variable and per-capita consumption as the dependent variable.

Functions Applied

The following functions have been estimated by means of least-squares regression:

a. Total Supply

$$(1) \quad QT_T = \alpha + \beta_1 RP_{T-1} + \beta_2 R_T + \beta_3 M_T + \beta_4 T_T + \beta_5 CH_T + \beta_6 T + e_T$$

$$(2) \quad QT_T = \alpha + \beta_1 \text{Log} RP_{T-1} + \beta_2 \text{Log} R_T + \beta_3 \text{Log} M_T + \beta_4 \text{Log} T_T + \beta_5 \text{Log} CH_T + \beta_6 \text{Log} T + e_T$$

$$(3) \quad \text{Log} QT_T = \alpha + \beta_1 \text{Log} RP_{T-1} + \beta_2 \text{Log} R_T + \beta_3 \text{Log} M_T + \beta_4 \text{Log} T_T + \beta_5 \text{Log} CH_T + \beta_6 \text{Log} T + e_T$$

b. Domestic Supply

$$(4) \quad QD_T = \alpha + \beta_1 RP_{T-1} + \beta_2 R_T + \beta_3 T_T + \beta_4 CH_T + \beta_5 T + e_T$$

$$(5) \quad QD_T = \alpha + \beta_1 \text{Log} RP_{T-1} + \beta_2 \text{Log} R_T + \beta_3 \text{Log} T_T + \beta_4 \text{Log} CH_T + \beta_5 \text{Log} T + e_T$$

$$(6) \quad \text{Log} QD_T = \alpha + \beta_1 \text{Log} RP_{T-1} + \beta_2 \text{Log} R_T + \beta_3 \text{Log} T_T + \beta_4 \text{Log} CH_T + \beta_5 \text{Log} T + e_T$$

c. Demand

$$(7) \quad QT_T / POP_T = \alpha + \beta_1 RP_T + \beta_2 Y_T / POP_T + \beta_3 CP_T / POP_T + \beta_4 T + e_T$$

$$(8) \quad QT_T / POP_T = \alpha + \beta_1 \text{Log} RP_T + \beta_2 \text{Log} (Y_T / POP_T) + \beta_3 \text{Log} (CP_T / POP_T) + \beta_4 \text{Log} T + e_T$$

$$(9) \quad \text{Log} (QT_T / POP_T) = \alpha + \beta_1 \text{Log} RP_T + \beta_2 \text{Log} (Y_T POP_T) + \beta_3 \text{Log} (CP_T / POP_T) + \beta_4 \text{Log} T + e_T$$

Functions 1, 4, and 7 are linear functions. Functions 2, 5, and 8 are semi-logarithmic. Functions 3, 6, and 9 are log-log functions.

CHAPTER 4

EMPIRICAL RESULTS

Both the demand and the supply equations were estimated by use of the ordinary least squares (OLS) estimation procedure. It is assumed that the equation errors are normally distributed with zero mean and finite variance. Thus, the estimated coefficients will be consistent and asymptotically efficient, and will have approximately a normal distribution. This makes it possible to use the t-test for approximate statistical inference.

Interpretation of Estimated Coefficients

In interpreting the parameter estimates, an attempt will be made to assess the validity of the estimates in relation to economic theory. The extent to which signs and relative magnitudes of the estimated parameters agree with expectations will be noted, and explanations for possible deviations from the expected will also be put forward. This section concentrates only on the estimated coefficients.

Supply. Various specifications for the total supply equation and the domestic supply equation were tried. In each case, evidence of multicollinearity in the exogenous variables was detected. When the equations

were estimated using all six exogenous variables, the individual t-tests on the coefficients for the price of rice, tractors, and rainfall indicated that the null hypothesis (that each coefficient is equal to zero) could not be rejected, although the value of the \bar{R} -squared indicated a very good fit. Additionally, the coefficients were very sensitive to slight modifications of the model. The correlation coefficients indicated that both the tractor variable and the hectarage-of-cassava variable are highly correlated with time (i.e., each is above 0.9). Since the hectarage of cassava was only a proxy variable, it was first dropped out of the model specifications.

The models were estimated with the hectarage-of-cassava variable excluded. Again, the t-statistics indicated that the coefficients for the price, rainfall, and tractor variables are zero, although the \bar{R} -squared value still indicated a good fit. Because of the high correlation between the tractor and time variables, the models were specified with one of these variables excluded at a time. In each of the two equations, the specifications with the time and cassava hectarage variables excluded gave a better fit than when the time and tractor variables were excluded. The estimated equations and relevant statistics follow.

$$(1) \quad QT_T = 271.044 + 0.456RP_{T-1} - 0.062R_T + 2.484M_T +$$

(81.580) (0.150) (0.027) (0.637)

$$0.475T_T$$

$$(0.115)$$

$$\bar{R}\text{-squared} = 0.9023$$

$$\text{Durbin-Watson Statistics} = 2.0487$$

$$\text{Standard Error of Regression} = 31.8357$$

$$(2) \quad QT_T = 1076.89 + 147.062\text{Log}RP_{T-1} - 211.763\text{Log}R_T$$

$$(953.646) \quad (56.2296) \quad (115.961)$$

$$+ 25.1063\text{Log}M_T + 18.363\text{Log}T_T$$

$$(10.7442) \quad (6.8999)$$

$$\bar{R}\text{-squared} = 0.7547$$

$$\text{Durbin-Watson Statistics} = 1.6761$$

$$\text{Standard Error of Regression} = 50.4379$$

$$(3) \quad \text{Log } QT_T = 7.587 + 0.459\text{Log}RP_{T-1} - 0.601\text{Log}R_T$$

$$(2.557) \quad (0.511) \quad (0.311)$$

$$+ 0.083\text{Log}M_T + 0.062\text{Log}T_T$$

$$(0.029) \quad (0.018)$$

$$\bar{R}\text{-squared} = 0.8161$$

$$\text{Durbin-Watson Statistics} = 0.6436$$

$$\text{Standard Error of Regression} = 0.135217$$

$$(4) \quad QD_T = 333.090 + 0.253RP_{T-1} - 0.065R_T + 0.596T_T$$

$$(90.245) \quad (0.144) \quad (0.032) \quad (0.120)$$

$$\bar{R}\text{-squared} = 0.8349$$

$$\text{Durbin-Watson Statistics} = 2.0028$$

$$\text{Standard Error of Regression} = 37.2557$$

$$(5) \quad QD_T = 1424.65 + 118.507\text{Log}RP_{T-1} - 231.352\text{Log}R_T$$

$$(878.910) \quad (48.312) \quad (110.438)$$

$$+ 18.728\text{Log}T_T$$

$$(6.504)$$

$$\bar{R}\text{-squared} = 0.7216$$

$$\text{Durbin-Watson Statistics} = 1.6845$$

$$\text{Standard Error of Regression} = 48.3778$$

$$\begin{aligned} (6) \text{ Log QD}_T &= 9.180 + 0.349\text{LogRP}_{T-1} - 0.714\text{LogR}_T \\ &\quad (2.710) \quad (0.149) \quad (0.341) \\ &\quad + 0.070\text{LogT}_T \\ &\quad (0.020) \end{aligned}$$

$$\bar{R}\text{-squared} = 0.7555$$

$$\text{Durbin-Watson Statistics} = 1.6708$$

$$\text{Standard Error of Regression} = 0.149173$$

The figures in parentheses below each coefficient are the standard errors. The Durbin-Watson statistics in each equation indicate that one can neither accept nor reject the hypothesis of serial correlation. The values of the \bar{R} -squared can be interpreted as the proportion of the variation in the endogenous variable explained by the regression equation. Because of the different functional forms used, the value of \bar{R} -squared cannot be used to compare which of the estimated equations gives a better fit. Except for the rainfall variable, all of the signs of the exogenous variables are theoretically correct. (A possible explanation for the negative sign of the rainfall variable will be given later.)

Interpretations of the estimated parameters of each equation differ with the type of functional relationship employed. In the linear equations, each unit change in the exogenous variables changes the value of the

endogenous variable by the value of the co-efficient-- assuming that the other variables are held constant.

In the log-log equation, every percent change in the exogenous variable changes the endogenous variable by the value of the coefficient percent. For example, in equation 3 above, a 1 percent change in lagged price will increase quantity supplied by 0.459 percent. In the semi-log equations, a unit change in the natural logarithm of the exogenous variable will change the value of the endogenous variable by the value of the coefficient.

In all of the equations, the value of the constant indicates the value of the endogenous variable if all the other exogenous variables are held at level zero. Since the models were formulated to apply to variables which have no zero values, the values of the constants have no intrinsic meaning.

The lagged retail price value is a hypothesized indicator of farmers' price expectations. The one-year lag seems appropriate because rice is an annual crop, and, since current production techniques require minimal capital investment, it is assumed that farmers' lagged response cannot extend for more than one year.

The coefficient of the tractor variable in all functional forms is relatively high. This is because it tends to pick up much of the trend effect. It should

therefore be interpreted as a "gross" estimate representing all other relevant variables not included in the model.

In all of the estimated equations, the rainfall coefficients are negative. At first glance, one would expect that an increase in rainfall intensity and distribution would have a positive effect on supply. However, heavy rainfall during seeding and/or transplanting can wash away the seedlings or newly planted rice, thus reducing potential total supply. Coupled with this, upland rice and rice from mechanically cultivated land are major sources of rice supply in Sierra Leone. Both types of rice cultivation need a fairly prolonged dry spell if large areas are to be cultivated: upland traditional methods need sunshine for drying and burning of the bush, while lowlands need dry ground for use of tractors. Rain falling early in the wet season will reduce area cultivated and thus reduce supply. This may explain the negative rainfall coefficients.

Demand. Various specifications for the demand function were tried. As in the supply equations, the time variable in the demand equations was dropped because of relatively high correlation with the other variables, and because, when included in the model, it was statistically not significant even at the 15 percent level. A lagged endogenous variable was included as an explanatory variable. The estimated parameter of this variable should be interpreted as a "gross" estimate representing all

other relevant variables not included in the model.

The estimated equations are shown below.

$$\begin{aligned}
 (7) \quad QT_T/POP_T &= 0.162 + 0.651Y_T/POP_T - 0.000168RP_T \\
 &\quad (0.075) \quad (0.367) \quad (0.000130) \\
 &\quad - 6.048CP_T/POP_T + 0.800QT_{T-1}/POP_{T-1} \\
 &\quad (3.828) \quad (0.348)
 \end{aligned}$$

$$\bar{R}\text{-squared} = 0.6395$$

$$\text{Durbin-Watson Statistics} = 2.2805$$

$$\text{Standard Error of Regression} = 0.0173262$$

$$\begin{aligned}
 (8) \quad QT_T/POP_T &= 0.152 + 0.0912\text{Log}(Y_T/POP_T) \\
 &\quad (0.265) \quad (0.0446) \\
 &\quad - 0.04172\text{Log}RP_T - 0.1622\text{Log}(CP_T/POP_T) \\
 &\quad (0.0303) \quad (0.0961) \\
 &\quad + 0.0845\text{Log}(QT_{T-1}/POP_{T-1}) \\
 &\quad (0.0446)
 \end{aligned}$$

$$\bar{R}\text{-squared} = 0.6887$$

$$\text{Durbin-Watson Statistics} = 2.2834$$

$$\text{Standard Error of Regression} = 0.0160991$$

$$\begin{aligned}
 (9) \quad \text{Log}(QT_T/POP_T) &= -1.7149 + 0.6784\text{Log}(Y_T/POP_T) \\
 &\quad (1.8965) \quad (0.3189) \\
 &\quad - 0.3079\text{Log}RP_T - 1.1557\text{Log}(CP_T/POP_T) \\
 &\quad (0.2168) \quad (0.6868) \\
 &\quad + 0.6327\text{Log}(QT_{T-1}/POP_{T-1}) \\
 &\quad (0.3188)
 \end{aligned}$$

$$\bar{R}\text{-squared} = 0.7155$$

$$\text{Durbin-Watson Statistics} = 2.2903$$

$$\text{Standard Error of Regression} = 0.115053$$

The \bar{R} -squared value indicates the proportion of total variation in per-capita consumption explained by the regressors in the model. The Durbin-Watson Statistics cannot be used to test for serial correlation because of the use of the lagged endogenous variable as a regressor. All of the signs of the estimated parameters are theoretically and logically correct.

The values of the constants have no intrinsic meaning, since all of the explanatory variables included in the analysis have non-zero values.

The coefficients for each functional form are interpreted similarly, as indicated in the supply equations above.

Relative Performance of the Models

The demand and supply models can be further evaluated by examining the number of errors in the estimation of the turning points and the frequency of underestimation and overestimation errors, and by plotting the actual and estimated endogenous variables. The turning-point error for each dependent variable is determined by comparing the direction of change in the observed values with that in the estimated values. This information is summarized in Table 9. All formulations tended to have more underestimation errors than overestimation errors. The number of turning-point errors was relatively higher in the demand formulations than in the supply formulations.

TABLE 9

TURNING POINT ERROR, UNDERESTIMATION AND OVERESTIMATION
ERRORS FOR ESTIMATED EQUATIONS

Equation	Dependent Variable	Turning Point Errors	Under-Estimation Errors	Over-Estimation Errors
<u>Total Supply</u>				
1 (linear)	QT_T	5	8	8
2 (semi-log)	QT_T	6	10	6
3 (log-log)	$\text{Log}QT_T$	6	9	7
<u>Domestic Supply</u>				
4 (linear)	QD_T	3	7	9
5 (semi-log)	QD_T	6	9	7
6 (log-log)	$\text{Log}QD_T$	5	9	7
<u>Demand</u>				
7 (linear)	QT_T/POP_T	7	9	7
8 (semi-log)	QT_T/POP_T	7	10	6
9 (log-log)	$\text{Log}(QT_T/POP_T)$	7	9	7

The performance of the models can also be evaluated by comparing visual plots of the actual values and of the estimated values against time. This information is contained in Figures 4 through 12.

Elasticities

The lagged-price elasticity of supply is calculated for each equation in the total-supply and domestic-supply models. The price elasticity and income elasticity are calculated for each equation in the demand model. For each linear equation, the elasticity estimate can be computed. Assuming that $Y = \alpha + \beta_i X_i$, the elasticity estimate is calculated as

$$\frac{\partial Y}{\partial X_i} \left(\frac{\bar{X}_i}{\bar{Y}} \right) = \beta_i \left(\frac{\bar{X}_i}{\bar{Y}} \right)$$

where Y is the endogenous variable; X_i , the appropriate exogenous variable; β_i , the estimated coefficient corresponding to X_i , and \bar{Y} and \bar{X} , mean values of the endogenous and exogenous variables, respectively. The elasticities increase numerically with an increase in the exogenous variables and decrease with increase in the endogenous variable. In the table, the elasticities are given for the average of the variables during the period.

In the semi-logarithmic functions, there is an inverse proportionality. Assuming that $Y = \alpha + \beta_i \text{Log} X_i$, then the elasticities are estimated as follows:

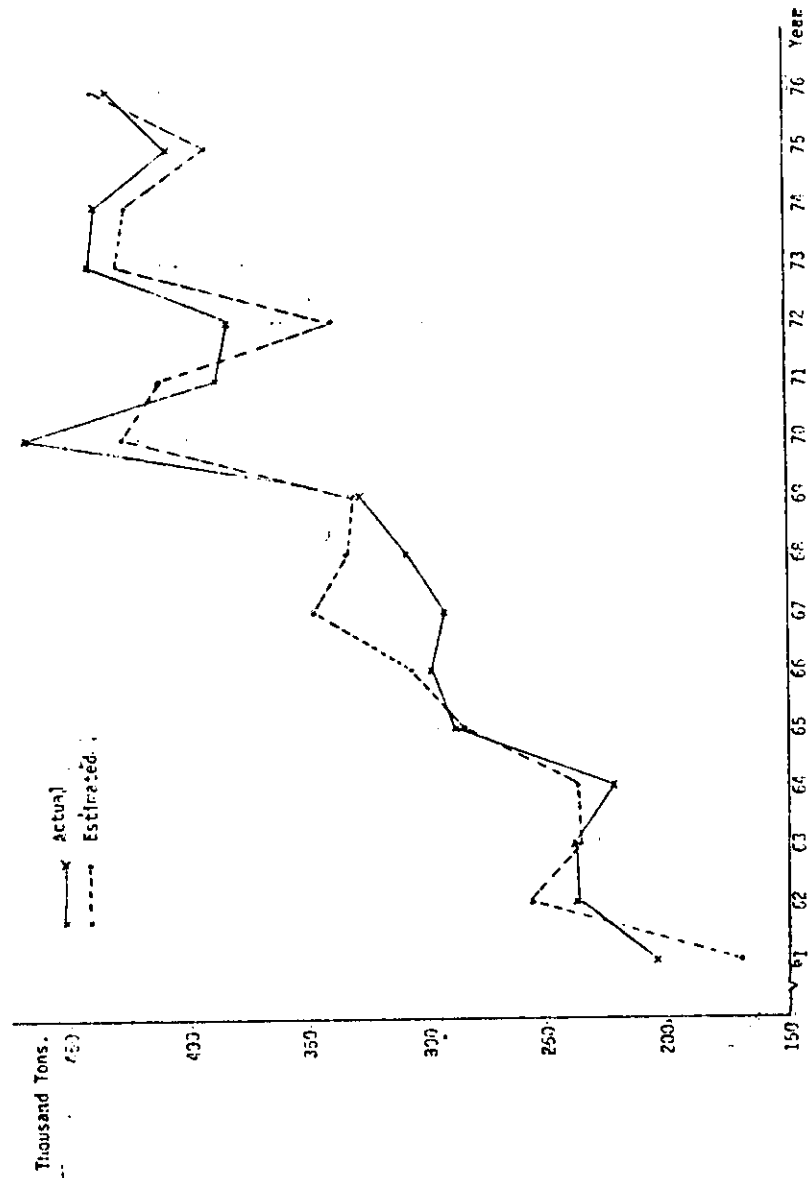


Figure 4: Total Supply of Rice: Actual and Estimated. (Linear)

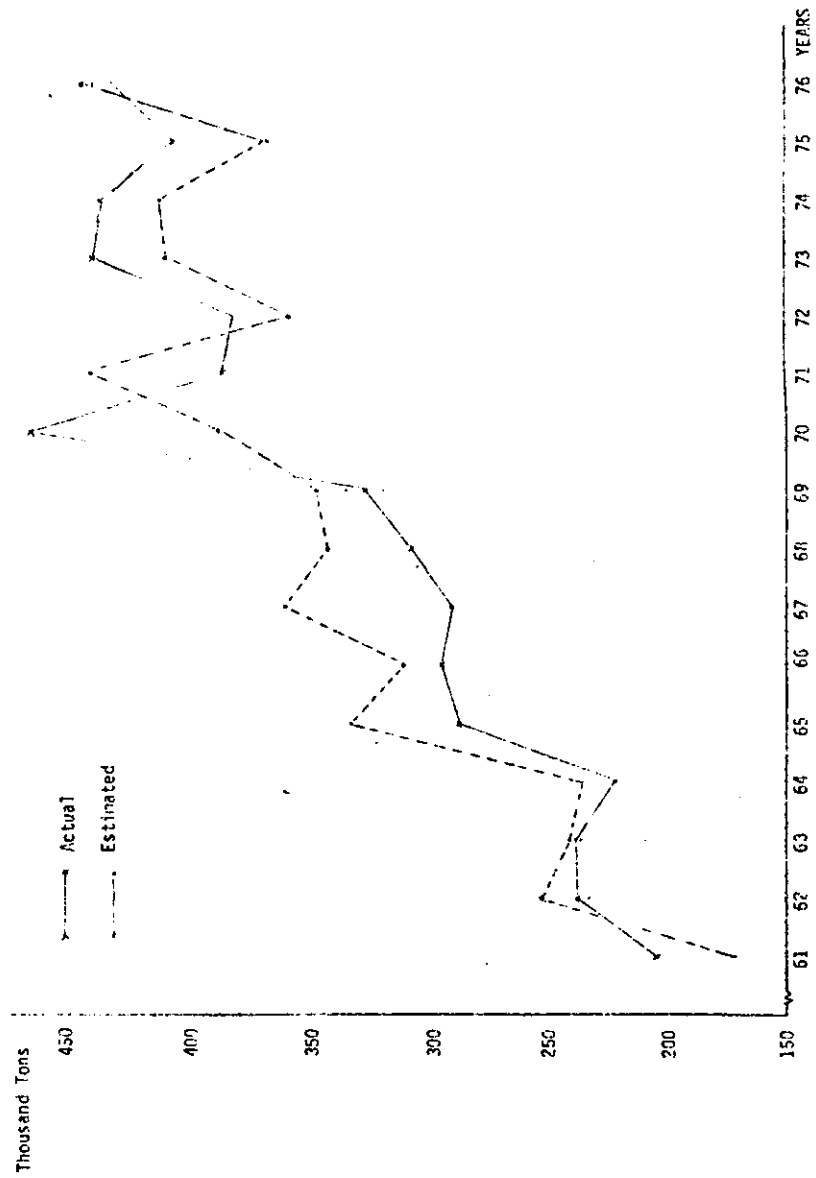


Figure 5: Total Supply of Rice: Actual and Estimated (Semi-log)

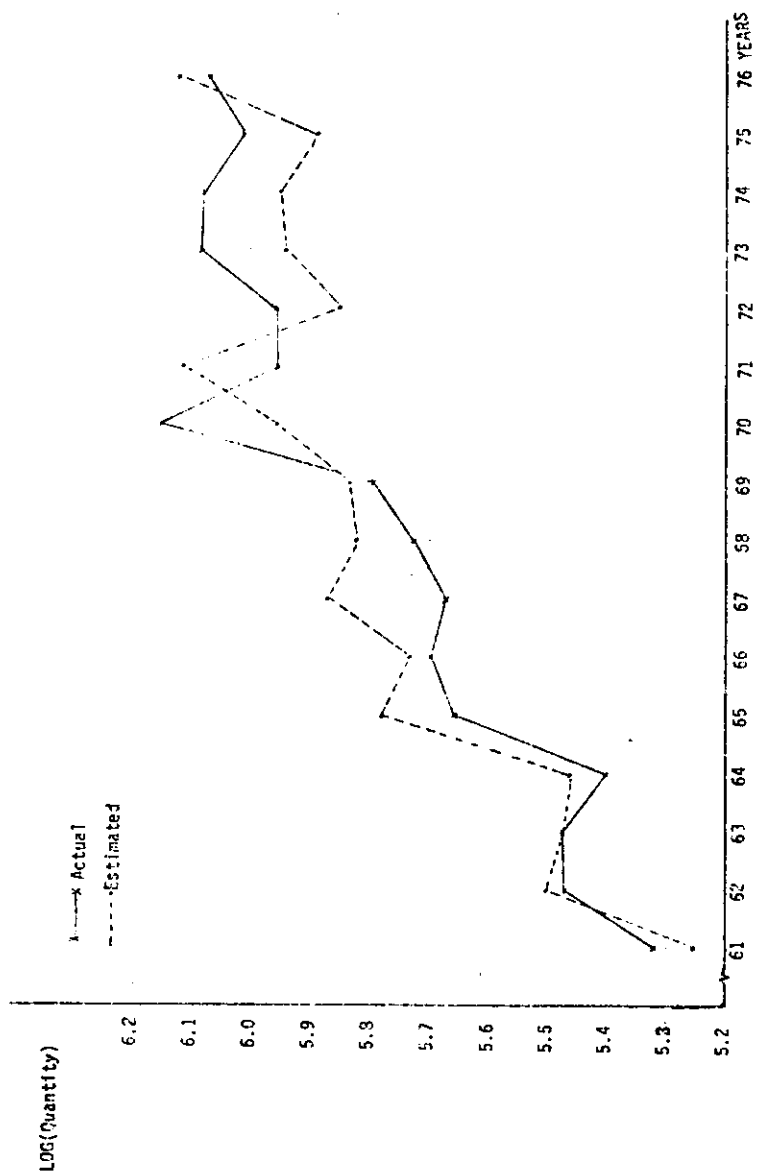


Figure6: Total Supply of Rice: Actual and Estimated (Log-log)

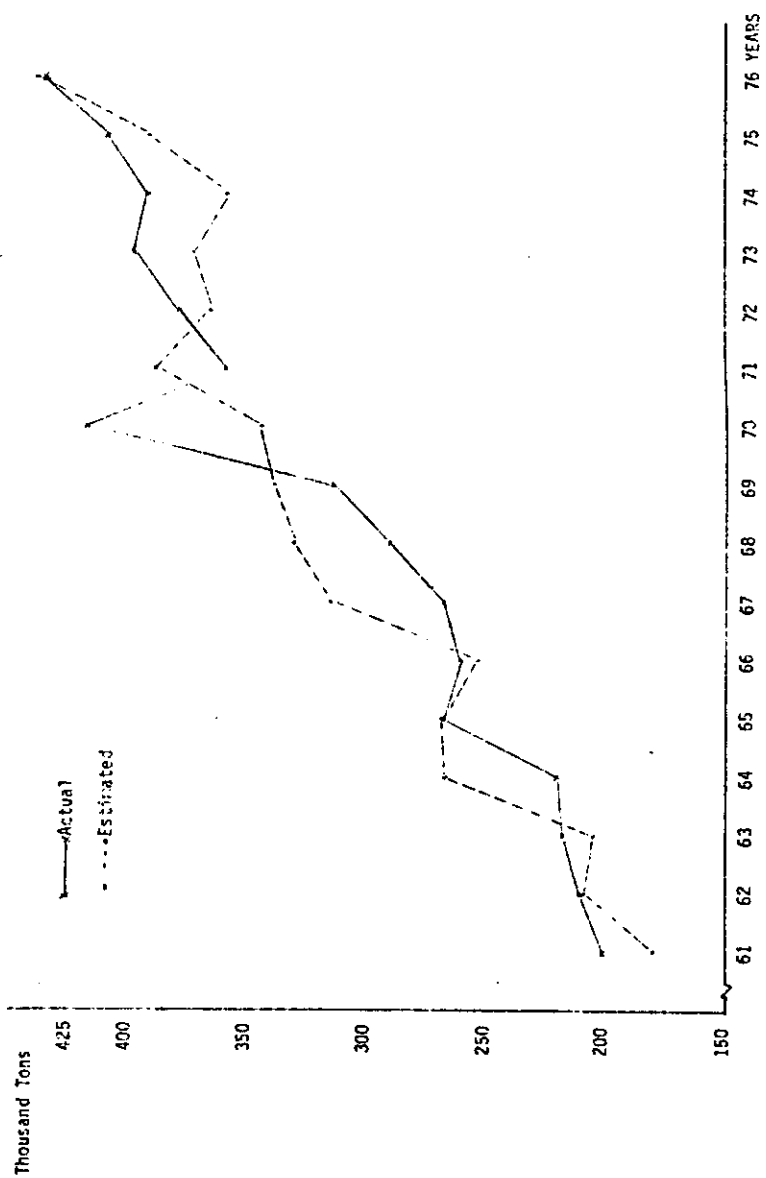


Figure 7: Domestic Supply of Rice: Actual and Estimated (Linear)

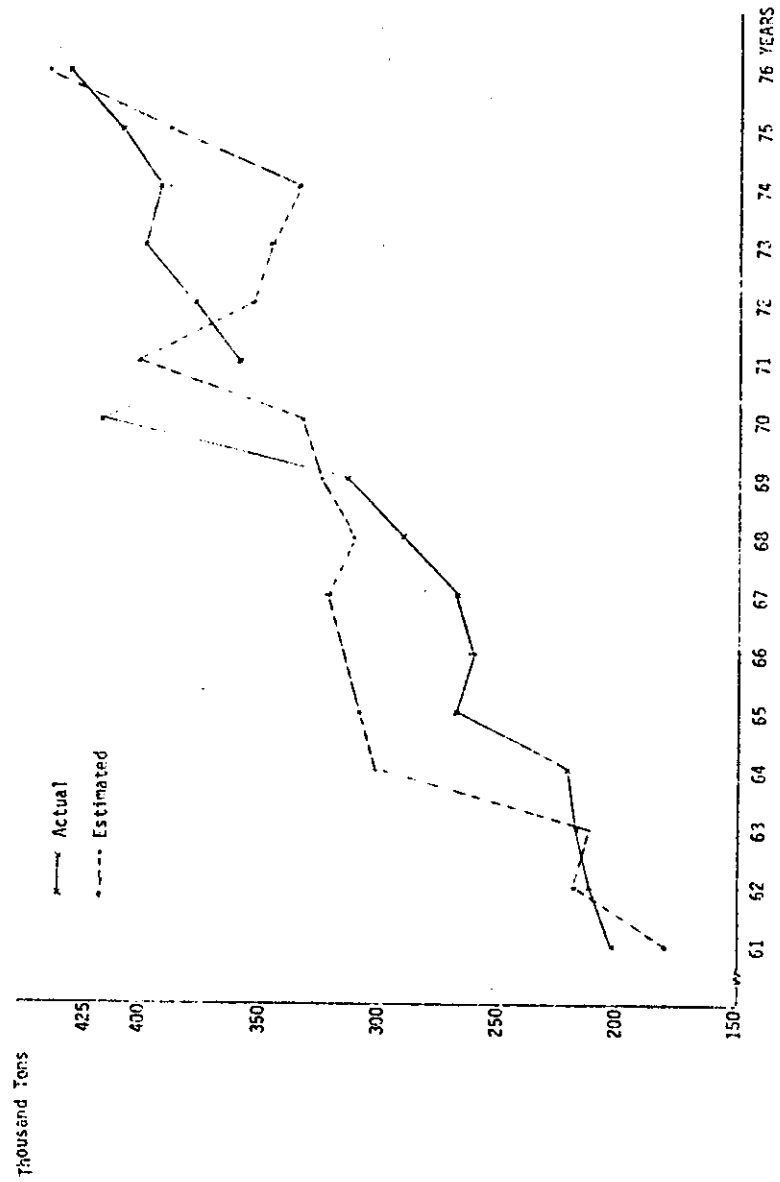


Figure 8 Domestic Supply of Rice: Actual and Estimated (Semi-log)

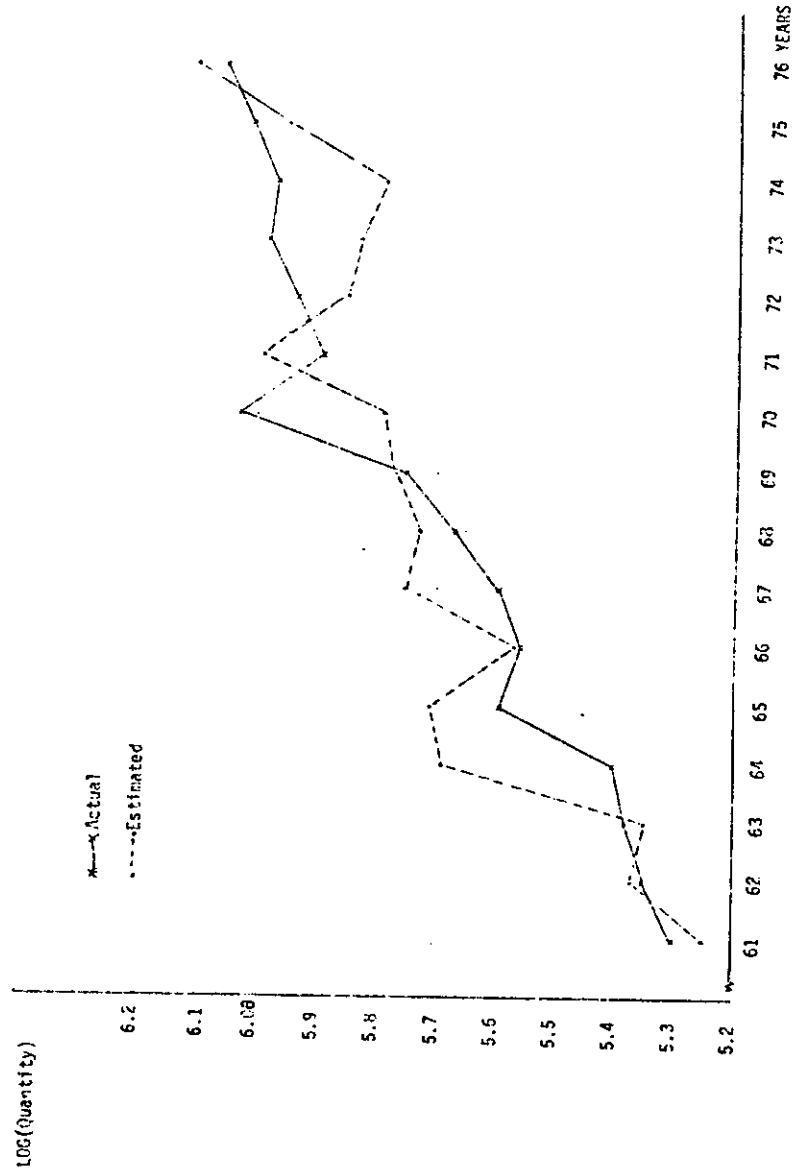


Figure 9: Domestic Supply: Actual and Estimated (Log-10)

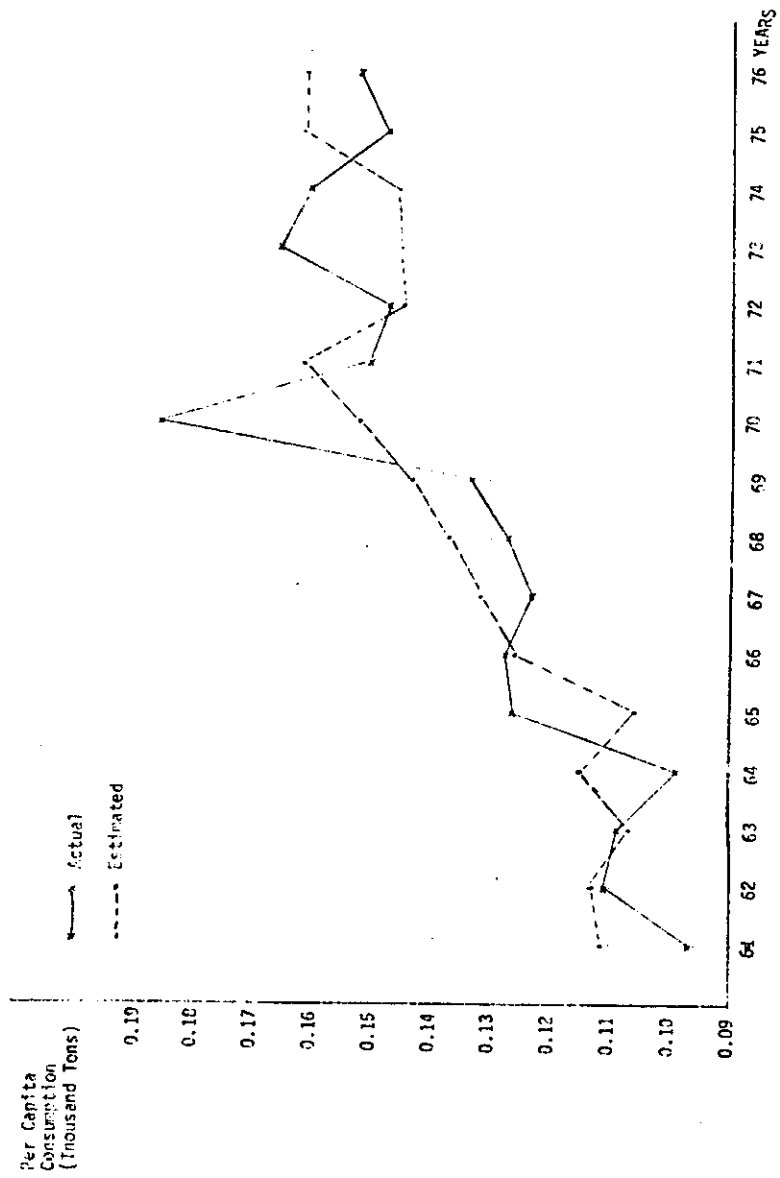


Figure 10 Rice Demand: Actual and Estimated (Linear)

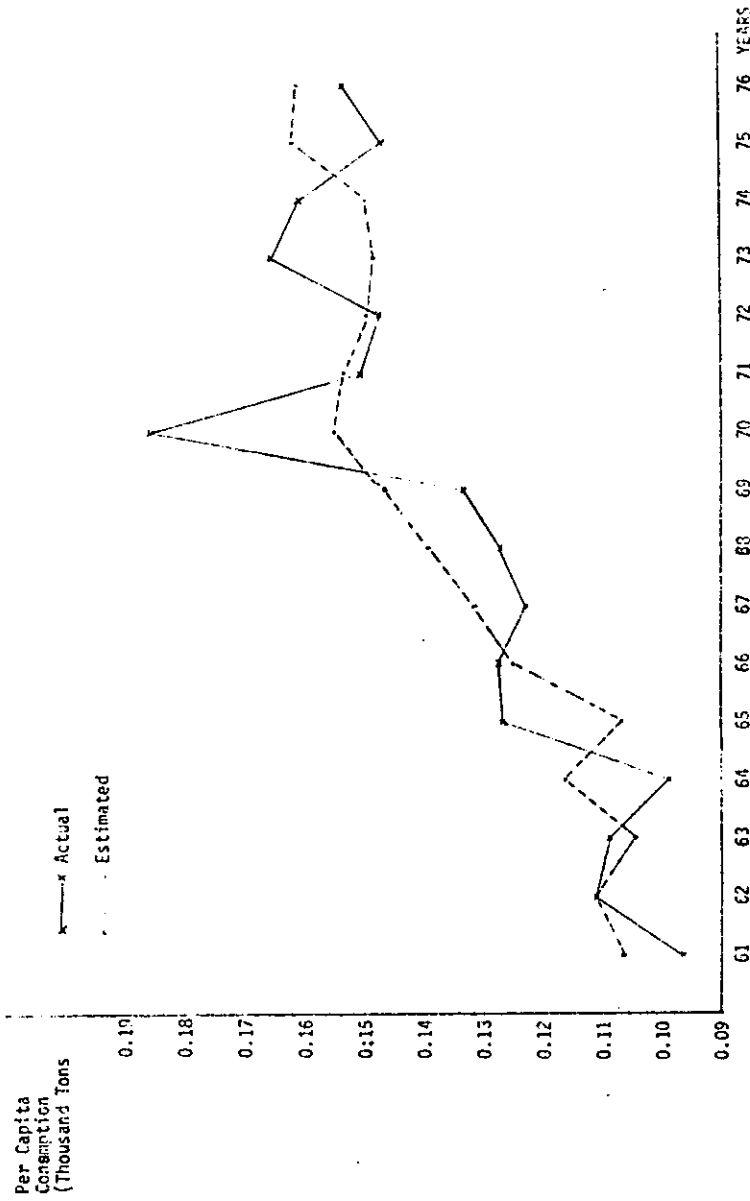


Figure 11 Rice Demand: Actual and Estimated (Semi-ton)

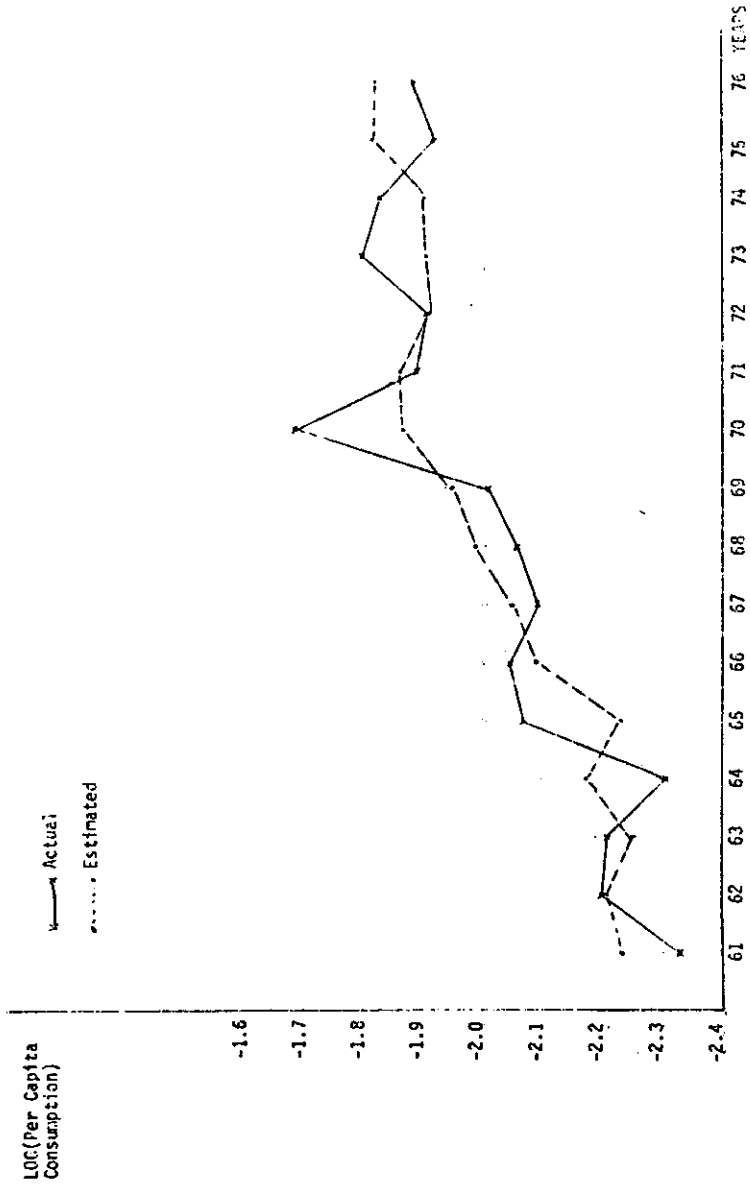


Figure 12 Rice Demand: Actual and Estimated(Log-log)

$$\frac{\partial Y}{\partial \text{Log} X_i} \left(\frac{\bar{X}}{\bar{Y}} \right) = \frac{\beta_i}{\bar{X}} \left(\frac{\bar{X}}{\bar{Y}} \right) = \frac{\beta_i}{\bar{Y}}$$

The symbols are as defined above and the endogenous variable is measured at the average for the period.

In the log-log functions, all elasticities are constant regardless of the level of the exogenous variables. The elasticities are equal to the estimated coefficients β_i . The elasticity estimates are summarized in Table 10.

All elasticities estimated from the linear function are lower than those from the semi-log and log-log functions. Except for the price elasticity of demand, the values of the other elasticity estimates conform with expectations. The price elasticity of demand in the log-log function indicates that a 1 percent increase in the price per ton of rice will decrease rice consumption by about 0.3 percent. Because of the absence of a close substitute, and based on the homogeneity condition,¹¹ one would expect the price elasticity of demand to be close to the income elasticity in absolute

¹¹Tomek and Robinson, Agricultural Product Prices (Cornell University Press, 1972), pp. 37-39. The homogeneity condition states that the sum of the own- and cross-price elasticities and income elasticity for a particular commodity is, taking account of signs, zero. In mathematical symbols, this can be represented as

$$E_{ii} + E_{ij} + E_{iy} = 0$$

where

$$E_{ii} = \text{own-price elasticity}$$

TABLE 10

ELASTICITY ESTIMATES

Elasticity	Functional Form		
	Linear ^a	Semi-log ^a	Log-log
Lagged price elasticity of total supply	0.301	0.438	0.459
Lagged price elasticity of domestic supply . . .	0.178	0.376	0.349
Price elasticity of demand .	-0.294	-0.309	-0.309
Income elasticity of demand	0.576	0.676	0.678

^aElasticities are calculated at the mean of the appropriate dependent and/or independent variables.

values. However, the low estimates may be due to the effects of aggregation.

The supply elasticities are low because of the government pricing policy, which has effectively held down the price paid by consumers and has prevented it from rising to provide farmers with an incentive to increase production or adopt new methods. Estimates of all elasticities are based on the existing low prices.

Comparison of the elasticity estimates in this study with those in other studies is difficult because of differences in method and data. While estimates in this study are derived from time-series analysis, most estimates in other studies are derived from cross-section data. Cross-section material cannot usually be regarded as typical of the whole population, because it mostly includes only wage and salary earners, who, in Sierra Leone, constitute only a small percentage of the total population. Also, cross-section analysis yields an estimate of the relationship between income and consumption for a short period in which many factors affecting consumption are constant; while time series analysis, on the other hand, estimates elasticities on the basis of

E_{ij} = cross-price elasticity

E_{iy} = income elasticity

Under the assumption that the cross elasticity is positive and its lower limit is zero, if E_{ij} is low (close to zero) because of the absence of a close substitute, then

$$|E_{ii}| \geq |E_{iy}|.$$

a relatively long period during which some of the constant factors may change. These changes may have important implications for the estimated elasticities.

Comparison is also rendered difficult due to the fact that the definitions of the various variables in cross-section data may differ from the definitions in time-series data. In a cross-section analysis, consumption is usually measured in expenditures, whereas for time-series analysis, consumption is mostly measured in physical units of the product. Other things being equal, the cross-section elasticities will be higher than those from time-series, because an increase in income is often followed by an increase in the quality of the product consumed. Robert King estimates an expenditure elasticity of rice that is close to unity, as compared to 0.676 estimated in this study. Various international organizations have estimated the income elasticity of demand for rice to be between 0.2 and 0.9.

CHAPTER 5

APPLICATION OF THE MODEL

Because of the paucity and low quality of data used in this analysis, any attempt to use the results for either policy analysis or policy formulation must be approached with extreme caution. Sierra Leone is a country in its early stages of development. There is a lack of adequate data on nearly all areas of the economy.

In addition, studies dealing with long-term projections are necessarily subject to the limitations inherent in supply-demand analysis. Firstly, long-term projections are inevitably based on a wide range of assumptions which may or may not hold true over the projected period. Secondly, assumptions about consumer behavior, changes in tastes, and preference patterns may be deceptive in a society that is undergoing rapid change. Finally, the conditions that determine levels of consumption and production do not lend themselves to simple quantitative measurement.

Projections of Supply

Rice production forecasts for Sierra Leone have generally been based on production trends in recent

years. It is often assumed that the future will look more like the recent past than like earlier years. This method, although inadequate, seems appropriate because most of the data available show only relative magnitudes, rather than the true values of the variables.

A similar method of trend projection is used in this study. However, instead of using a simple linear trend function, this study attempts to forecast each of the regressor variables separately. These regressor forecasts are then used in the estimated equations to make projections of domestic supply for the years 1980, 1985, and 1990.

Rainfall. The average annual rainfall for the entire period of the analysis is 2681.73 mm, with a standard deviation of 302.543. This average compares with the 1961-65 average of 2688.31 mm and the 1972-76 average of 2534.4 mm. The decrease in average rainfall --about 5.7 percent in recent years--may be due to the 1973-74 drought which affected most of West Africa. For the period under consideration, the lowest recorded rainfall was 2199 mm in 1973. For the purposes of this study, it is assumed that, by 1980 and thereafter, rainfall will have reached its pre-drought level, averaging 2748.70 mm per annum, which is the annual average for the years 1961-71.

Retail price. The retail price of rice in Sierra Leone is not determined by the interaction of the market

forces of supply and demand. Government intervention has kept the retail price below what it would be in a free market. Because of the human element involved in this intervention, it is very difficult to predict what the price will be in the near future. For the period under analysis, the following retail prices were recorded:

TABLE 11
RETAIL PRICES OF RICE RECORDED FOR THE PERIOD
UNDER ANALYSIS

Year(s)	Price, Le/Ton	% Increase
1960-64	174.2	. . .
1965	191.8	10.10
1966-69	211.6	10.32
1970	249.1	17.72
1971	205.0	(17.70)
1972	156.5	(23.66)
1973	198.4	26.77
1974	414.5	108.92
1975-76	412.2	(0.55)

From the stagnant price of Le174.2 per ton in 1960 through 1964, prices increased to a high of Le249.1 per ton in 1970. Thereafter, prices declined to a low of Le156.5 per ton in 1972. Starting in 1972, there was

a dramatic increase in price, which reached a peak of Le414.5 per ton in 1974. From 1974 to 1976, prices decreased by only 0.55 percent from their 1974 peak.

It is difficult to discern any pattern of price movements from the annual figures. On the whole, however, there has been a tendency for prices to increase. From 1960 to 1970 there was an average annual increase of 3.47 percent, while for 1971-76 the average annual increase was 15.63 percent.

For the purposes of this analysis, it is assumed that the retail price of rice will remain at its 1976 level through 1978. It will be assumed that prices will increase at a modest annual rate of 5 percent, starting in 1978. This annual rate of increase appears conservative when one considers that money prices are being used in the analysis and that the inflation rate in Sierra Leone for 1978 was estimated at 30 percent. Thus, using the above assumptions, the retail price of rice in Sierra Leone is estimated at Le432.81 per ton in 1979, Le552.38 per ton in 1984, and Le 704.99 per ton in 1989.

Tractors. The number of tractors in operation in Sierra Leone has been increasing at a decreasing rate since 1965. The number of tractors increased from a total of 90 in 1965 to 200 in 1967. By 1971, there were 225 tractors in operation. In 1974 this number

increased to 240; in 1975, to 250; and in 1976, there were 255 tractors. Assuming that this trend continues, a semi-log function can best approximate the number of tractors in the future. To predict the number of tractors in 1980, 1985, and 1990, the following function was fitted:

$$T_T = C + \text{Log}(\text{TIME})$$

where

$$T_T = \text{number of tractors in year } T$$

$$\text{TIME} = \text{trend variable (1961 = 1)}$$

Using this function, the estimated numbers of tractors in operation are 289 in 1980, 315 in 1985, and 336 in 1990.

Using the values of the variable forecast above, and employing each of the three equations estimated in Chapter 4, the domestic supply projections shown in Table 12 are calculated. A simple trend projection has also been included for comparison.

As can be seen in Table 12, the trend projections showed consistently higher estimates than the other three projections. Of the estimated equations in this study, the linear model had the highest projection estimates for all of the years, while the semi-log model had the lowest estimates. Based on different assumptions, WARDA and Spencer have projected domestic production at 458.95 and 511.61 metric tons, respectively, for 1980; and 629.8 and 801.92 metric tons, respectively, for 1990.

TABLE 12

DOMESTIC SUPPLY PROJECTIONS

Projection Estimate ^a for	Method			
	Trend	Linear	Semi-Log	Log-Log
1980	507.76	436.17	418.09	420.35
1985	587.37	481.92	448.62	460.48
1990	669.97	533.04	478.73	503.67

^aEstimates are in milled equivalent and assume a 67 percent recovery rate. Quantities are in thousands of metric tons.

Demand Projections

Simple linear extrapolations of past trends are often used to project demand requirements. In such projection exercises, there are necessarily major limitations. The time period is often short and fundamental changes in outlook are not captured. Moreover, the use of past trends as a basis for projections is further circumscribed by the influence of weather, which makes it extremely difficult to determine a normal period to serve as a base for the projections. Also, rice is only one type of food, albeit a staple one. Projections often cover a period in which economic and social conditions may change, inevitably affecting food-consumption patterns. There is already evidence that rice consumption among the high-income class in Sierra Leone has peaked, and

that further income growth will see a trend towards higher-protein diets. To the extent that demand patterns can be expected to change in the next decade or so, biases will arise from considering rice in isolation.

In this analysis, two methods are employed. The first method assumes that income and population are the chief determinants of the demand and is based on the following formula:

$$d = \text{Pop} + nY$$

where

d = rate of growth of consumption

Pop = rate of growth of population

n = income elasticity of demand

Y = rate of growth of per-capita income

The estimate for the rate of growth of consumption will depend on the assumptions made regarding the rates of growth of population and per-capita income. This paper will assume a rate of growth of 2.1 percent for both population and income--a figure which appears to be consistent with the data used in this analysis. The income-elasticity estimate obtained in the semi-log demand function will be used. When the rate of growth of consumption is obtained, projections are then based on the following equation:

$$D_T = D_0 (1 + d)^T$$

where

D_T = projected consumption in time T

d = rate of growth of consumption

T = time in years from D_0 to D_T

In the second method, an attempt is made to forecast the major variables affecting demand, and to use these forecasts in the estimated equations of the demand model to project total demand.

Retail price. Assumptions for the forecast of retail prices in the demand projections are similar to those in the supply projections. Thus, it is assumed that retail prices will be Le412.2 in 1980, Le526.08 in 1985, and Le671.42 in 1990.

Population. Actual census figures for 1963 and 1974 show total population at 2,180,000 and 2,729,000, respectively. These figures indicate an annual total population growth rate of 2.10 percent. In this analysis, it is assumed that this population growth rate will continue into the future. Thus, total population is estimated at 3,019,100, 3,264,850, and 3,510,600 in 1980, 1985, and 1990, respectively.

Income. For the period under consideration, national income at market prices increased at an uneven rate. Income increased from Le172.2 million in 1961 to Le314.6 million in 1970, representing an annual average growth rate of 8.27 percent. From 1971 to 1976, national income increased from Le 317.8 million to Le 590.1 million, representing an annual average growth rate of 14.3 percent at market prices. (This high growth rate may be due to

the implementation of the National Development Plan in 1974, and therefore may not represent a normal trend.) The growth rates will be much lower when calculated on the basis of real income. For example, Gross Domestic Production (GDP) at factor cost (in constant 1963-64 prices) grew at an average rate of 4.3 percent per annum between 1963-64 and 1970-71. The National Development Plan, 1974-75 to 1978-79, envisaged a GDP growth rate of 6.2 percent over the plan period. This is about 2 percent higher than the growth rate of the previous period. In this paper, it is assumed that the trend in income growth during the period under analysis will continue into the future. A simple linear time trend function was therefore used to estimate future income. Thus, income is estimated at Le579,020, Le700,100, and Le821,270 in 1980, 1985, and 1990, respectively.

Cassava production (consumption). Cassava is considered to be a major rice substitute in consumption, but it is not a perfect substitute. In this paper, it is assumed that increases in the consumption of cassava will occur at a decreasing rate. A semi-log function, with time as a regressor, was fitted to forecast cassava consumption. Thus, cassava consumption in 1980, 1985, and 1990 is estimated at 83,100, 85,850, and 88,100 metric tons, respectively.

Using the values of the variables forecast above, and employing each of the three equations for the demand

model estimated in Chapter 4, projections for the demand of rice for 1980, 1985, and 1990 are shown in Table 13.

TABLE 13

DEMAND PROJECTIONS

Estimates ^a for	Method 1	Method 2		
		Linear	Semi-Log	Log-Log
1980	485.77	528.94	551.95	595.31
1985	577.49	634.95	648.04	778.33
1990	686.53	655.73	731.89	944.60

^aEstimates are in milled equivalents and assume a 67 percent recovery rate. Quantities are in thousand metric tons.

Demand projections based on the equations estimated in this analysis are highest with the log-log function and lowest with the linear function. While these projections may seem absurd, they tend to shed some light on the future situation of the Sierra Leone rice industry. Assuming that the assumptions made here will be true in the future, there is a clear indication that domestic production will continue to lag behind total demand up to the 1990s. If the government continues to hold prices at low levels that cannot cover production costs, it is obvious that production will accelerate at a very low rate. On the other hand, the relatively low price paid by consumers, and the increases in incomes and

population, will help to accelerate the rate of demand for rice--thus widening the gap between domestic production and demand. In the absence of a radical reorientation of the government's agricultural policy, there is little basis for optimism for the future performance of the rice industry. The price of rice is probably the most important policy instrument available to the government for improving the Sierra Leone rice economy. In the next section an attempt is made to calculate the equilibrium price that will equate demand and supply of rice under the assumptions employed above.

Equilibrium Price Projections

The algebra for the determination of the equilibrium price can be illustrated by means of a simple three-equation model:

$$\begin{aligned} Q_T^d &= a - bP_T \text{ (demand)} \\ Q_T^s &= c + dP_{T-1} \text{ (supply)} \\ Q_T^d &= Q_T^s \text{ (market clearing at equilibrium)} \end{aligned}$$

where

$$Q_T^d = \text{quantity demanded at time } T$$

$$Q_T^s = \text{quantity supplied at time } T$$

$$P_T = \text{price at time } T$$

$$P_{T-1} = \text{price lagged by one year}$$

a , b , c , and d are constants; a and c are assumed to incorporate the other variables.

At equilibrium, the quantity demanded will be equal to the quantity supplied. Equating these quantities, one obtains:

$$\begin{aligned}
 Q_T^d &= Q_T^s \\
 a - bP_T &= c + dP_{T-1} \\
 P_T &= \frac{a - c - dP_{T-1}}{b}
 \end{aligned}$$

If equilibrium conditions are obtained, then $P_T = P_{T-1}$. Let P_E represent the equilibrium price when that is so. Then

$$\begin{aligned}
 P_E &= \frac{a - c - dP_E}{b} \\
 &= \frac{a - c}{b + d}
 \end{aligned}$$

Equilibrium price projections are made for each of the equations estimated in the demand and domestic supply models. An estimate has been made for 1976 using observed values for the other independent variables. For 1980, 1985, and 1990, the values forecast above are used for the independent variables besides prices. If the assumptions made in the forecasts are true, the projected equilibrium prices are as summarized in Table 14.

As can be seen in Table 14, the linear function showed the lowest price-projection estimates, while the log-log function showed the highest estimates, when each was compared with the other two estimates. These estimates reflect the lower and higher demand estimates of the linear and log-log functions, respectively.

TABLE 14

PROJECTED EQUILIBRIUM PRICES

Estimates ^a for	Function		
	Linear	Semi-Log	Log-Log
1976	473.53	482.24	428.46
1980	660.36	791.61	947.64
1985	798.15	1609.81	1242.51
1990	892.02	1879.63	1858.335

^aEstimates are in leones per metric ton of milled rice.

In all of the projections, the linear function tended to produce more realistic estimates than did the other functions, especially with respect to the demand and price projections. It would be unrealistic to expect total demand in 1990 to be almost two times its 1976 level, and it is even more unrealistic to assume that equilibrium prices will increase more than four-fold by 1990, as is depicted in the semi-log and log-log functions. Nevertheless, the results above indicate a wide gap between the price actually paid by consumers and the price that would equate the demand and the supply of rice in the absence of imports.

Economic and Welfare Effects of the Sierra Leone
Rice-Pricing Policy

Over the past year, the government of Sierra Leone has employed several means to keep the price of rice from rising to its free domestic market level, and at the same time has maintained a producer price that is above world market prices. This policy has a fundamental effect on producers, consumers and the government that is difficult to quantify. However, it is possible to define the aggregate costs and welfare transfers involved in such a policy. This kind of analysis employs supply and demand curves and suggests welfare implications based on the concepts of producer and consumer surplus. The general framework for this analysis is shown in Figure 13. The domestic demand and supply curves are drawn to reflect the elasticities estimated above.

If there is no government intervention and free imports are allowed, the price of rice will be at the low world price of P_w . Domestic production and demand will be Q_1 and Q_2 , respectively, resulting in net imports of $Q_2 - Q_1$. However, because of government intervention, the price is maintained at P_d , which is below the equilibrium price of P_E (without imports) but above the world price level. At P_d , domestic production is increased to Q_3 and domestic demand reduced to Q_4 .

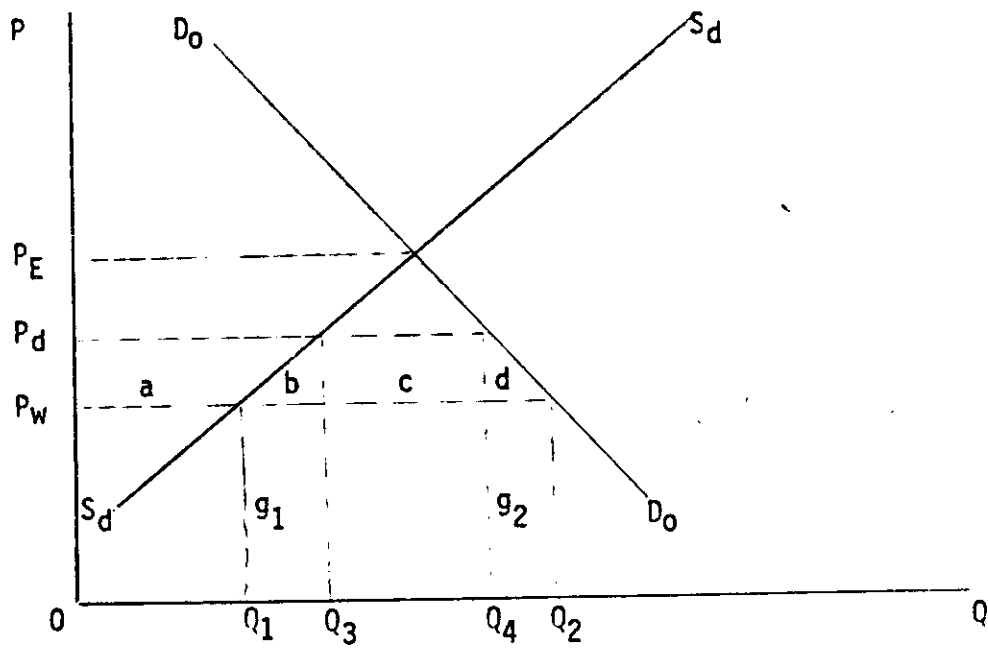


Figure 13 Economic and Welfare effects of the Government Pricing Policy on Rice.

This results in net imports of $Q_4 - Q_3$. This policy has four distributional effects:

1. Government earns revenue from rice imports
2. Additional resources are pulled into rice production
3. Producers receive a transfer of welfare from consumers
4. Society loses the consumers' surplus attached to the reduction

In addition, there is a balance-of-payments effect.

With respect to Figure 13, the loss of consumers' surplus due to government price policy is equal to the area $a + b + c + d$. The government earns a revenue from the rice imports equal to area c ($= P_d P_w \times Q_3 Q_4$).

The area under the domestic supply curve and between Q_1 and Q_3 represents the opportunity cost in terms of foregone outputs of other goods as a result of increasing output by $Q_3 - Q_1$. The area b therefore is the increase in opportunity costs associated with replacing imports with domestic production. This area is also a loss to domestic consumers and represents the cost of additional resources pulled into rice production.

Area a shows another redistribution effect: it represents the transfer by consumers in the form of higher prices paid on domestic output to domestic

producers. Resources employed in the production of $Q_3 - Q_1$ are receiving a factor return higher than that necessary to keep them employed in that capacity.

Assuming that gains to one group are comparable to losses by another group, a general welfare statement can be made about the effects of the pricing policy. The components of the consumers' losses, a and c, are simply transfers to producers and to the government, respectively. Their net effect on the country's welfare is zero. The areas b and d are losses to the country and to consumers in particular. Area b represents less-efficient use of resources, and area d is a loss to consumers that is not offset.

Finally, there is a balance-of-payments effect associated with the higher prices. The high prices reduce expenditures on imports equivalent to area $q_1 + q_2$. This directly improves the current account of the balance of payments.

Another aspect of the Sierra Leone government rice policy is associated with the strategy of subsidizing investments to bring about a technological change necessary to shift the supply curve outward. Government has subsidized mechanical cultivation, fertilizers, and swamp development for the past decade. These subsidization programs have three main effects which are related to the pricing effects above. Firstly, more domestic resources are drawn into production. Secondly, the

government budget is affected due to a fall in imports that are replaced by domestic production and the increased need to pay for the additional subsidized factors. Thirdly, only farmers using the subsidized inputs receive a transfer, putting them at a competitive advantage over the other farmers.

Although it is difficult to calculate any quantities for these three effects, it is clear that the economy as a whole has suffered dead-weight losses due to government policy. The area d is a net welfare loss which has neither economic nor social justification. More important, perhaps, is the dead-weight loss of productive efficiency (b) caused by diverting resources from other uses into domestic rice production. In a country striving for rapid economic development, the need for using scarce resources efficiently cannot be overemphasized.

CHAPTER 6

SUMMARY AND CONCLUSIONS

Summary

Rice is the staple food of Sierra Leoneans, and in recent years the need to increase its production has received substantial attention from the government, policy makers, and the populace in general. The achievement of self-sufficiency in rice by whatever means is an important politico-economic goal, and it is generally believed that the sooner this goal is reached, the better.

Despite several government programs of input subsidization and price support, the need to import rice has continued through the 1970s and has contributed to a worsening of the already precarious foreign exchange position of the country. Government's concern over the rice situation has not subsided; in April 1979 it took one bold step in scrapping the Rice Corporation, whose functions and activities have long been under criticism from various quarters.

A major setback to the government's rice-production strategy is the lack of adequate, quality data on which to base projections, especially with respect to elasticity

estimates. This setback continues to be a problem because, even where adequate methodologies are employed, the usefulness of the results is often a function of the quality of data used. Available data are usually of very poor quality. In this paper an attempt has been made to estimate income and price elasticities based on secondary data from various sources. The specific objectives of this study were as follows:

1. To develop an econometric model based on theory and knowledge of the economic relationships of the Sierra Leone rice industry
2. To formulate and estimate the statistical model for supply and demand relationships of the economic model
3. To interpret and apply the model to current conditions
4. To use the model in forecasting demand and supply of rice in Sierra Leone
5. To study the impact of government policy on the Sierra Leone rice industry

The economic relationships affecting the domestic production of rice are shown in Figure 1. An economic model using only the price of rice as the major determinant of demand and supply is also presented. The statistical model used quantity of rice supplied as the dependent variable in the supply equations and per-capita consumption as the dependent variable in the demand equations.

In both equations it was assumed that cassava is a close substitute in both production and consumption. Because price data for cassava were not available, a price proxy--calculated from hectares planted with cassava, and from per-capita consumption of cassava--was used in the supply and demand equations, respectively.

The results obtained are shown and discussed in Chapter 4. The price elasticities of supply and the income elasticities were consistent with expectations. The price elasticity of demand was lower than that expected. For a staple agricultural product, one would expect the price elasticity of demand to be near the income elasticity in absolute value, especially when it lacks close substitutes.

The quantitative results cannot be used without qualifications. However, the results clearly demonstrate a higher income elasticity of demand for rice than is usually assumed. The projections based on the equations derived in this analysis do not give welcome results. They indicate a widening gap between production and consumption in the years ahead, with production lagging behind consumption.

The rice-pricing policy maintained by the government has a definite adverse impact on consumer welfare and on the nation as a whole. Producers, however, are blessed by the gains from welfare transfer.

Conclusions

This exercise represents an attempt to gauge the magnitudes of the demand and supply elasticities of rice in Sierra Leone. No attempt has been made to formulate appropriate strategies or policies by which self-sufficiency in rice could be achieved. The results and discussions, however, leave little doubt that a considerably greater effort is needed to achieve the so-called self-sufficiency strategy. The possible welfare effects and costs are discussed qualitatively. At the present population growth rate, it will not be long before land scarcity becomes another important economic and agricultural problem. To avert such a problem, government should place greater emphasis on employing technology which will increase the yield per hectare rather than increasing total hectarage planted with rice.

In the absence of a radical reorientation of the government's policy toward rice production, the past performance of the rice industry provides little basis for optimism for its future development. The most important area that needs a change is the pricing policy. The government can pursue one of two alternatives, both of which contribute to economic efficiency. The first possible alternative is to allow the retail price to rise to its equilibrium level. This would

shift the burden of the input subsidy from the government to the consumer and there would be greater dead-weight loss in consumer welfare. Because rice imports would fall, this policy would save foreign exchange, and government investment in rice production could be shifted to other projects with higher economic efficiency. Domestic production would increase.

The other alternative is to lower the producer price to world price levels, with imports being used to equate supply and demand. In this case, consumption levels and consumer welfare would remain unchanged. There would be a much smaller loss in production efficiency, since domestic production would decline.

Unless other alternatives are available and feasible, one of the above short-term alternatives will have to be adopted. As long as world prices are low, relative to domestic production costs, it will be difficult to find innovations that will make Sierra Leone competitive in rice production. As either of the above policies is pursued, government should concentrate on further research with the specific objective of determining whether, in fact, Sierra Leone has a comparative advantage in rice production vis-à-vis the rest of the world. Efforts should also be made to discourage the consumption of rice and encourage the production and utilization of other calorie-rich food sources, of which cassava appears to be the most promising.

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