DEMAND VERSUS A SEVERELY CONSTRAINED DOMESTIC SUPPLY: AN ANALYSIS OF THE RICE IMBALANCE IN SENEGAL

by

BOCAR NENE DIAGANA

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Major Professor

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Chapter 1

INTRODUCTION

BACKGROUND OF STUDY

THE IMPORTANCE OF RICE IN THE SENEGALESE DIET

The history of rice consumption in Senegal goes as far back in time as the early colonial period. Though the cultivation of this grain in Southern Senegal antedates the Portuguese penetration (Linares, 1981), its use was spread in the other parts of the country by the French settlers who brought in cheap rice from Indochina (Pearson et al, 1981). From then on, rice demand has expanded in all urban areas.

Now, rice is by far the main staple food in urban Senegal. National annual per capita consumption averaged 57 kg in the 1975-1982 period, and is still increasing. The Food and Agriculture Organization (FAO) figures showed that rice accounted for 21.7 percent of the total daily caloric intake in Senegal and 20.9 percent of the protein from 1961 to 1977.

Not only is rice demanded for its intrinsic nutritional values (source of carbohydrates, superior quality of its protein), but also for its cooking and eating properties largely determined by the starch composition of the grain. The starch is a mixture of amylose and amylopectin, and the ratio of these two components determine the cooking and eating qualities. In fact, the higher

the ratio of amylose to amylopectin, the greater the tendency of the rice grain to cook dry and fluffy, and the greater the resistance of the grain to disintegration even after prolonged cooking. The high digestibility of rice, its enduring palatability and the relative rarity of cases of hypersensitivity to it make this commodity attractive to the consumer.[1]

The high demand for this cereal has been boosted by a rapid urban population growth due not only to natural cause (demographic expansion), but also to steady movement of people from the deprived countryside to the cities in the quest for better living conditions.

RICE IMBALANCE

The low domestic production has covered at best only two-fifths of rice consumption. Consequently, the Senegalese government has repeatedly resorted to massive imports of rice to meet the national consumption. Net imports of rice average 150,000 tons per year, and can exceed 300,000 tons during a "bad" year (approximately 334,000 tons in 1981). Thus, the rate of self sufficiency, ranging from a low of 9 percent (in 1973) to a peak of 39.8 percent (in 1970) according to the West African Rice Development Association (WARDA) figures, is one of the lowest in the west African region.[2]

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[1]R.F. Chandler, Rice in the Tropics (Boulder, Co.: Westview Press, 1979).

[2]WARDA, Rice Statistics Yearbook, June 1983, p. 14.

GOVERNMENT ENDEAVORS TO INCREASE LOCAL RICE PROCUREMENT

As a result of the deteriorating food situation in Senegal, the authorities have ranked food self-sufficiency as the "priority of the priorities", and this objective has been unambiguously stated in most recent development plans. Insofar as rice is the predominantly demanded cereal in the Senegalese cities, it has attracted much more attention than the other grains.

The government has signaled its intentions by launching some ambitious programs of rice development. The main goal is to enhance domestic production in two major areas through improved water control and new cultivation technologies. Projects are located in the Northern Fleuve Region where large irrigation schemes are under construction and in the traditional rice growing region of Casamance where newly developed technological packages are being introduced.

Substantial investments have been made, along with price and input distribution and subsidy policies. Institutional changes are also sought. All of these aim to create a physical, economic and social environment where such projects could be technically, economically and socially acceptable and feasible.

PURPOSE OF THE PAPER

With all these efforts being devoted to tackling the rice problem in Senegal, crucial is the need for a study of the two interrelated sides of the problem. As a matter of fact, not only is the low domestic rice output a problem, but

the growing demand for consumption is also a severe one. Many studies (see Chapter 3), have centered on the supply side and have almost unanimously underlined the severely constrained conditions of rice production which show no good prospects for the drastic changes needed to solve this food challenge. In contrast, this study positions itself at the opposite side. While aiming globally at appraising the short and long run alternatives available to Senegalese policy makers, this paper will focus on the causes of this strong demand for rice. Specifically, we wish to investigate the impact of the traditional determinants of demand provided by economic theory (price, income, substitutes, population), analyze their importance and derive some policy implications with regard to food self-sufficiency in particular and economic growth in general.

PLAN OF THE FOLLOWING CHAPTERS

The paper is organized as follows. In Chapter 2, an outlook of the world rice economy is given. In Chapter 3, the country of Senegal is presented and its rice sector is broadly analyzed with a review of literature. Chapter 4 provides the theoretical framework used to solve the specified rice problem along with the presentation of the data. The empirical results are presented and interpreted in Chapter 5 and policy implications are derived. A final chapter summarizes the problem and findings, draws some conclusions and makes some recommendations.

Chapter 2

WORLD RICE ECONOMY

PLACE OF RICE

AS A STAPLE FOOD AND A CROP

Rice is the staple food of a large proportion of the world's population. Nearly two billion people (40 percent of the planet's population) depend on rice for over 80 percent of their diet. The Far East ranks first as a rice consuming region; the apparent annual average consumption of rice for the principal rice eating countries of Asia is well over 100 kilograms a person. The Near East, Latin America and Africa have increasingly adopted rice in their diets, boosting world rice demand. Low levels of per capita consumption exist mainly in developed countries such as Western Europe and the United States; the average American consumes only 6 kilograms rice a year. This regional contrast indicates that rice is important in developing nations because more diversified diets or more substitutes for rice seem to exist in developed economies. Also, other grains (wheat, corn, ...) have a comparative advantage over rice in most of Europe and North America, and people usually eat what they can raise best.

Rice consumption is related to its varieties. Different varieties of rice exist among which oryza sativa is the most

common. Another specie grown for food, oryza glaberrima, is found solely in Western Africa; its importance tends to decrease as modern varieties of oryza sativa replace it.

Four basic types of rice exist:

- Glutinous, also known as waxy or sweet rice (grown in Thailand, Laos, Japan, China);
- Aromatic, often called basmati rice (Middle East);
- Japonica (Indonesia, South Korea);
- Indica (Southern US, China) which consists of the bulk of the world rice trade.

The classification criteria are based on the starch content and hence the cooking qualities (tenderness and stickiness of grains once cooked).

Also, the main use of rice is for food, which distinguishes it from the other grains. Only 7 percent of the rice crop is used for non-food purposes, compared to about one-fourth of the total world wheat crop. Furthermore, utilization of rice as food varies significantly from region to region and from type to type: desserts, cakes, ceremonial foods, main or sweet side dishes can be prepared with rice.

As a crop, rice presents the following characteristics. First is its worldwide production. Every continent on the earth produces rice. It's cropped from the equator to latitudes of 53 degrees north (in China) and 35 to 45 degrees south, and to elevations in tropical regions as high as 2,400 meters above

sea level (Chandler, 1979). Second is its uniqueness as a food crop in that it is adaptable to a broad range of climatic and soil conditions. In effect, the semi-aquatic nature of the plant allows it to be grown in standing water. Continuous cropping on the same land is possible without any difficulties. The grain also presents a high resistance to insect attacks or plant diseases and has a large "tolerance" to soil acidity and alkalinity.

Hence, stemming from these properties of the rice plant, diverse forms of rice cultivation have been developed around the world. Following are a few of them:

- deep-water or floating rice (Thailand, India, West Africa);
- upland rice or rice grown in fields like any other cereal (Philippines);
- rainfed paddy where rainfall is the major source of water (South and Southeast Asia);
- irrigated lowland rice: in this scheme, irrigation systems fed from wells or rivers control the depth of water on the fields (Japan, South Korea, China).

AS A TRADED COMMODITY

Though of primary importance as a food item, rice plays only a secondary role as an item of international commerce. It ranks fourteenth among agricultural commodities in the

World Bank's Commodity and Price Trends[3]. Such a second-class ranking for so important an element in most of the diets around the world arises from the following facts. Rice is the principal food grain raised in areas of subsistence agriculture. In such areas, there is little surplus for trade. Also, those people preferring rice to other food grains have low per capita incomes; thus, even if there is a shortage, they cannot enter foreign markets to buy rice. The overlapping of production and consumption is a very common phenomenon not only worldwide, but within each producing country as well (Siamwalla and Haykin, 1983). In Thailand, the ratio of rice trade to total production hardly reaches one-half; in Senegal, the bulk of the rice output coming essentially from the Southern region, does not get to the official market place.

As a result, the volume of international rice trade is significantly reduced. Despite a 120 million metric ton (mmt) increase in world paddy production from 1960-64 to 1975-1979, the quantities of rice traded changed only slightly (7.1 to 9.9 mmt). In 1983, 11.8 mmt were traded worldwide out of an estimated 420 mmt of produced paddy rice. The Food and Agriculture Organization (FAO) of the United Nations estimated the value of that trade at 3.5 billion U.S. dollars. Table 1 shows the evolution of world rice production and trade and the relative stability of the small ratio of trade to production.

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[3]IBRD, Commodity Trade and Price Trends (Washington, D.C.: IBRD, 1981).

Nonetheless, rice remains the leading traded commodity among developing countries. Trade between them accounted for $2.2 of the $3.5 billion of 1983 world rice trade.

Table 1: World Rice Production and Trade in Million Metric Tons

Year	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85(a)
Production						
- Paddy	377.4	398.8	412.4	420.1	438	451.8
- Milled	254.4	271.6	280.6	285.3	305.4	307.5
Trade						
- Milled	12.731	13.128	11.611	11.830	12.359	11.894
Ratio of Trade/ Production %	4.945	4.833	4.137	4.146	4.046	3.867

a) Estimation for Sept. 14, 1985

Source: Rice Outlook and Situation Report, Economic Research Service. US Department of Agriculture. March and October 1984 Issues.

STRUCTURE OF WORLD RICE MARKET

MAJOR EXPORTERS

Major exporters are located in monsoon Asia where almost all world rice (more than 80 percent) is cropped (see Table 2). Thailand has emerged in the last few years as the leading exporter followed by Pakistan, Burma, People's Republic of China, North Korea and Japan. Some of the exporters are not stable rice

Table 2: World Rice Trade (Milled Basis): Major Exporting Countries or Regions.

Country or Region	Calendar Year				
	1980	1981	1982	1983	1984(a)
	in 1,000 metric tons				
Argentina	107	110	92	70	185
Australia	321	335	530	251	400
Burma	675	674	701	750	850
China, Mainland	1,116	583	460	550	600
China, Taiwan	261	92	307	531	275
EC-10	804	812	625	800	769
Egypt	178	134	22	21	50
India	423	1,143	633	165	150
Japan	653	795	318	321	100
Korea, N.	284	200	250	250	250
Pakistan	971	1,127	794	1,299	1,300
Philippines	231	83	0	40	0
Thailand	2,700	3,049	3,620	3.700	4,250
United States	2,977	3,008	2,487	2,330	2,000
Uruguay	165	215	227	189	225
Other	865	768	545	563	755
World Trade	12,731	13,128	11,611	11,830	12,359

(a) Estimated

Source: Rice Outlook and Situation Report, Economic Research Service U.S.D.A., October 1984.

sellers: India's rice exports shrunk from 1.143 mmt to .165 mmt between 1981 and 1983. The United States leads the group of non-Asian exporters which also includes the European community, Australia, Argentina, Uruguay, and so on.

MAJOR IMPORTERS

From Table 3, it can be seen that the distribution of rice is more widely spread on the import side. Although Asian countries such as Indonesia, South Korea, China, Malaysia, still dominate the international rice market, other buyers such as the USSR, the European community, the Middle East foursome (Iran, Iraq, Saudi Arabia, United Arab Emirates), some African (Ivory Coast, Malagasy, Nigeria, Senegal) and South American countries (Cuba, Peru, Mexico) have gained an increased share of the market.

TRADING PATTERNS

Siamwalla and Haykin (1983) observed some changes in the trading patterns since World War II. Above all, the three prewar leading exporters (Burma, Thailand, Vietnam) do not dominate the rice trade anymore. Only Thailand has maintained its position, whereas Burma and Vietnam's shares of world exports have been shrinking steadily. Also the market share of former large rice sellers like Taiwan and Korea has been substantially reduced with Korea even becoming an erratic importer. New entrants like Pakistan, China, Japan and the U.S. make up for the decline of the prewar exporters. On the import side, the same pattern exists: a decline of Asian imports concomitant to the rise of the Middle East and Sub-Sahara

Table 3: World Rice Trade (Milled Basis): Major Importing Countries or Regions

Country or Region	Calendar Year 1980	1981	1982	1983	1984(a)
	in 1,000 Metric Tons				
China, Mainland	18	110	250	75	100
Cuba	224	199	200	200	150
East Europe	328	353	299	288	310
EC-10	889	1,079	1,080	1,114	945
India	-	70	10	310	800
Indonesia	2,040	543	332	1,175	500
Iraq	379	350	369	474	500
Iran	507	583	475	680	680
Ivory Coast	254	335	363	434	350
Korea, Rep. of	822	2,202	228	216	50
Malagasy	177	191	357	250	200
Malaysia	167	267	403	352	450
Mexico	128	66	16	0	155
Nigeria	394	686	666	711	775
Peru	250	103	58	101	35
Saudi Arabia	350	427	471	500	525
Senegal	304	340	321	365	375
V.A. Emirates	441	285	170	175	175
USSR	694	1,283	859	400	450

(a) Estimated

Source: Compiled from Rice Situation and Outlook Report Economic Research Service-USDA, October 1984.

African nations. In sum,the rice trading nations formerly concentrated in Asia cover now a larger geographical area because of the new non-Asian participants.

CHARACTERISTICS

It should be mentioned that there is no globally recognized central market for rice. Therefore, there is no "central" market price for rice compared to the London daily or the New York world market price for sugar, or the Chicago Board of Trade prices for wheat, soybeans or maize. Hence, free on board (F.O.B.) prices posted weekly by the Thai Board of Trade are often referred to as the "world price".

Despite the lack of central institution where transactions between rice buyers and sellers take place, some characteristics of the so-called world rice market can be observed.

THINNESS OF THE MARKET

The world rice market is a "thin" market. A thin market is usually defined as one where the number of transactions is inversely related to the variability of prices. This aspect is evidenced by the small ratio of trade to production mentioned earlier, the limited number of buyers and sellers, and the relatively unpredictable level as well as the sources of demand. With regard to the structural causes of the thinness of a market, Siamwalla and Haykin (1983) argued that the most commonly cited cause, i.e. the small number of participants, may not be as

important as the stability of their presence. With stable transactors, vertical integration or long term agreements will sooner or later change the power of one or more buyers or sellers. For them, such market cannot survive long as an "arm's length market"[4]; therefore, the thin rice market should be viewed as an ephemerally thin market.

In addition, when rice trade does occur, it does not follow well established channels. New buyers make sudden appearances, purchasing large volumes while old sellers and buyers see their exports and imports change drastically over time. This exaggerates the volatility of the market.

Furthermore, Siamwalla and Haykin (1983) attested that the introduction of high yielding varieties of rice in Asia has added to the thinness of the world rice market because the new technology has been more readily accepted by importing countries. This shift of comparative advantage in Asia has prompted traditional importers like the Philippines and Sri Lanka, whose environments were better suited to the new varieties,to expand their production and reduce imports. On the other hand, rice output stagnated and exports declined in traditional exporting countries like Burma and Vietnam. Such factors have led to an instability of the world rice market.

INSTABILITY AND UNCERTAINTY

The world rice market is highly sensitive to fluctuations

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[4]An arm's length market is a market where participants select trading partners at random, i.e., they do not trade regularly with the same partners.

in production and consumption. A very small change in total amount produced can provoke a very big change in the quantity of rice available for exports. Levasseur (1981) reported that a 1 percent change in total production might cause a 25% variation of total exports, if consumption levels in exporting countries remained unchanged. Hence, the world rice market is highly unstable and uncertain,and price forecasts are likely to be erroneous. After the Asian "Green Revolution", price analysts predicted the drop of world rice prices in 1968 would follow a downward trend. But the 1973 events proved their forecasts to be wrong. In 1973, a fall of world production of 3.5 percent below trend and 2.8 percent below 1972 level, a decline that was unequally distributed among major producers (Indonesia, Thailand, Taiwan, U.S.) brought about an unprecedented 250 percent upsurge of world prices between May 1973 and January 1974. Rice prices peaked in 1974, then declined progressively until 1978 and turned upward again. In 1980, they oscillated between $400 a metric ton for broken rice and $600 for good quality rice.

FRAGMENTATION OF THE MARKET

Also, rice trade is stratified according to rice types. Thus, the market for rice becomes segmented with respect to the different qualities (high, medium and low) of rice. Such a feature compounds the complexity of the structure and the functioning of the market.

In sum, all these characteristics - diversity of product, rigid infrastructure, lack of a central world market, uncertainty about production and trade -- result in high search and transaction costs (Slayton, 1984). These costs burden the participant countries and induce their governments to pursue national interests by undertaking policies designed to shelter their economies against the negative consequences of the market inefficiency and instability. Promoting self-sufficiency and maintaining large domestic carryovers are commonly followed strategies.

Unfortunately, individual protectionist actions motivated by the conflicting objectives of the rice traders contribute more to destabilizing the international rice market than to stabilizing it. As a matter of fact, because of these actions the mechanism of the rice market has been distorted, turning it into an imperfectly functioning institution. Siamwalla pictured the world rice market as an "n-country version of the prisoner's dilemma game"[5]. Even though every intervener would benefit from a well functioning rice market, yet each one finds it to be in its best interests to avoid relying too much on it. Lack of coordinated and concerted policies, conflicts of interests jeopardize an improvement of the conditions of international exchange of rice.

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[5]The prisoner's dilemma game is a game in which a prisoner must choose between cooperating with the jailers in an attempt to secure leniency for himself or maintaining silence for the possible benefit of himself and the other prisoners.

However, some optimism is permissible in the long run. There seems to be an increased regularity of the presence of some buyers and sellers (Middle East and Africa, U.S. and Thailand). This could lead to a trading pattern based on specialized production capabilities or on clear comparative advantage. Then, orderliness and stability in this market would mean better organized market and thus increased marketing efficiency. The market would then provide all relevant information necessary for good decisions to the benefit of all regular participants.

For rice importers like Senegal, destined to remain so, the stability of the rice trading relations is very important. A trade agreement with Thailand in the last few years follows the logic of regular rice procurement at more stable prices that will reduce potential welfare losses which ordinarily follow domestic production shortfalls.

Chapter 3

PRESENTATION OF THE STUDY CASE

ECONOMIC GEOGRAPHY OF SENEGAL

PHYSICAL SETTING

Senegal is a crossroads of contact between an ocean and a continent, between Black and Arab Africa, and between the Sahel and the Sahara. It lies between the latitudes of 11 and 17 degrees north and covers an area of 196,722 square kilometers situated on the most westerly point of continental Africa.

Its climate is varied, ranging from the arid zone in the north to the subtropical zone in the south. There are two distinct seasons in the country. A long dry season lasts from November to June with hot temperatures which vary from west to east. Temperatures range from 15 to 32°C in Dakar on the Atlantic Coast and from 17 to 46°C in the southeastern town of Tambacounda. Mid-June to October is the period of the rainy season. During that season, the frequency and the intensity of the effects of the Sainte Helene monsoon determine the volume and the rhythm of rainfall. Generally, the quantity of rainfall decreases and its variability increases the farther north one moves (300 mm of rainfall concentrated in one month and half in the north and 1,400 mm in four months in the south).

The hydrographic network comprises the Senegal, Saloum, Gambia and Casamance rivers plus some intermittent rainfed streams of water.

The country is administratively organized in eight regions: Cap-Vert in the West; Diourbel, Thies, Louga and Sine Saloum in the center-west or Groundnut Basin; the Fleuve along the Senegal River; Oriental Senegal in the East and the Casamance in the South. In 1984, the Sine-Saloum and the Casamance regions were each split in half, bringing the number of regions to ten.

Most of Senegal's soils are ferruginous, permeable and poor in organic matter. Around 12 to 14 percent of the total land area is cultivated, and another 25 percent is potentially arable.

Different agro- ecological zones exist in the country:

- the Senegal River Valley;
- the Sahelian Region;
- the North Coast and Cap-Vert Region;
- The Central Region which includes the central and southern part of the Groundnut Basin;
- The Eastern Region;
- the Casamance Region in the higher rainfall areas of the south.

The road transportation network is concentrated in the midwest part of the country, and connects the capital city Dakar with different towns. The Eastern region, beside the railway line that passes through it to give an access

to the Atlantic Ocean to Mali, still suffers from isolation from the rest of the territory. Also, communication problems with the south are compounded by the existence of the enclaved Gambian territory, mostly because of the lack of fluidity in transportation through its borders.

DEMOGRAPHIC OUTLOOK

Senegal's population was estimated in mid-1980 at 5,660,732 people. This represented a density of 28.7 people per square kilometer. According to official statistics, the population is growing at 2.8 percent per annum.[6]

Rural population accounts for 75 percent of the total population and continues to grow, despite an important rural-urban migration. Of the total rural population, almost 60 percent live in the central Groundnut Basin which covers about one-fourth of the country's land area. Urban populations are expanding at a fast rate: 3.6 percent per year during the 1960-80 period.[7] The tiny region of Cap Vert contains one-fifth of the entire country's population.

The age distribution of the population reveals a high dependency ratio because about half of the population is under 15 or over 60 years of age. Life expectancy at birth averaged 44 years in 1982, that is low by today's world standards and masks some disparities between rural and urban areas.

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[6]Government of Senegal, Ministry of Planning and Cooperation, Sixth Four-Year Economic and Social Development Plan 1981-1985.

[7]Ibidem

ECONOMIC PERFORMANCE

Senegal is an underdeveloped country and this feature is proven by the level of commonly used economic indicators. World Bank statistics that categorize Senegal in the group of lower middle-income oil importing countries showed an annual per capita Gross National Product (GNP) of $490 in 1982.[8] Government figures[9] estimated total Gross Domestic Product (GDP) at 517,000 millions of CFA Francs[10] in 1980 of which the primary sector (agriculture) contributed 31.5 percent. Total GDP grew almost at the same rate as the population, therefore per capita GDP almost stagnated in the 70's.

Another indication is given by the evolution of the savings and trade gap since independence. As expected in a poor country, domestic savings have always fallen short of the needed capital investment since 1960, creating a chronic and variable savings gap. This gap, very big in the early days after independence, has been narrowing until the early 70's when the two drought cycles (1972-73, 1976-77) struck the country, plunging the economy, largely dependent on the agricultural sector, into a depression. In general, savings

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[8]World Bank, World Development Report 1984 (New York: Oxford University Press, 1984).

[9]Government of Senegal, Ministry of Planning and Cooperation, Sixth Four-Year Economic and Social Development Plan, 1981-1985.

[10]The CFA Franc is the currency of Senegal; it's rigidly tied to the French franc at an exchange rate of 1 CFAF = .02FF.

rates averaged 6.9 percent in the 1959-72 period and 10.8 percent between 1972 and 1980; in the meantime, investment rates rose from 14.25 to 16.5 percent. Thus, the savings investment gap has diminished from its earlier levels, but it continues to follow an irregular path demonstrating the vulnerability of the economy to the exogenous shocks. A similar remark can be made about the trade gap, which is the difference between exports and imports. A chronic trade deficit seems to constitute a "normal" feature of the external economic relations. Also it is highly correlated with the evolution of the primary products, bad harvest years coinciding with bigger deficits.

The conclusion from these economic indicators is that economic performances are rather poor; officially, three main factors are deemed to explain the sluggish growth path:

1. the absence of water control that leaves the economy to the mercy of erratic natural conditions;
2. the reduction of the demand for primary products by the OECD countries, Senegal's main economic partners;
3. the low return to investments which are mainly directed toward sectors with low profitability.

To complete the list of these stagnation-causing factors, policy biases against the agricultural and exports sector along with various constraints should be added.

AGRICULTURE IN THE SENEGALESE ECONOMY

General Situation

Senegal's economy is agriculturally based. In spite of poor soils and irregular rainfall which renders agricultural

production risky, this sector dominates the entire economy, as is the case in almost all developing countries. Reasons for the predominance of the agricultural sector are found in Mellor (1966).

Agriculture is the engine of the national economy: it occupies 70 percent of the total labor force and contributes for 24-30 percent of the total GDP (Table 4).

Table 4: Importance of Agriculture in Senegal's Economy (1960-1979)

	1960-1964	1965-1969	1970-1974	1975-1979
GDP Billions CFA	178.7	209.1	255.9	474.6
% Agriculture in GDP	30.6	30.8	29.2	24.1

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

Millet, sorghum, maize, rice and cowpeas are the main food crops whereas peanuts and cotton constitute the cash crops. Millet and peanuts dominate the rural sector; combined, they occupy more than 85 percent of the total cultivated land (see Table 5). Peanuts provide 75 percent of the monetary income of the rural sector and contribute for more than 50 percent of the value added of that sector.

Labor force in the rural sector comes almost exclusively from family farms (95 percent) which use traditional inputs and cultivation practices in a rainfed agriculture. Although rural per capita income grew at 8 percent until 1967, it has

Table 5: Cultivated Areas (in 1000 ha) by Major Crops in Senegal

Major Crops/ Area	1973	%	1976	%	1978	%	1979	%
Millet & Sorghum	1093.5	46.3	952	37.6	1054.7	42.3	954.8	41.4
Rice	65.3	2.8	88.9	3.5	91.3	3.7	82.1	3.6
Maize	39.2	1.7	47.	1.9	60.1	2.4	51.2	2.2
Cassava	28.6	1.2	20.	.8	17.5	.7	32.0	1.4
Cowpeas	52.9	2.2	50.	2.	62.4	2.5	60.	2.6
Cotton	28.6	1.2	43.	1.7	48.3	1.9	30.9	1.3
Groundnuts	1044.7	44.3	1330.8	52.5	1160.	46.5	1097.7	47.5
Other	7.4	.3	--	--	--	--	--	--
Total cult. area	2360.2	100.0	2531.7	100.0	2494.5	100.0	2308.7	100.0
As % of total land area	12		12.9		12.7		11.8	

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

been declining ever since, leading to a significant worsening of rural conditions of life and to a widening rural-urban income differential, and contributing to rural exodus (Todaro, 1971).

Total land devoted to agriculture amounts only to 12 percent of the total land area. Concentration of people in the Groundnut Basin has increased population pressure on land. In contrast, the other rural regions are almost empty despite attempts from authorities to relocate people by helping them through an incentive system to migrate from overpopulated to underpopulated areas.

Evolution of Agricultural Production

Table 6 shows the evolution of agricultural output during the 1960-1980 period.

Table 6: Agricultural Output Evolution (Base Year 1967)

	1960/80	1960/68	1969/73	1974/77	1978/80
Average index	109	107	96.4	129	106

Source: Government of Senegal, Ministry of Planning and Cooperation - 6th Four-Year Plan for Economic Development, 1981.

Agricultural output almost stagnated (only .8 percent of growth rate) in the first two decades of independence opposed to a 2.8 percent rate of growth of total population or a 1.56 percent of active rural population growth rate. Hence, per capita agricultural output declined and the decline is representative of the situation of agriculture in Sub-Saharan Africa (World Bank, 1981). Tantamount to this drop of per capita agricultural production is a decreasing labor physical productivity (.7 percent per annum). Once again, this reflects a general picture of what has happened in labor productivity in Africa. Some economic development models have built on this assumption of near zero labor productivity (the Lewis model and the Ranis-Fei model). But the seasonal aspect of the labor productivity problem should be recognized for, at critical points of the agricultural season, marginal productivity of labor is well above zero and labor shortages are experienced.

A decomposition of the agricultural output growth rate indicates that increases in areas cultivated account for 75 percent of that growth and only 25 percent is due to yield improvements. However, these aggregate figures mask some disparities between crops because increases in areas cultivated for peanuts, due to their higher profitability, are more than offset by a decline in yield. Meanwhile, both yield and areas increased for the cereal grains.

Constraints and Problems

Because of its leading role in the Senegalese economy, a slow down or a decline in the growth rate of the rural sector has, as expected, major impacts on the overall economy's structure. It has been noted that the share of agriculture in total GDP has been diminishing over time; but, contrary to the idea of economic expansion that would ease and speed up the process of economic transformation, this pattern reflects the weakness of the agricultural sector instead. Such a backward path stems from various physical and institutional constraints.

The major constraint is the erratic nature of rainfall. Agriculture in Senegal is essentially rain-fed, but the seasonal distribution, the absolute amount and the variability of precipitations have repeatedly been unpredictable. In fact, so erratic has been rainfall in the last twenty years that national weather services have judged it critical to define new criteria for a "normal" yearly rainfall. Previous criteria based on the average of the 1931-1960 period no longer correspond to the dismal reality of the 60's, 70's and 80's. Sharp declines of agricultural output

and severe ecological problems accompany years of drought when agricultural production can drop to 60% below the average level. This brutal production shortfall not only amplifies the food deficit and depresses rural incomes, but reduces foreign exchange earnings from agricultural exports, thereby aggravating the disequilibrium of the balance of trade and of payments. Also, massive imports are resorted to in order to make up for the agricultural commodities shortages. For example, cereal imports explain more than one-third of the country's total trade imbalance. Therefore, the need intensifies for finding ways to decrease the vulnerability of the economy to rainfall. For the government, improved water control by irrigation schemes as explained by on-going dam constructions (Manantali, Diama on the Senegal river under a regional project) seems to be the way out of this dilemma.

A second problem deals with the poor quality of the country's soils. Overcropping, especially in the Groundnut Basin, wind erosion, desertification, and poor farming and animal husbandry practices, cause some agronomic threats for they all explain the reduced soil fertility that implies lower harvests and output.

The importance of peanuts in Senegalese agriculture raises some concern because of the negative trends stressed earlier. Such a specialization in peanut production based upon traditional comparative advantage principles needs to be revised if long-term effects like the agronomic and ecological problems (Rigoulot, 1980; 6th development plan 1981-1985) or

international price instability (Jabara and Thompson, 1980) are considered. These factors have been overlooked for so long that the time has come for their complete appraisal and inclusion in rural development strategies.

An important determinant of the achievements of the agricultural sector is the incentive system. Producer prices constitute a pillar of that system, as Bates (1980) pointed it out: "...insofar as the incentive to produce is determined by the level of satisfaction which can be obtained by consuming goods purchased from the proceeds of farming, then, other things being equal, low producer prices result in a weakening of the incentives to engage in food production...". In Senegal, agricultural prices are still low and favor peanuts over the other crops and thus do not generate strong incentives for farmers to increase output. Therefore, a restructuration of the incentive system is critical and this, among other things, draws upon an adequate price policy.

Other problems consist of input provision insufficiencies and timeliness, inefficient marketing and distribution strategies, technological practices that have obstructed the expansion of the rural output. Last but not the least, peasants are not involved in the decision making process for measures that affect their daily existence.

New Strategy for Agricultural Development

The difficult conditions of a continued weakening of agriculture that have been felt even in urban areas and in the government's budget have stimulated the authorities to

revise the ineffective policies of the past. In the last development plan (1981-85) the government declared without any ambiguity its commitment to undertaking policies aimed at reversing the path followed by a drought-stricken agriculture. Objectives are, according to the Plan:

- food self-sufficiency;
- improvement of rural conditions of living;
- environmental protection;
- reduction of regional disparities;
- promotion of rural participation in the management of their activities.

Above are the main goals to be pursued. Measures have been proposed in a food and agricultural policy package.

Food Policy. It is the top priority in the plan. To prove its resolution toward the goal of food self sufficiency, the government claims that even higher costs of production would be incurred if necessary for the sake of self sufficiency. The food policy program is stratified in four levels:

1. Production. Production and productivity would be encouraged through specific programs of control and distribution of factors of production, programs assigned to land development agencies.

2. Marketing. It was noted that weak postharvest channels (storage, processing, distribution) hindered the expansion of the sector more than the price level. Thus, marketing strategies seek to incite producers to yield surpluses

by securing their income (sales, price and marketing guarantees); other measures are designed to regulate and to stabilize the cereal market (security stock of 70,000 tons to be constituted). Finally, the private sector is encouraged to take charge of these marketing functions.

3. Consumption and Organization. Coordination of sectorial activities and management of food aid and national security stock are the organizational tasks whereas price measures are taken to depress the demand for imported products (rice, wheat).

Agricultural Policy. It consists of reforms designed to remodel relations between the rural sector, the land development agencies (LDA), and the banking sector. It is based on an increased participation of rural populations in the decision making. This would reduce the role of the public sector.

Credit policies and input and seed distribution tasks are to be carried out by the cooperative system and the LDAs which should however improve their management.

Other programs deal with agricultural research, the constitution of a complete and reliable agricultural data base, and the creation of employment opportunities in rural areas.

In sum, this strategy reflects the new orientation given by Senegalese policy makers to agriculture. In fact, though new in terms of emphasis, it is paradoxically a restatement of the traditional goals set for a dynamic agriculture. In some instances, it is a deja vu for some measures are repeatedly

proposed. Despite this well intentioned and ambitious strategy, timid actions have been taken so far. Delays in irrigation projects, lack of funding to carry out certain projects, rigid infrastructure plus some management and administrative flaws slow down the rhythm of execution of the measures and thus the transformation of the agricultural sector. Also, firm measures developing backward and forward linkages between agriculture and industry seem to be missing. Therefore, it would become more and more difficult for the agricultural industry to play the five traditional functions described by Mellor (1966).

IMPORTANCE OF RICE SECTOR

REVIEW OF LITERATURE

The Senegalese rice sector found its origin some centuries ago. Olga Linares (1981) said that Porteres (1962) postulated that the southern region of Casamance was part of an ancient heartland where indigenous varieties of the African rice specie, Oryza glaberrima, were domesticated. According to Linares, evidence exists that the techniques of diking, desalinating, ridging and transplanting practiced by the Diola, an acephalous wet rice growing people living in southern Senegal, almost certainly antedate all European contacts. Linares reported that, well before the Portuguese explorers introduced the Asian variety of rice, oryza sativa, in West Africa in the early sixteenth century, the Diola had already transformed most of their swamp land into a network of paddy fields.

Despite this ancient history of rice cultivation in Senegal, particularly in the Casamance region, the same constraints that have plagued its expansion since the beginning remain essentially unchanged. Rigoulot (1980) analyzed the constraints that limit the expansion of rice output in Casamance. In so doing, he categorized several causes as limiting factors. They consist of:

- physical (climate, geography);
- institutional (marketing, credit, research and extension);
- social (migration, education);
- and economic factors (incentives, marketing, and processing restrictions);

He recognized that most of these constraints could be overcome provided that adequate policies were implemented. Comparing the returns to labor from groundnuts and rice, using official prices announced after planting, Rigoulot discovered that the pricing policy strongly discriminated in favor of peanuts, and induced peasants to produce rice only for home consumption and peanuts for their liquidity needs. In effect, higher prices in the illegal parallel market offered more incentives to farmers to produce rice for sale. He then implied that a hike in official producer prices could boost rice production and marketing because of the responsiveness of farmers to price stimuli. He also suggested that legalizing on-farm paddy processing and sale of milled rice was likely to yield welfare gains to farmers because of the positive returns to

milling and marketing of rice by farmers themselves (16.32 CFAF per kilogram for handpounding and 15.01 CFAF for small scale milling). Rigoulot concluded that rice produced in Casamance could compete on a cost basis with the imported Asian rice if both were to be consumed in the Casamance and nearby areas. This finding would make the government's goal to encourage domestic rice production in order to diminish current imports more feasible. Even though he admitted an apparent comparative advantage of Senegal in peanuts over rice, he hinted that a consideration of the agronomic effects of a quasi-peanut monoculture and of the political and strategic costs of the country's continued dependence on food imports might turn around this situation if some institutional and economic adjustments were made in the rice industry.

Jabara and Thompson (1980) pointed in the same direction as Rigoulot in the peanut versus cereal dilemma for Senegal, even though their approach was fundamentally different. Recognizing the validity of the implications of the traditional and static Ricardian theory of comparative advantage, i.e., "free, undistorted international trade is the first best policy for all countries to follow"[11], they stressed the need for relaxing the assumption of "perfect certainty" underlying this theory of international specialization when applying to small countries like Senegal. They argued that two forms

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[11]Cathy Jabara and Robert Thompson, "Comparative Advantage and Price Uncertainty", American Journal of Agricultural Economics 62 (May 1980): 2.

of uncertainty enveloped agricultural trade. Not only is agricultural production a biological process using inputs that have uncontrollable characteristics (e.g. rainfall), but future international prices are also unpredictable, "known at best in a probabilistic sense".[12] Such uncertainty generates some levels of risk and hence involves some subjective costs to be included in the trading model of small agricultural countries. Therefore, it becomes essential to refine and extend the concept of comparative advantage by explicitly considering the subjective costs of international agricultural price uncertainty, borne almost entirely by less developed countries (LDC).

Jabara and Thompson utilized a price endogenous linear programming model developed for Senegalese agriculture. The model indicated that the apparent comparative advantage of Senegal in peanut production was less clearcut under the assumption of risk aversion of Senegalese policy makers to price uncertainty. They found that the more risk adverse they were, the more profitable cereal production became relative to peanuts. Consequently, import substitution programs could be preferrable to free undistorted trade for the small open economy of Senegal. This implied that diversification, rather than specialization in agricultural commodities whose markets are highly unstable, could generate more welfare gains than would have been obtained by a trading position derived from a conventional comparative cost analysis. Such welfare gains

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[12] Ibidem.

could also be ensured by policy measures that would distort internal prices away from the international terms of trade to reflect the cost of risk to the economy. These distortionist strategies make some economic sense, according to Jabara and Thompson, who cautioned however against the bandwagon effect. If these strategies were to spread to many LDC adverse effects would result: more instability in the world market and more welfare losses.

A. Hasan Tuluy (1981) took an opposite stand on the problem of rice production in Senegal. In his study, he attempted to estimate the net private and the net social profitability of rice production. First, he described different rice production techniques used in different regions of Senegal. His findings from a cost-benefit analysis showed most techniques to be privately profitable; but all of them were socially unprofitable, excepted for the gray soils, animal traction cultivation and production for on-farm and regional consumption. The difference of results between net private and net social profitability could be attributed to the high degree of trade protection and of input subsidies in Senegal. Also, he reported that rice could be more efficiently produced in the Casamance with its greater natural availability of water than in the Fleuve where irrigation schemes are used. Furthermore, rice from the Casamance, of good quality, would effectively compete with the expensive imported rice on the basis of the resource cost ratio criterion. The latter point parallels Rigoulot's finding. However, the higher profitability of the other crops (peanuts, corn, fruits) in that region

challenges the emphasis on rice production. Tuluy concluded that "with currently known technologies and factor prices, Senegal can best advance its objectives of rice policy by promoting low cost irrigation projects, which increase and stabilize farm incomes without incurring high social costs,[an] approach [that] can be complemented by expanding output in the Casamance with efficient techniques using animal traction which greatly reduce labor requirements."[13]

In contrast, scrutinizing the Senegalese rice policy from 1930 to 1977, Kathryn Craven and A. Hasan Tuluy (1979) discovered a policy conflict between the desires for income growth and for income security. In fact, historically, policies have centered on the government's decision to import the least expensive rice in the world market to feed urban consumers. This practice conflicted with the declared aim of enhancing domestic production of rice that required an increase of farmer incomes. Craven claimed that price policies tied to movements in international prices have seldom benefitted the rice producers. Such aspect qualifies the Senegalese rice policy for what Bates (1981) called a "derived policy, i.e., choices with respect to food production are to a high degree made to serve the interests of groups other than producers themselves..."[14]. Bates went on to say that in such a case, "food price policies are part

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[13]A. Hasan Tuluy, "Rice Production in Senegal," in Rice in West Africa, ed: Pearson, Stryker and Humphreys (Stanford University Press, 1981).

[14]Robert Bates, "Food Policy in Africa: Political Causes and Social Effects," Food Policy (August 1981).

of an implicit bargain between the government and the urban workers, ...bargain that rural producers are called upon to pay the price..."[15]

For Craven, the choice of location and techniques is of strong importance in the production investment strategies if local rice were to be a source of greater food security and possibly a profitable food alternative. She suggested a weighing of the loss of national income against the benefits from an increased domestic rice output before adopting any import replacement strategy. Also, an improvement of local production and processing of maize and millet could be thought of as a mean to dampen the reliance on local rice supplies. The author finally proposed the establishment of a regional import insurance scheme to protect member countries against high world prices and brutal domestic shortfalls.

Another study was carried out at the regional level by Levasseur in 1981. Levasseur conducted an evaluative analysis of the rice production policies followed by some West African countries of the WARDA group. In so doing, he compared the objectives the WARDA members pursue, the constraints they face, and the policy instruments they employ.

For the goal variable, he noted that self sufficiency was a common long-term objective that could be decomposed into three fundamental short term targets:

1. efficient generation of income (EGOI)
2. more equal income distribution (MEID)

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[15]Ibidem

3. food stock security (FSS)

As known, some trade-offs are involved in this categorization; also the evaluation of the overall strategy of self-sufficiency by enhanced internal production depends on the effects (positive or negative) of such programs on each of the fundamental objectives cited above.

Levasseur classified the countries according to the importance attached to each objective. Importance is measured on a scale from 1 to 3, where 1 reflects the primary goal, 2 the secondary goal, and so forth. Table 7 shows the rank of each objective in the concerned countries.

Table 7: Importance of Objective in Some WARDA Countries

	Countries					
Objectives	Ivory Coast	Liberia	Mali	Senegal	Sierra Leone	Togo
EGOI	1	1	3	3	1	1
MEID	2	2	2	2	2	3
FSS	3	3	1	1	3	2

Source: Levasseur, "Les Politiques de Developpement de la Riziculture en Afrique de l'Ouest". FAO project PCT/SEN-/0001 February 1981.

The author showed that geographical characteristics influence each country's goals. For forest countries (Ivory Coast, Liberia, Sierra Leone), securing rice production is of lesser importance than the other goals mainly because climatic variations do not cause important annual production shortfalls.

Accordingly, food availability is not a critical issue since financial means (foreign exchange) are more important. Hence, these countries favor income generation and distribution. In contrast, the Sahelian economies of Senegal and Mali, recurrent victims of drought and related food shortages, single out food security as a top priority. Consequently, they strongly support the strategy of improved water control to develop rice production.

The constraints that each country faces are the following: rainfall, capital investment needs, credit, managerial capacity, infrastructure, and so on. The different policies used in these countries consist of price, tax, subsidy, credit or investment policies.

In summary, Levasseur noted that rice development policies in this zone were too recent and were following a trial-by-error process, which rendered their evaluation quite difficult. The diversity of geographical and political situations, the variety of consumption habits and the changing relative importance of rice here and there added to the complexity of the task, but suggested that not one, but many alternative policies of rice development could be implemented in West Africa.

Ross (1980) recognized the heavy burden of massive rice imports upon the balance of payments of Senegal and suggested two possible alternatives to them. One was to increase domestic production, but this solution was undermined by the fact that the domestic resource cost of producing rice in Senegal was greater than its market price. Then, the remaining solution was to enhance domestic production of millet and maize. But

this could only be a viable alternative if these cereals were accepted by the consumers, especially the urban dwellers. Thus, Ross decided to gauge the degree of preference of the Senegalese consumers toward these grains. In so doing, he conducted a survey of 75 households in the capital city of Dakar in 1977-1978.

The results of his survey demonstrate once again the complexity of the rice consumption problem. First, he found a strongly marked preference for the imported (Siam) rice explained by its qualities: volume after cooking, low oil absorption and better taste. This induced a willingness from the rice eaters to pay a premium for that quality of rice. An implication of this is that rice varieties are not perfect substitutes; the same result was observed at the international level (see Chapter 2).

Second, in these people's diet, millet was mainly consumed in the evening and rice at midday. This is a good representation of the time distribution of the grain-based meals in the Senegalese urban diet. Consequently it becomes difficult to replace rice by millet in the diet. This difficulty is compounded by technical and psychological constraints on millet demand ranging from difficulty of preparation, digestibility, preference for rice and even income. Despite these limits, a strong price responsiveness of millet demand was found. It suggested that the use of price policy to stimulate millet demand could be effective. But, Ross doubted such policy would have real effects on rice consumption for he questioned the high degree of substitutability between rice

and millet that a deeply rooted and longheld opinion supposed to be strong.

The other cereal, maize, was residually consumed by the households in the sample; its low demand resulted either from ignorance or from dislike of maize-based dishes.

In sum, Ross foresaw no indication that price policies through substitution and income effects would really work. For him, millet has not been accepted yet as a midday substitute for rice because of its heaviness and its lesser compatibility with fish. His findings support only the possibility of increased millet consumption as an evening meal. This increase is likely to be at the expense of other foodstuffs besides rice. On the other hand, maize seems to have greater substitution potential in the rice-fish dish, but immense promotion efforts should be made to increase people's awareness and acceptance of this grain.

Sow (1983) analyzed the cause of the increasing demand for imported rice in Senegal. He defined import demand for rice as the difference between the national consumption of rice and the supply of local rice. Particular attention was paid in his study to the effects of government interventions in the rice sector, interventions consisting of the public determination of domestic prices. An econometric model of four simultaneous equations described the real consumer price for rice, the local production, the local consumption and the net rice import variables.

His model showed the growth of urban populations to be a strong determinant of the level of national consumption of rice. Contrasted to the large impact of the population variable upon the demand for rice, those of prices and incomes were found to be marginal; rice demand exhibited low price and income elasticities (-.38 and .38 respectively). Thus, he claimed that a focus of the government short term interventions on the price and income variables to slow down imports of rice would be fruitless because of their observed marginal impacts.

For the supply of local rice, Sow foresaw very slim short-term prospects for a substantial increase in rice output largely conditioned by an erratic rainfall. He advocated the need for increased agricultural productivity to be attained through improved farming practices, adequate technological packages and better management of the land development agencies. He also favored rainfed agriculture for rice production over irrigated agriculture on the ground that the latter is too costly and that Senegalese farmers do not seem to be familiar with it.

With respect to public policies, Sow reported a close link between domestic and world prices, as did Craven as seen earlier. World price fluctuations have to a great extent been transmitted to government-set internal prices. But, despite this public effort to smoothen the spatial price transmission mechanism, the price stabilization policy did not yield all sought results.

As a general recommendation, Sow stressed that government actions be concentrated on promoting substitutes for rice (millet-sorghum, maize) and on improving marketing facilities for cereals. However, he said the cornerstone of any agricultural policy should be the improvement of the conditions of production and of the standards of living in the rural sector to reduce the human outflow toward cities where a rapid urbanization apparently bears a good deal of responsibilities on the large demand for rice.

RICE INDUSTRY

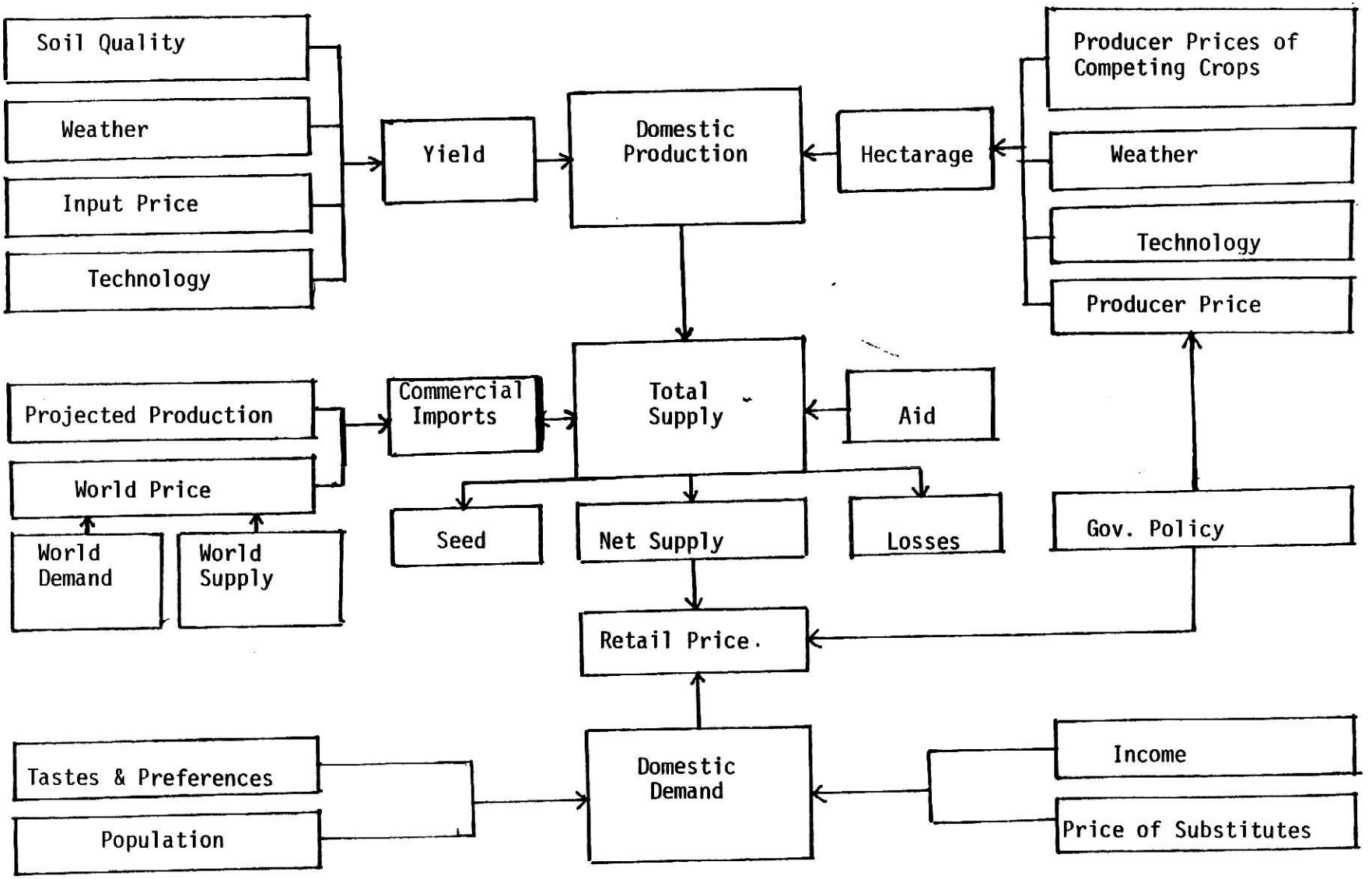
Despite its importance in local urban diet, rice is not the predominant cereal in Senegal. Nationwide, consumption of millet is larger except in the Casamance region where rice remains the staple food. This dichotomy in the rice situation makes its industry unlike the others: major consumption centers do not coincide with producing areas. Rice demand is almost exclusively an urban phenomenon whereas its supplies are generated from rural and external channels.

Figure 1 shows the economic relationships in the Senegalese rice industry between the two major aggregates (supply and demand) and their determinants. Following is an analysis of each of them.

The Demand for Rice

The major components of the demand for rice are similar to the demand determinants provided by economic theory. Tomek and Robinson (1981) list a commodity price, price of substitutes, income, population and tastes and preferences as vectors of demand for a commodity. However, no ranking as to the strength

Figure 1: Economic Relationships in the Senegalese Rice Industry



Source: Niane (1979) from SONED - Vol. 1, p. 105, revised by the author.

of their impact is given because only circumstances would determine it. Their influence on demand varies from one case to another; instances exist where presumably strong determinants of rice demand were found to be actually weak and vice versa as we shall see later.

Commodity Price. Provided an undistorted interplay of natural market forces, price explains a good deal of the quantity demanded of a good. The law of demand states an inverse relationship between the price of an item and its quantities demanded, other factors being held constant. Aggregate or market demand of a good represents the alternative amounts of that good all consumers are willing and able to buy at different prices, other things remaining constant.

In the Senegalese case, a peculiar aspect is worth noting. Prices for imported rice are set by the government in Dakar on the basis of the C.I.F.[16] import price plus a variable levy; some marketing margins are added to this base price to allow wholesale and retail prices to differ regionally as a function of transportation costs.

Income. It constitutes a crude measure of the ability to pay for desired goods and services. The more income one has, the greater one's capacity to acquire desired goods, other things being held constant.

Besides its traditional impact, income is expected to partly explain the rural-urban distribution of rice demand

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[16]C.I.F.: Cost insurance freight

in Senegal. Lower incomes in rural areas limit rice demand for consumption. Table 8 reveals a declining importance of rural per capita income since the independence of 1960. This negative trend is likely to reinforce the place of millet millet in the rural consumption models.

Table 8: Evolution of Rural Per Capita Income in Senegal

Year	Rural per cap. income (in 1000 CFAF)	As % of total domestic per cap. income
1960-1964	18.378	36.18
1965-1970	19.86	36.86
1971-1975	18.04	25.24
1976-1981	35.285	23.31

Source: Matar Gaye, Master's Thesis, Michigan State University, 1983.

Price of Substitutes. Its evolution demonstrates the substitution effect of a change in relative prices inducing rational consumers to reallocate their resources to obtain a desired level of satisfaction.

In Senegal, millet and to a lesser extent maize, have been considered as substitutes for rice. The degree of substitutability between rice and millet is to be more precisely evaluated. There seems to be some evidence about the relatively weak substitutability between the two grains. As Ross (1980) indicated, they are mainly consumed at different times, what actually biases the competition between them and reduces the

extent of substitution. Millet is consumed more at midday in rural areas than in the cities. Since the bulk of rice consumption takes place in urban centers and at noon, millet could only be a strong substitute for rice if there was an increased consumption of millet-based lunch meals, what has yet to be the case.

However, the argument for strong substitutability is supported by two factors. First, nutritionally, millet presents the same potential as rice in providing calories and proteins. In fact, millet surpasses rice in these two matters in Senegal (Table 9). Second, price-wise, the two food grains have followed the same positive trend as is the case with any two substitutes. Table 10 shows the evolution of the two grains prices in the market place of Dakar for the last ten years.

From Table 10, it is noticed that millet prices have been more volatile than rice prices for they were responding to changes in supply and demand while rice prices which were publicly set were more stable. From 1974 to 1983, millet prices jumped by 254 percent and those for rice by only 71 percent. This discrepancy in the rhythms of growth would in no way benefit any strategy for reducing rice consumption. If millet is to replace rice in consumption, its price should be more "attractive" to consumers to offset its higher preparation costs or its taste or preference disadvantage. In reality, relative prices measured by the ratio of millet prices to rice prices have changed from .536 to 1.11 in the 1974-83 period, favoring more rice than millet demand.

Table 9: Nutritional Contribution of Rice and Millet to the Senegalese Diet.

	RICE		MILLET		TOTAL	
Period	# of calories Per day	Grams of Proteins Per Day	# of Calories Per Day	Grams of Proteins Per Day	# of Calories Per Day	Grams of Proteins Per Day
1961-1965	500	13.6	661	17	2200	61.8
1967-1970	489.25	13.4	645.75	16.575	2279.75	64.725
1971-1974	466.75	12.675	609.5	15.625	2197.5	61.75
1975-1977	478	13.166	650	16.666	2238.666	65.766

Source: United Nations, Food and Agriculture Organization: Food Balance Sheets - various issues.

Table 10: Average Retail Prices (in CFAF/kg) of Broken Rice and of Millet "Souna" in Dakar.

Year	Broken Rice	Millet "Souna"
1974	69	37
1975	122	45
1976	86	55
1977	90	61
1978	88	64
1979	90	60
1980	93	73
1981	89	68
1982	114	82
1983	118	131
1984*	130	150

*as of June 1984

Source: Government of Senegal: Direction de la Statistique Ministere de l' Economie et des Finances, 1984.

Population. Population has a strong impact upon demand levels. Intuitively, it is clear that the more people, the more demand for goods, especially foodstuffs because of the critical biological need they satisfy. Therefore, the rhythm of growth of population is expected to push demand levels in the same direction as population. Authors like J.W. Mellor found the impact of population upon demand for food to be symmetrical (proportionate change in demand for food in response to change in demographic rate) via the equation below.[17]

$$D = P + ng$$

where D: rate of change of demand for food,
P: rate of change of population,
n: income elasticity of demand for food,
g: rate of growth of average per capita income.

In Senegal where total population is growing at 2.8 percent per year, urban population is increasing rapidly. The population has grown at 5 percent per year since the independence in the western and industrial Cap-Vert region. With high demographic growth in the cities, consumption of rice has expanded, leading to high urban per capita rice consumption levels that parallel those of the main Asian rice eating countries. A 1974 budget study conducted by the "Institut Universitaire de Technologie (IUT)" found an average per capita consumption for rice

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[17]John W. Mellor, Economics of Agricultural Development. (Ithaca: Cornell University Press, 1966).

of 132.5 kilograms a year in Dakar.[18] Sow (1983) attributed a stronger impact to the population variable rather than to the price or income variable. Recognition of this influence heightens the level of difficulty involved in devising a remedy to the rice problem. Also, an idea is given about the length of time needed for any remedial strategy.

Tastes and Preferences. The decision to buy a good or service demonstrates the consumer's desire, thus his tastes and preferences. Micoreconomic theory of the behavior of the rational consumer assumes them to be given for a certain period of time.

A fundamental aspect of the Senegalese urban consumer behavior is his strongly marked preference for the imported broken rice. This strong preference has left little room for the other grains to gain wider acceptance by consumers. The Senegalese consumer is very choosy about the type of rice he eats and he is willing to pay a premium for the variety he likes rather than take up another type of grain, unless exceptional circumstances (food shortages) dictate it. There have been very few instances where a radically different type of rice offered on more favorable terms has been widely accepted.

However, apparent consumer tastes and preferences are somewhat influenced by the product availability, price and income. As they change, tastes also may change, though not instantaneously.

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[18]Scott Pearson, J. Dirck Stryker, and Charles Humphreys, Rice in West Africa (Stanford University Press, 1981).

Availability and Access to Rice. Though not explicitly considered in the explanatory model of the demand for a good, the two factors have some influence on it. Difficult access to a good may turn consumers away from it if the opportunity cost of acquiring it outweighs the satisfaction it provides. Lesser availability would induce consumers to shift their demand toward other goods.

In Senegal where most of the consumed rice comes from abroad, the problem of availability of the grain is of concern for the authorities. Availability and access can be promoted via public actions. Although lessened availability of rice might be a cause for the substitution shift, it can lead to social unrest. Previous rice shortages paved the way for increased black market transactions, political exploitation and social tensions. Also, they led people to adopt or use their ingenuity to make up some alternative grain-based recipes. But, as soon as market equilibrium was restored, people went back to their original consumption model, proving once again the strength of the consumer preference factor.

The Supply of Rice

As described by Figure 1, total supplies of rice are totally explained by domestic production, commercial imports and food aid.

Domestic Production. It covers one to two-fifths of total supply. It peaked in 1979 with an harvest of almost 146,000 tons of paddy rice. This production compared to 372,000 tons of milled rice demanded. The evolution of domestic rice

output has followed the errance of climatic conditions; a record low of 38,000 tons was harvested in 1973, the year of severe drought. This makes water control a necessary condition for enhancing local rice output.

Rice production is not uniformly distributed nationwide. There exist two major rice producing regions in the country: the Casamance and the Fleuve. As shown by Tables 11 and 12, together they produce more than 90 percent of the total domestic rice and use almost all of the land area devoted to paddy. Around 65 to 75 percent of the rice harvest takes place in the swamp and uplands of the Casamance where traditional techniques (a few hand tools to prepare the land, transplantation and knife harvest) are employed within small family farms. In this region, Linares (1981) found an organization of rice production closely tied to the social and religious stratification of the community. A marked sexual division of labor assigns a major role to women in rice cultivation. Women decide which kind of rice to grow, where to plant it, do the transplanting, weeding and harvesting without much interference, but with some advice from men primarily interested in the cash crops. Knowledge of soil and water conditions in different paddy fields at different times is said to be a man's area of expertise. But the significant role of women in rice production is not fully recognized because they encounter some difficulty getting access to credit and inputs mainly directed toward male household heads. Recently, the government has begun an intensive program of modernization of swamp rice cultivation by introducing improved

Table 11: Regional Distribution of Paddy Rice Production (in metric tons)

	REGIONS					
Year	Cap Vert	Casamance	Fleuve	Senegal Oriental	Sine Saloum	Thies
1970/71	21	68486	23000	1417	335	388
1971/72	15	73010	27940	4222	2390	380
1972/73		27661	6541	3487	152	148
1973/74		49154	9809	6008	180	430
1974/75		86360	17220	12509	4271	202
1975/76	23	97397	12955	18384	1423	335
1976/77	15	88767	23315	12705	1560	57
1977/78		34088	17300	11362	168	
1978/79		108421	27380	9831	794	
1979/80		56821	30775	8500	471	
1980/81		26805	31584	5556	713	
1981/82		76700	36850	13842		
1982/83		55135	35930	3960		

Source: Government of Senegal, Ministry of Rural Development, 1984.

seeds, chemical fertilizers and insecticides, by making some land improvements and by encouraging more effective soil preparation, seeding and weeding.

But the bulk of public investment in rice development has been directed to the Senegal River Valley where irrigation methods are used along with modern inputs and machinery. However, saltwater incursion from the Atlantic Ocean and low natural flooding of the Senegal River due to insufficient rainfall jeopardize the feasibility of the irrigation projects.

Table 12: Regional Distribution of Area Devoted to Rice (in hectares)

		REGIONS				
Year	Cap Vert	Casamance	Fleuve	S. Oriental	Sine Saloum	Thies
1970/71	16	74511	15766	1496	1105	649
1971/72	21	65346	11748	4255	2737	596
1972/73		34952	11534	3971	2846	676
1973/74		49737	8049	5028	2050	550
1974/75		63771	9391	7716	4260	242
1975/76	26	70944	10522	10365	1679	296
1976/77	30	65068	10725	11033	1840	240
1977/78		41914	7777	12444	1165	
1978/79		71786	9490	8813	1205	
1979/80		57832	9798	10115	973	
1980/81		48744	9692	7016	1723	
1981/82		56866	10312	5870		
1982/83		50281	13699	4185		

Source: Government of Senegal, Ministry of Rural Development, 1984.

Furthermore, peanuts and millet-sorghum constitute the crops competing against rice. Higher farm prices for peanuts have shifted farm production plans to more peanuts to increase cash receipts needed to acquire desired goods and services. Higher adaptability of millet to arid conditions plays also in its favor.

External Supplies: Commercial Imports and Food Aid. Table 13 describes the evolution of commercial imports and food aid for the first two decades of independence.

Table 13: External Supplies of Rice in Senegal
(Index: 1960-64 = 100)

	1960-64	1965-69	1970-74	1975-79
Total imports (1000T)	119	165	177.8	213.7
Index	100	139	149	180
of which food aid			.6	2.5
Value of Rice as % of total value of imports	7.5	12.2	10.3	5.5

Source: Service Importations de Riz ONCAD in Rice Statistics Yearbook - WARDA 4th edition, June 1981.

Imports of rice have always been the main source of rice, particularly for the capital city and the Groundnut Basin. Consumption centers, far from producing regions (Casamance, Fleuve), have made transportation costs act as a barrier to the competitive delivery of local rice. Thus, imported rice is still the cheapest rice for the urban centers. On the average, commercial imports have met around 75 percent of domestic demand and are still growing. The first years of the 80's have seen net imports stabilizing around 300,000 tons a year for 1980-82.

Also, the 1973-75 world rice price hike has increased Senegal's concern with price fluctuations in the international market (See Chapter 2). This has not only strengthened the government's commitment to rice self sufficiency, but also it has pushed the authorities to seek more stable and regular rice suppliers in the world market. As a result, the number of rice sellers to Senegal has narrowed down to Thailand and Pakistan the years following the 1973 price shock (Table 14).

As shown in Table 13, food aid has a small share of external rice supplies, although it has grown in the 70's and 80's. The cereal food aid, because of the recurrent droughts that have caused substantial losses of cereal output, explains the creation of the "Commissariat a l' Aide Alimentaire". The latter institution was founded to take charge of the storage and the distribution of the food aid to the needy people. But cereals other than rice make most of the foreign aid because it is primarily aimed at rural people more severely affected by the consequences of the drought.

Accordingly, rice aid makes only a small portion of the assistance from the international community and hence has not had the damaging effects expected by Mellor (1966) and Peter Bauer.[19] In effect, the low level of rice producer prices could not be attributed to food aid, nor has the latter weakened the government's commitment to agricultural development by being a long-term alternative to rice excess demand.

Even though some remote instances of aid mismanagement for political purposes were witnessed here and there, no strong evidence exists to support that food aid was detrimental to the rice producers of the recipient country of Senegal.

Storage, Milling and Marketing

Storage and milling determine the quantity of domestic rice available for consumption while marketing facilitates the

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[19]Peter Bauer, "Adverse Repercussions of Aid," in Leading Issues in Economic Development, ed: Gerald Meier (New York: Oxford University Press, 1984), pp. 293-298.

Table 14: Senegal's Imports of Rice by Country of Origin (in metric tons)

Country	1974	1975	1976	1977	1978	1979
Argentina				30081	5246	
Brazil			18640	11934	33758	
Burma					23917	
Cambodia	31504					
China, P.R.	17639		5945			
Italy	32365	41464				
Pakistan	36674	31994	98310	34315	87496	63251
Thailand	67800	17246	102643	84618	41481	199080
United States	18294	10999		66587	36129	
Other	2904	39	9884	917		
Total	207180	101742	235427	228506	228027	262331

Source: Service Importations de Riz - ONCAD in Rice Statistics Yearbook - WARDA 4th edition, June 1981.

access of people to local and imported rice. Storage centers and mills are the property of the government. Increased storage capacity with better management would reduce post-harvest losses estimated at 10 percent of total rice production. This would also permit large carryovers that could be used to prevent rice shortages. The rice milling rate in Senegal averages 67 percent. But most of the mills operate below their rated capacities because of the low levels of the government purchases of locally

produced paddy rice. As mentioned by Rigoulot (1980), higher prices are offered in the illegal parallel market in the Casamance and on-farm paddy processing seems to be more profitable than off-farm processing. These problems highlight the inefficiency of the rice marketing system. The dissolution of the monopolist marketing agency in the early 80's was partly motivated by the need to make rice marketing more efficient.

Imports of rice are under the government's control which is trying now to involve the private sector in importing rice. Licenses are distributed to private traders approved by the Ministry of Finances. A stabilization fund, the "Caisse de Perequation et de Stabilisation des Prix" (CPSP) operates to offset differences between delivered costs of local and imported rice.

In sum, the rice industry is one of chronic excess demand. Low rates of rice self sufficiency illustrate this constant disequilibrium (Table 15). The food deficit has created a delicate economic situation. Important rice imports with reduced foreign exchange earnings due to the drop of the world prices of the country's main export products (phosphate and peanuts) have generated a serious budgetary and balance of payments crisis. The external debt of the country has augmented dramatically.

Consequently, it has become crucial to reverse this uncomfortable situation. A global plan emphasizing a restructuring of the economy to offer more incentives and better perspectives for future growth to endogenous forces is to be defined.

Table 15: Evolution of Rice Self-Sufficiency Rates in Senegal (in percent)

Year	1961-65	1966-70	1971-75	1976-1980	1981-82
Rate %	27.72	29.2	21.2	20.38	12

Source: Rice Statistics Yearbook - WARDA 5th edition, June 1983.

Among the policy actions to be implemented are those directed to the rice industry. In fact, if peanuts and phosphates have been the Achilles' heel of the Senegalese economy, rice has gained in importance. Its unbalanced situation has strained the economy and will continue to do so until firm actions are taken to stabilize it. In the following chapters, we will carry out an empirical study of the rice sector (mainly from the demand side) to evaluate certain policies hitherto undertaken to remedy the profound and lasting rice imbalance analyzed throughout the first part of this paper.

Chapter 4

THEORETICAL FRAMEWORK

OBJECT OF STUDY

As said earlier, we wish to investigate the impact of the traditional determinants of demand upon the consumption of rice in Senegal. To do so, we will estimate the equation of the aggregate demand for rice in three different ways, each corresponding to an actual or hypothetical situation susceptible of shedding some light upon some questions of interest. A presentation and discussion of these three cases will be made in later sections of this chapter.

METHODOLOGY

To estimate the demand function of rice in Senegal, an econometric technique, namely the ordinary least-squares (OLS) regression method, will be used provided that the ideal conditions are met.

PRESENTATION OF THE OLS METHOD

Our description of this statistical technique follows the same lines as Johnston's[20] exposition of the OLS principle. Let us assume a linear relationship between a variable Y and K + 1 explanatory variables, X_0, X_1, .., X_k and a disturbance

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[20]J. Johnston, Econometric Methods. (New York: McGraw Hill Book Company, 1972), pp. 121-175.

term U. If a sample of n observations exists on Y and the X's, one can write:

$$Y_t = a_0X_{0t} + a_1X_{1t} + \ldots + a_iX_{it} + \ldots + a_kX_{kt} + U$$

with $t = 1, 2, \ldots, n$;

$i = 0, 1, \ldots, k$;

and $X_{ot} = 1$, for any t.

While real world observations reveal the levels of Y and of the X's, the regression coefficients a_i and the parameters of the error's distribution are unknown to us. Our task is to get some estimates of these unknowns. By definition, each coefficient a_i represents the impact of the variable X_i on Y, other things being held constant; mathematically speaking, a_i, in a linear function, is called the partial derivative of the function Y with respect to the variable X_i. To estimate the a's, the least-squares principle is applied. It determines the combination of the a's such that the sum of squared residuals is minimized, the residuals being the differences between the actual levels of Y and its values predicted by the regression model. In fact, the problem is one of solving for the a's in order to minimize a certain function, the sum of squares of the residuals. This function is preferred over some other functions of the errors (sum of the errors or sum of the absolute errors) because of its computational simplicity and the desirable statistical properties of its estimated parameters (unbiasedness, consistency and efficiency).

UNDERLYING ASSUMPTIONS OF THE OLS METHOD

The use of the OLS principle is justified and helpful if and only if certain conditions are satisfied.

-The errors should be distributed normally, identically and independently around a mean zero and a constant variance.

-The matrix of the independent variables X must be non-singular and composed of nonstochastic elements or, equivalently, the variables X's should not be correlated with the errors U.

Any violation of the conditions above would induce some problem with the use of the OLS technique. But, depending on the nature and the seriousness of the violation, some alternatives exist. They have been devised in lieu of the OLS method to yield estimates with better statistical properties. We shall encounter later one of those remedial techniques.

STATISTICAL MODELS

A model is a rigorous representation of a theory usually in mathematical form. Figure 1 in the preceding chapter maps out the economic relationships in the Senegalese rice industry and hence determines the variables to be used in the corresponding economic model of the demand for rice. Not all variables would appear in the statistical model because some are non-measurable in any commonly accepted yardstick and then are not explicitly considered in the model as variables. For example, tastes and preferences, though theoretically important, would not enter the rice demand statistical model; instead, they would be assumed given over the period of study.

Therefore, for the rice demand function, only measurable factors deemed to be theoretically sound will be used. They are the retail price of rice, national income, population, and the quantities of the substitute for rice in consumption, namely millet. For the income variable, both nominal and real incomes are alternatively considered. One could argue and rightly suggest the use of real income to validate the assumption of the absence of money illusion of the rice buyers. But this supposes that the market is efficient, i.e., it provides all necessary information for good economic decision making. In reality, distortions in the market obstruct its efficiency. Evidence exists that consumers are more readily informed about changes in their disposable income than about relative prices between market goods. Then, short term decisions to consume could be influenced by nominal income levels. However, the long term behavior is one of adjustment by revising previous decisions to consume in order to allocate resources more efficiently.

Also, the rice demand model would be set up in three ways using the same explanatory variables. Following are the three cases with the corresponding demand equations to be estimated by the means of the OLS or, if needed, the instrumental variable econometric procedure.

CASE 1: SINGLE RICE DEMAND EQUATION

Here, we assume that supply and demand for rice are independent of each other. The assumption stems from the exogenous determination of rice prices in Senegal. The setting

of prices outside the market place is likely to reduce the interaction between supply and demand forces, and the recognition of this fact allows us to specify a unique rice demand equation that is independent from that of rice suply. In addition, we include an interaction term between price and income in the model. Maddala (1977) reported that Frederic Waugh[21] used that interaction specification when estimating a demand function for food. For the Senegalese case, Ross (1980) hinted that the price elasticity of the demand for rice was apparently varying with income levels. Thus, we are trying to verify such a claim by introducing a price-income ratio term that would eventually capture such an effect. The ratio form is one of the numerous ways to represent this interaction and, with it, the price elasticity of the demand for rice would be a function of income.

The demand equation is then specified as follows:

$$TNC_1 = a_0 + a_1 P_t + a_2 Y_t + a_3 \frac{P_t}{Y_t} + a_4 POP_t + a_5 QCMS + e_t$$

where

TNC: annual national consumption of rice in 1000 metric tons,

P: retail price of rice in CFAF/kilogram,

Y: nominal gross domestic product in current prices (in billion of CFAF) used as a proxy for national income,

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[21]Frederic, Waugh, Demand and Price Analysis-Some Examples from Agriculture, U.S. Department of Agriculture Technical Bulletin 1316, November 1964, p. 16.

P/Y: ratio of price to income in CFAF,

POP: population in 1000 people,

QCMS: quantities consumed nationally of millet-sorghum in 1000 metric tons,

e: error term,

a_i: regression coefficients to be estimated,

t: time period (years).

Both the linear and the double logarithmic forms would be tried as suggested by the plot of data and theory. The double logarithmic form presents an advantage over the simple linear model because it yields directly the demand elasticities with respect to the independent variables. The OLS method is used to estimate the demand equation above, and it is assumed that the ideal conditions described earlier are met, unless otherwise stated. It should be added that the time variable was initially thought to belong to the demand model. But, its high correlation with population (.995) and the near unity R-square found in the artificial regression of time on population (.9989) suggested a serious case of multicollinearity between the two variables. Consequently, the time factor was deleted from the model because it provided no additional information with the population variable already in the model. Under the ideal conditions, the OLS regression estimates are unbiased, consistent and efficient; these properties also hold asymptotically. Therefore, the t and F tests validate the statistical inferences.

CASE 2: SIMULTANEOUS EQUATION SYSTEM

This is the case when supply and demand fully interact via the market channels and thru prices. It means that price and quantity are simultaneously and endogenously determined in the model and their levels would be equilibrium levels for a given period. To apply this specification to the Senegalese case, a critical assumption is needed. It was said previously that rice prices are set and controlled by the government in Senegal. We will assume that the Senegalese price policy makers react to changes in supply and demand when determining price levels. In other words, market forces are strongly relied upon in the exogenous price determination procedure. Thus, disequilibrium in the domestic rice market (excess demand or supply) would push the price makers to adjust price levels to restore equilibrium.

Needless to say, this is a very strong assumption and no less unrealistic. However, as Friedman[22] puts it: "...a theory cannot be tested by the 'realism' of its assumptions... Complete realism is clearly unattainable, and the question of whether a theory is realistic 'enough' can be settled only by seeing whether it yields predictions that are good enough for the purpose in hand or that are better than predictions from alternative theories..."

This methodological statement about positive economics convinces us to retain the assumption until proven wrong by

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[22]Milton Friedman, "The Methodology of Positive Economics," in Readings in Microeconomics, ed: Breit and Hockman, 1971.

false predictions, what ultimately reveals the lack of robustness of our model and hence its invalidity. The test of this model helps examine the rice pricing policy hitherto used in Senegal. It should be remembered that traditional economic theory stipulates that government or any centrally made decisions ought not to substitute for the outcome of the market mechanism. A radical stand on this issue is taken by the monetarist school whose disciples argue that public policy makers are poorly informed about market matters and thus are likely to destabilize the whole economy by their actions.[23]

For the rice market model, the same demand equation as in Case 1 (with no price-income interaction term, however) is employed. Considered to interact with it is the total supply of rice made of domestic production, commercial imports and food aid. Rice supply responds to factors such as rainfall, official farm prices of competing products (groundnuts and millet-sorghum), time, and so forth. It is supposed here that quantities adjust in response to a disturbance to bring the market back to equilibrium. Hence, the demand model will have quantities consumed of rice as a regressand; the logarithmic specification will provide demand elasticities. Then, the inverse demand function (price as regressand) will be used to compare public versus market pricing of rice.

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[23]See William Poole, Money and the Economy: A Monetarist View, (Readings: Addison-Wesley, 1978); Lawrence Harris, Monetary Theory. (McGraw Hill Book Company, 1981).

To estimate the quantity and the price dependent demand equations, the OLS technique should not be used. With the simultaneous equations, price influences quantity demanded and vice versa because of the interdependence of supply and demand. Thus, price and quantity are a function of each other and are not fixed, but stochastic. Either one used as a regressor of the other would be stochastic and, more, correlated with the error term in the same period. This constitutes a serious violation of the ideal conditions for the OLS method; in fact, OLS estimates in this case would be biased, inconsistent and thus inefficient, even asymptotically, and therefore useless. A cure to the problem underlined above is the two-stage least-squares (2SLS) method. Basically, it consists of finding some instrumental variables that would be used in lieu of the stochastic regressors and that would provide the same amount of information as them. The instruments are chosen such that they are not correlated contemporaneously with the error term. Then, the OLS regression could be used on the model with the instrumental variables to obtain better statistical results.

CASE 3: CASE 2 WITH INTERACTION BETWEEN THE RICE AND MILLET MARKETS

Since millet is generally said to be a substitute for rice in consumption and production as well, we hypothesize that their markets shoud interact to a large extent. Dis-equilibrium in one should affect the other. Thus, we include the demand and supply equations for millet, which gives us a set of four simultaneous equations whose solutions determine

equilibrium price and quantities in both markets. We suspect that the inclusion of the millet market in the model would reinforce the influence of millet upon rice consumption if the substitution relation between the two grains was actually strong. Again, the same assumption as to the government pricing behavior still holds; the equations are expressed in double log-linear form and the 2SLS method is used.

DISCUSSION ABOUT THE DATA USED

As much as theory, data determine to a large extent the outcome of any empirical study. In response to a problem to be analyzed, they indicate the correct method, the adequate model and the appropriate functional form to be used. Therefore, proper attention should be devoted to them by assessing their contribution to the validity of the obtained results. Two issues are of importance in this section: the sources of the data and the problems related to their collection, quality and availability.

SOURCES OF DATA

The lack of a complete and reliable data base is a common phenomenon in developing countries. Senegal, as its peers, suffers from this shortcoming. As a result, for this study covering the 1960-1981 period, quite a few sources were consulted to obtain data on the selected variables. As much as possible few sources were used as inconsistencies and ambiguities in data were detected from publication to publication. The West African Rice Development Association (WARDA) Rice Statistics

Yearbook provided the bulk of the data on the rice related variables (total consumption, net imports, domestic production, areas cultivated, yield, population, per capita consumption, self-sufficiency rates, etc.). Official figures from Senegalese governmental offices were also used (gross domestic product). Various FAO publications (Trade and Production Yearbooks) were consulted to collect data on millet-sorghum. The price data came from bulletins of the "Banque Centrale des Etats de l'Afrique de l'Ouest" (BCEAO). Other minor sources were articles and theses published in different U.S. universities.

DATA PROBLEMS

The most serious problem is that of quality which is related either to the form or the source of the data. All collected data are annual figures. This aggregate nature masks the temporal disparities which exist for most variables. Also, they constitute some kind of average which eliminates most of the inherent fluctuations. More importantly, quality deficiencies originated from the diversity of sources. A cross examination of the data about the same variable but from different publications revealed ambiguities in them and raised an element of concern as to which source to rely on to minimize the data errors. Consistency of the observations was a criterion of selection, so were the uniqueness and the closeness of the source to the study case. Despite all the attention paid to this problem, the quality of the data could not be absolutely assessed and it is very possible that the

data used would not correctly reflect the expected impact of some variables in our analysis. Nonetheless, we would settle for the best we can get from them, although this might impede us from finding straightforward answers to some interesting questions.

Along with the quality problem came that of availability. Since this study went as far back in time as 1960, some difficulty was encountered to gather data on some variables at that time. Some missing ones were generated (e.g. the total rice consumption in 1960 was estimated by adding net imports to domestic rice available for consumption, the latter being itself determined using domestic production, seed, harvest loss and milling rate). Also, because no data were available on the retail price of millet-sorghum, we used the quantities consumed of that grain to capture the substitution effect. Gross domestic product was considered as a proxy for national income. Lack of observations on the African type consumer price index for the early 60's hindered somewhat the use of real variables in the statistical analysis.

In terms of the statistical methods, two outcomes could be envisioned. Bad quality data or the forced use of proxies may result in problems of multicollinearity or stochastic regressors autocorrelated with the error term. Lesser availability of data would reduce the size of the studied sample and jeopardize the robustness of the results because most corrective econometric techniques (e.g. 2SLS) are only valid for large samples.

In short, the data problems discussed above show how critical a reliable data base is to the development of research programs, particularly in agriculture. This issue is at the core of the agricultural development strategies in developing countries. But, it has yet to receive all the due attention and investments necessary to construct it.

Chapter 5

EMPIRICAL RESULTS, ANALYSIS AND POLICY IMPLICATIONS

The results for the rice demand equations for the three cases discussed earlier are presented in this section with statistical inferences and computation of elasticities. The analysis of the results and their policy implications are also included.

CASE 1: SINGLE DEMAND EQUATION

Different models were tried with nominal income and real income respectively in simple linear and log-linear form. Also, a per capita demand function instead of an aggregate demand was tried, but did not provide satisfactory results. The model that was finally selected was the double log-linear aggregate demand equation with nominal variables. It gave the following results:[24]

$$\underset{}{\text{Log } TNC_t} = \underset{(12.407)}{35.509118} + \underset{(3.349)}{9.291314}\ \text{Log } P_t - \underset{(2.424)}{6.038748}\ \text{Log } Y_t$$

$$- \underset{(19.198)}{57.304251}\ \frac{\text{Log } P_t}{\text{Log } Y_t} + \underset{(.876)}{.924773}\ \text{Log POP} - \underset{(.128)}{.081175}\ \text{Log QCMS}$$

$\bar{R}^2 = .8133$
Durbin-Watson Statistic = 2.088
Root Mean Square Error : .126
F-Statistic (5,16) : 19.294
Sample Size : 22
Dependent variable mean: 5.421

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[24]Between parentheses are the standard errors of the OLS estimates.

Statistical Inference

The value of $\bar{R}^2$ shows that 81.33 percent of the variability of TNC around its mean level is explained by the independent variables. The F ratio of 19.294 at (5,16) degrees of freedom against a tabulated value of 4.44 is highly significant (at more than 99 percent level). This strongly supports the adequacy of the log-linear relationship between the regressors and the regressand. The value of the Durbin-Watson statistic or d-test indicates that an hypothesis of zero first-order autocorrelation between disturbances could not be rejected (at 5 percent level). Only the coefficients of population and millet- sorghum consumption are insignificant (small t-ratios). All these results converge to support, at least statistically, the use of the OLS technique.

Interpretation

Apparently, three coefficients (price, income, interaction term) have wrong signs. Actually, that is not the case as the computation of demand elasticities would prove it. The price elasticity of the rice demand, E_p is defined as follows:

$$E_p = \frac{d \text{ Log TNC}}{d \text{ Log P}} = 9.291314 - \frac{57.304251}{\text{Log Y}}$$

The significance of the price-income interaction term supports the idea that the elasticity of rice demand with respect to price varies with income. From the relation above, income levels vary inversely with the rice price elasticity, low levels of income being associated with higher price elasticity

of the demand for rice. At mean value of Log Y from the sample, $E_p = -.862$, i.e., a 1 percent increase in rice price would induce a .862 percent decrease in quantities consumed of rice, ceteris paribus. Similarly, the income elasticity of the demand for rice, E_y, is

$$E_y = \frac{d \text{ Log TNC}}{d \text{ Log Y}} = -6.038748 + 57.304251 \frac{\text{Log P}}{(\text{Log Y})^2}$$

At mean values of Log P and Log y, $E_y = .953$, that is higher in absolute value than E_p, suggesting a stronger responsiveness of total rice consumption to income rather than price.

A possible policy implication of these elasticities is that price policy to depress demand for rice is likely to be more effective with low income groups. But, since low income groups contain mostly rural people who are not the main consumers of rice, price policy might deteriorate their conditions of living by reducing their real income rather than affecting substantially the main rice eaters of the urban centers. Also, since rice demand is inelastic to price, substantial price hikes are needed to diminish it very significantly, but they are a source of potential welfare losses and social tensions because of the reduction of consumer surpluses.

Furthermore, the population coefficient has a correct sign and is greater than those of price and income. Although it seemingly indicates a stronger impact of the demographic factor upon the demand for rice, what supports Sow's findings, we would not claim such an impact because of its statistical insignificance. The coefficient of millet consumption has also a correct negative sign, but is insignificant. Its small

value, not statistically different from zero, suggests a weak substitution degree between rice and millet in consumption.

CASE 2: SIMULTANEOUS EQUATION MODEL

Both the usual (quantity dependent) and the inverse (price dependent) demand equations in log-linear form are presented here with the results of the 2SLS method.

Quantity Dependent Demand Model

$$\text{Log TNC} = \underset{(6.680)}{4.370} - \underset{(.325)}{.551}\ \text{Log P} + \underset{(.448)}{1.096}\ \text{Log Y} - \underset{(1.016)}{.373}\ \text{Log POP} - \underset{(.155)}{.031}\ \text{Log QCMS}$$

R^2 =	: .7315
Durbin-Watson Statistic	: 1.975
Root Mean Square Error	: .150
F-Statistic (4, 18)	:10.90
Sample Size	:22
Dependent Variable Mean	: 5.421

Statistical Inference

The R^2 of 73.15 percent provides a fairly good fit, though still lower than that of the single equation model. The d-test shows no first-order serial autocorrelated errors. The model is statistically significant at 99 percent level of confidence. But, only price and income are statistically significant at almost 90 percent confidence level.

Economic Interpretation

All signs in the model, but that of population, are as expected. Population was expected to have a positive impact upon demand, as theory suggests and as it did in the single

equation model. Either the model (simultaneous equation) or "bad" data could explain the bias in its coefficient. But one needs not worry too much about its sign because the coefficient is highly insignificant, as in Case 1.

The elasticities of demand for rice with respect to price and income are - .551 and 1.096 respectively, showing a price inelasticity and a near unitary income elasticity of the demand for rice. Compared to Case 1, the strength of the income variable is reaffirmed by the model whereas that of price is reduced by 36 percent. The results imply that price would not be a strong instrument to use to reduce consumption of rice substantially. A stronger response should be theoretically obtained with the income instrument, but no government will reduce income in order to cut rice consumption. In addition, the quantity consumed of millet- sorghum has an insignificant and small coefficient. This still does not contradict the idea of low substitutability between rice and millet.

Price Dependent Demand Model

$$\text{Log } P = \underset{(10.046)}{6.397} - \underset{(.722)}{1.392}\ \text{Log TNC} + \underset{(.625)}{1.742}\ \text{Log Y} - \underset{(1.43)}{.561}\ \text{Log POP} - \underset{(.221)}{.009}\ \text{Log QCMS}$$

R^2 =	.8403
Durbin-Watson Statistic	2.104
Root Mean Square Error	.210
F-Statistic (4, 16)	21.05
Sample Size	22
Dependent Variable Mean	5.421

Statistical Comments

The explanatory power of the regressors is strong (84.03%) and so is the statistical model because of the highly significant F-statistic. No serious first-order autocorrelation between the errors is detected by the d-test. The quantity consumed of rice and income variables have the only significant coefficients at 90 percent confidence level.

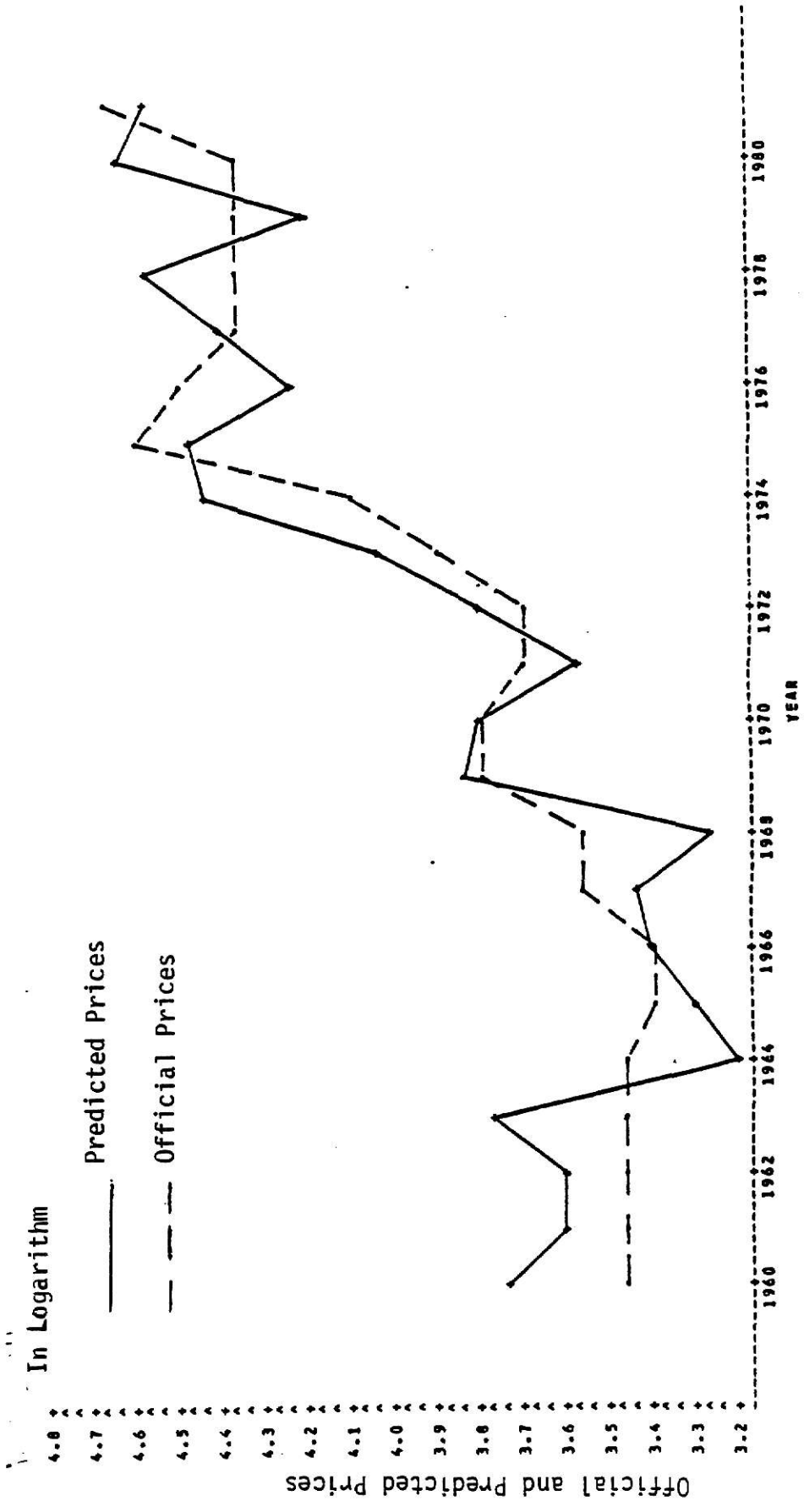
Economic Implications

The model above was set to appraise the Senegalese government rice pricing policy with respect to the market pricing represented by the price levels endogenously given by the model. Those levels are equilibrium prices and they are plotted versus time with the actual prices of rice in the country (Figure 2). This diagram indicates three main characteristics of the price policy used by the policy makers:

1. A freezing of the rice retail prices from 1960 to 1964 (32 CFAF/kilogram of broken rice) and from 1977 to 1980 (around 80 CFAF per kilogram of rice).
2. A systematic and periodic revision of the price of rice from 1965 to 1972: prices were revised approximately every two years.
3. And a flexible price from 1973 to 1976 and in the early 80's.

In general, the periods during which prices were fixed coincided with an underpricing of the rice grain. In fact, rice, because of its importance in urban diet, has had a sub-

Figure 2: Predicted (Market Equilibrium) versus Official Rice Prices in Senegal (1960-1981)



sidized retail price for many years in Senegal; this cushioned the impact of fluctuating market equilibrium prices on the national demand of rice. Also, large public-market price differentials were observed during those periods. When the government started to revise periodically (every two years) the rice prices, the smallest price differentials were obtained with official prices almost equaling the market prices in 1966 and 1970. The policy of volatile prices occurred with the 1973 events that disturbed the world rice market (see Chapter 2). The internal prices followed the rising trend of the world rice prices, but with official prices still being below the equilibrium levels until 1975-1976, period of over-pricing. In fact, during those years when the economy was still suffering from the aftermath of the 1972-73 drought, the government wanted to ease the financial pressures on the rice consumers by resisting to transmit to its full extent the hike in the imported rice price. This follows the logic that Timmer underlies as "a government that cannot raise food prices because it will no longer be the government, will not raise food prices, no matter how critical that is to long-run efficiency."[25]

In summary, besides the periods of fixed prices, the price makers have seemed to have responded to changes in the rice market by adjusting price levels, although not fully, to

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25. Peter Timmer, "Developing a Food Strategy," in Agricultural Development in the Third World, ed: Carl K. Eicher and John M. Staatz (Baltimore and London: Johns Hopkins University Press, 1984), pp. 122-23.

its equilibrium levels. Year-to-year fluctuation or two-year adjustment of the price levels to reduce the instability of the domestic rice industry seem to be better strategies than fixed prices. No serious and continued divergence between the official and the market prices has been noted for the whole period under study. This finding supports the validity of the assumption of rational pricing behavior of the Senegalese authorities. However, it does not condone the systematic replacement of the market mechanism by a public price determination institution.

CASE 3: CASE 2 WITH AN INTERACTION BETWEEN THE RICE AND MILLET MARKETS

$$\text{Log TNC} = \underset{(6.81)}{4.812} - \underset{(.332)}{.427}\ \text{Log P} + \underset{(.456)}{.982}\ \text{Log Y} - \underset{(1.042)}{.323}\ \text{Log POP} - \underset{(.212)}{.085}\ \text{Log QCMS}$$

R^2	: .7204
Durbin-Watson Statistic	: 1.8247
Root Mean Square Error	: .1536
F-Statistic (4, 18)	: 10.31
Sample Size	: 22
Dependent Variable Mean	: 5.421

Statistical Comments

Accounting for the millet market has not improved the explanatory power of the model which remains fairly stable (R^2 = 72 percent). Also, the regression model is as significant as before: the calculated F-statistic of 10.31 remains highly significant. No serious first-order autocorrelation of the errors could be detected, as shown by the d-test. But, compared to Case 2, the price coefficient becomes insignificant, even at 80 percent confidence level. In sum, the statistical features of this model correspond closely to those of the second case.

Economic Interpretation

Once again, the coefficient of the population variable has a wrong sign, which is hardly acceptable. But its statistical insignificance allows us to pay no attention to its magnitude since no inference could be made with respect to it. The inclusion of the millet market has dampened the effect of the price and income factors (their coefficients decrease in absolute value relative to Case 2) whereas the coefficient of millet consumption has more than doubled (-.031 to -.085), but is close to its value in Case 1 (-.082). However, it is still low and statistically insignificant. Rice consumption exhibits more responsiveness to income than to any other determinant. In sum, these results have provided some ground on which sound recommendations could be based. However, a word of caution is never too much for the use of the results above. These implications depend solely on the quality and the nature of the data used, and this should not be overlooked. Nevertheless, despite those quality problems referred to earlier, some general points can be made with appropriate care, and they are presented in the following conclusive chapter. A suggestion for further study concerns with using the three-stage least-squares (3SLS) method on the simultaneous equation model.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

Large rice imports to sustain Senegal's food balances have led to unfavorable trade balances, hindering development efforts. The demand for rice and its principal component, net commercial imports, have shown no sign of decline, implying an apparent failure of the national consumption policies. More than 300,000 tons of rice are now purchased annually by a total population of less than seven million people. The sustained high level of rice consumption makes the rice problem much more difficult and complex.

Contrastingly, the domestic production is plagued by physical, economic and institutional barriers which undermine the goal of rice self-sufficiency pursued by the Senegalese policy makers. The harshness of the constraints and the extent of the policy biases are such that the objective of increasing net domestic production of rice from 98,000 tons in 1980 to 191,000 tons in 1985, objective defined in the 1981-1985 sixth National Development Plan, is unattainable. Furthermore, there is no indication that any drastic change in this trend would be witnessed in the next years. Therefore, a closer look to the demand side of the problem is indispensable by focusing on the determinants of the rice demand in this small Sahelian country. This study has followed the lines of such an approach

and has shed some light on those determinants. From the results of this study have emerged the following conclusions and recommendations.

First, rice demand has shown a lower responsiveness to the price variable than expected in all cases of our analysis. At best, the price elasticity of the demand for rice was found to be - .862, i.e., a 1 percent increase in rice prices would decrease the total demand for rice by .862 percent, other things remaining the same. Thus, it would become difficult to use the price instrument to decrease rice consumption such that rice self-sufficiency rates would be greatly improved.

Second, income has exhibited throughout the study a higher potential than price in influencing the levels of rice consumption. Since no strategy should purposively seek to depress income, the dilemma of the rice situation is even greater than expected. The strong preference for rice manifested by the Senegalese consumers tends to reinforce the income factor. The more income the rice buyer has, the more premium he is willing to pay to obtain the quality of rice he likes.

Then, with the remarks above, the only alternatives left to the rice imbalance should draw upon controlling the population growth rate and promoting better substitutes for rice in consumption. Our analysis did not permit us to statistically measure the presumably strong theoretical importance of the population variable. But other studies like Sow's (1983) did find it to be very influential. This is not surprising because rapid population growth has generally coincided with

the rise of the demand of the most important element of the local urban diet. In Senegal, the human flow from the countryside to the cities, phenomenon known as "rural exodus", adds another dimension of complexity to the food problem. But, it seems that a solution to the rural-urban migration passes through a reduction of the disparities between cities and villages. Such a solution is by itself a whole policy of rural development that will make the rural areas better places to live. As a whole, population growth, especially in urban areas has followed so fast a rhythm that it urgently needs to be controlled by the means of long term health, nutrition and education policies.

Lastly, immense and intense efforts should be made to promote the cereal substitutes to rice. Our study did not prove that millet was a good substitute for rice, the way it was prepared and the time it was consumed. Almost four-fifths of the rice consumed in Senegalese towns is eaten at noon while millet is consumed at dinner after a long preparation. Consumption policies should seek to induce urban dwellers to shift the composition of their grain diet towards more millet and maize. A fundamental role is to be played by institutions like the "Institut de Technologie Alimentaire" (ITA) which have to develop research to elaborate millet and maize-based consumption products acceptable to the rice buyers. Aggressive advertisement campaigns must follow to increase people's awareness of the availability of tasteful and nutritionally rich millet and maize based dishes, particularly for lunch meals. Price measures

could then be taken to reinforce millet position in the diet by making the grain economically attractive to the rice consumers. The public ignorance of the enormous potential of maize could be taken care of by promotional programs. The wider acceptance of these two grains would introduce a needed element of diversity in the seven-day-a-week rice dominated diet observed in urban centers.

Meanwhile, the projects of rice development should be vigorously activated. It is almost unanimously accepted that water control is a first and necessary step toward increased rice output. Of course, price and institutional input policies should complete it to offer to farmers means and incentives to boost their production and improve their productivity.

As a final word, the panacea to one of Senegal's greatest hardships, the rice challenge, rests upon a global strategy mobilizing all the resources of the nation. All segments of the Senegalese society must be called upon to bear the burden of striving for a long-term alternative to the present, chronic and profound disequilibrium. The fate of the goal of rice and food self sufficiency depends as much on rural producers as on the urban people who should demonstrate less rigidity in their consumption decisions by curbing their overly marked preference for rice to tap the unexploited potential of the other cereals. Public authorities should stimulate the emergence and the consolidation of such attitudes by implementing well-advised, well-inspired and well-directed food policies.

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DEMAND VERSUS A SEVERELY CONSTRAINED DOMESTIC SUPPLY: AN ANALYSIS OF THE RICE IMBALANCE IN SENEGAL

by

BOCAR NENE DIAGANA

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AN ABSTRACT OF A MASTER'S REPORT

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ABSTRACT

Rice is by far the most important staple food in urban Senegal where four-fifths of its consumption occurs at noon meal. So predominant has been this grain in the local urban diet that purchases of rice have soared to more than 300,000 tons a year in the early 80's. In contrast, domestic production of rice has covered at best 40 percent of the total consumption, illustrating the serious imbalance that explains the high level of rice imports. The disequilibrium in the domestic rice industry has generated unfavourable trade balances which have hindered development efforts because of the profound budgetary and financial crises experienced by this small Sahelian economy of less than seven million people.

This study has focused on the demand side of the rice problem. It investigated the impact of the traditional demand determinants. It appraised the government rice pricing policy and examined the degree of substitution between rice and millet in consumption. Also, the international rice market was scrutinized to shed light on the possible effects of Senegal's continued reliance on the world market to feed its urban populations on the domestic rice production.

The rice demand equation was estimated in three different ways. The ordinary least-squares method was appropriately utilized in the first case of the econometric analysis whereas

the instrumental variable technique (two-stage least-squares) was used in the last two.

Throughout the empirical study, income was found to be the major determinant of rice demand in Senegal while the impact of price was relatively weak. Also, the price elasticity of the demand for rice was varying inversely with income levels. However, no evidence was provided by the data about the strong substitutability between rice and millet in consumption. Furthermore, it was discovered that market prices for rice did not vary appreciably with the government-set prices.

The data highlight the dilemma of the rice situation in Senegal. Price or income policy alone would be ineffective in controlling consumption of rice significantly. Thus, the remaining alternatives to the rice challenge rest on reducing urbanization rates which are apparently accountable for the high urban consumption of rice. More importantly, food research must be developed and aggressive promotional campaigns launched to increase the availability and acceptance of millet, maize or other products by the urban dwellers as possible substitutes for rice in their lunch diets.

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