RICE IN THE DEVELOPMENT OF IVORY COAST AGRICULTURE

By

Joshua L. Posner

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Introduction

The Ivory Coast, a prosperous country of 5.5 million people, enjoys one of the highest per capita income levels in Black Africa. This high level to date is based on an export agriculture of coffee, cocoa and timber, exchanged with Europe and the United States for manufactured products and foodstuffs.

The results of this orientation away from subsistence farming has brought to the forefront several problems with which present day Ivorian planners are attempting to deal. With the emphasis on export crops, the Ivory Coast has become a large importer of basic calorie-rich foods, spending $6 million on wheat, $8 million on rice, and $9 million on sugar in 1970 alone (19, p. 82). While this sum of $23 million dollars is only seven percent of the total value of exports in 1970, it has been growing rapidly in absolute terms. There is an attempt to rectify this drain on foreign exchange for basic foodstuffs by diversifying local production. The development plans for 1970's include improved rice production, improved maize production and the initiation of a commercial sugar cane plantation.

A second general problem facing Ivorian planners is rural unemployment and underemployment. This is indicated by the vast migrations to the cities and the seasonal labor migrations from the northern savannah areas to the southern forest belt. This situation has resulted from the unequal regional development during colonial times when the export crop

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producing regions received the necessary administrative inputs to insure their profitable exploitation. The concomitant political questions of equalizing regional development and reducing the "pull" forces from the rural areas and into the cities have been foremost in the minds of planners (21, p. 7). As a result, the efforts for the 1970's call for further agricultural diversification. More of the savannah land will see the production of cotton, rice, kanef and sugar cane. In the south the difficult transformation from old perennial crop stocks to new hybrids of coffee and cacao has been started. In addition new plantations of rubber, oil palm and coconut have been initiated.

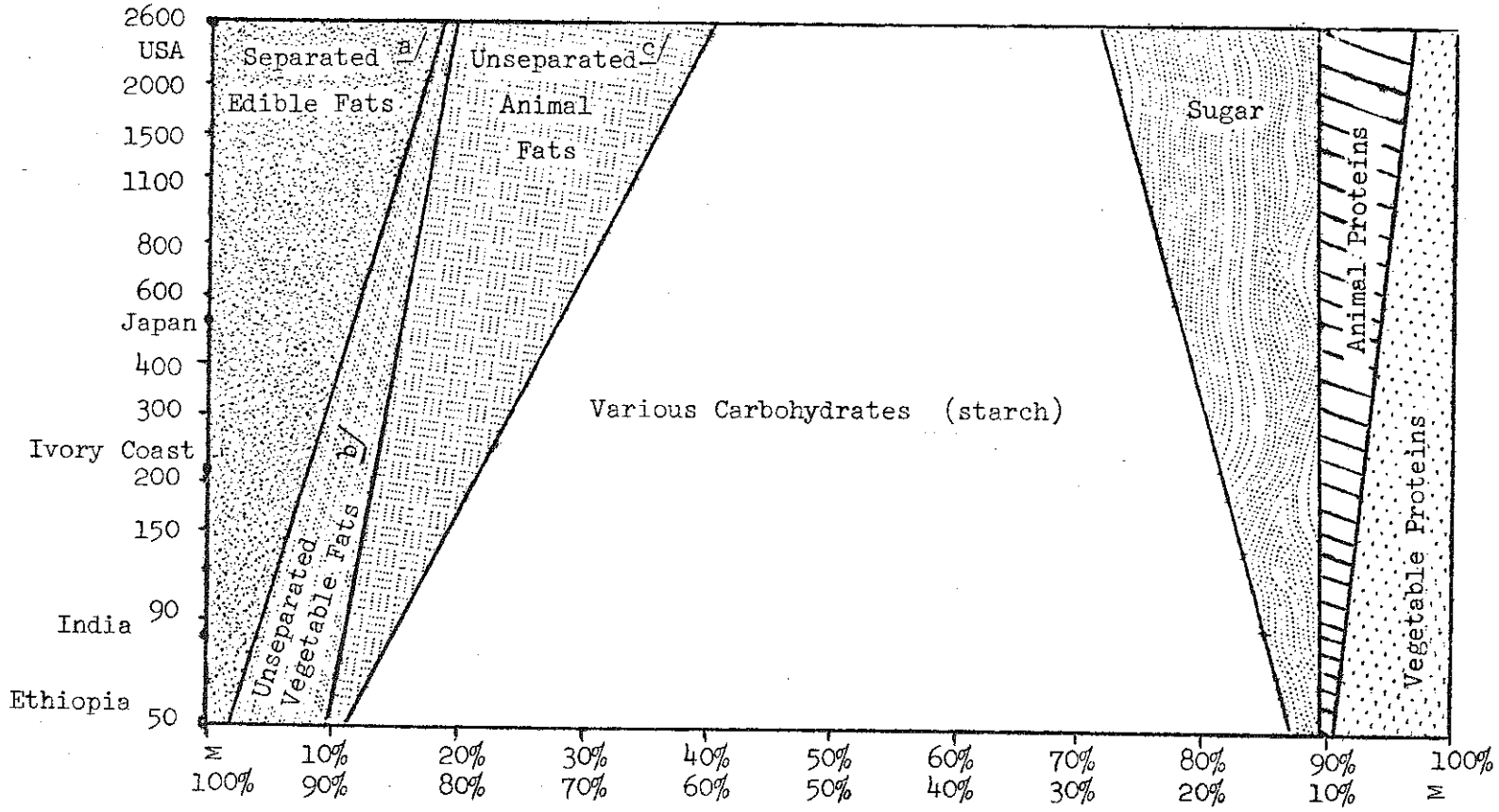
To solve both the problems of limited foreign exchange and employment generation in the rural sector, Ivorian planners are relying heavily upon the development of rice culture. Many observers have found in rice a unique solution to these problems. It is a highly labor intensive crop and also a highly preferred food. In addition, its low processing costs, easy storability and range of climatic needs further enhance its value in a developing economy. The purpose of this paper is to review the purported advantages of rice in the Ivorian context.

The Place of Rice in the Diet

Throughout West Africa, as in most less developed areas, carbohydrates serve as the main source of calories and proteins in the diet of the people. This fact is very much related to personal income and the general ecology of the region. For example, peculiar to tropical Africa is the heavy reliance on roots and tubers, not cereals as in the monsoon areas of Asia or historically in Europe (6, p. 8).

Figure 1 shows how reliance on carbohydrates as a source for calories diminishes with rising per capita incomes. As countries climb up the income ladder they replace these starchy staples with sugars, separated fats (cooking oil, butter and margarine) and increased consumption of animal proteins. An examination of the source of carbohydrates points

FIGURE 1. RELATION BETWEEN CALORIES DERIVED FROM FATS, CARBOHYDRATES AND PROTEINS AND PER CAPITA INCOME



a/ Such items as cooking oil, butter, margarine.

b/ Fats consumed as part of the carbohydrate consumption.

c/ Fats consumed as part of the animal protein intake (milk, meat).

* Source: J. Périssé, "Effect of Income on the Structure of Diet" FAO Nutritional Newsletter Vol. 7, No. 3, 1969, p. 4.

out the limited variety available. Table 1 shows the important role of roots and tubers in the West African diet. They account for nearly 50 percent of the daily calorie consumption.

At present, rice is the second or third most important source of calories in the Ivorian diet. A brief look at the evolution of the importance of rice can be seen in Table 2. The first Food Balance Sheet attempted in the Ivory Coast was compiled by the USDA in 1959-61. The per capita calorie intake does not reveal as much as the changing trends in eating habits. The high annual consumption of tubers and roots has been noted by many observers and conclusively documented by Household Budget surveys conducted at nearly the same time. What is obvious from this table and its projected ration for 1980 is that rice and maize will grow in importance at the expense of yams and manioc.

Regional Rice Consumption

As is often the case however, these "average" figures hide more than they reveal. In general terms the Ivory Coast can be divided into three major subsistence crop areas: the North, which exists on such cereals as millet, sorghum and corn; the East, which consumes mostly yams, manioc and plantain banana; and the West, whose major source of calories is provided by rice. Maps 2, 3, 4, and 5 show the major domestic food producing regions in the country. Map 6 is a composite outlining these general areas in which the different food crops are grown.

This suggests the first important division in rice consumption in the Ivory Coast. The Western region, as far as the Bandama River, depends on rice as a sustaining staple while the savannah-North and yam-eating Eastern areas historically have had little rice in their diets.

Urban Rice Consumption

The second important division in Ivorian "average" rice consumption is between urban and rural dwellers. As Table 3 suggests, population as a whole is growing by 2.8 percent per annum but urban population

TABLE 1. COMPARISON OF FOOD BUDGET SURVEY RESULTS: WEST AFRICA, OTHER TROPICAL, LOW-INCOME COUNTRIES, THE UNITED STATES*

	Pakistan	India	Mada-gascar	Maur-itius	Brazil	East Africa	West Africa	United States
Years	1960-63	1960-63	1962	1960-64	1960-62	1959-61	1959-61	1959-61
Total Calories	2090	2020	2220	2399	2780	2390	2460	3190
Total Protein (gm.)	47.7	51.5	48.2	49.2	66.3	65.2	51.8	95.3
Calories								
Cereals	1510	1346	1567	1335	1066	1592	839	664
Potatoes, Other Starchy Roots	9	26	340	28	362	296	1114	99
Sugar	149	188	77	396	425	103	37	501
Pulses	52	216	46	100	292	155	160	105
Vegetables	11	2	18	24	7	19	25	198
Fruits	45	27	36	11	120			
Meats	18	6	79	45	197	86	49	540
Eggs	2	1	1	7	13			
Fish	5	3	13	32	13			
Milk	156	108	13	96	93	57	15	431
Oil/Fats	134	93	26	283	189	81	221	654

* Emma B. Simmons,"Food Balance Sheet as a Parameter of Tropical Food Economies: The Case of Mauritius" (Cornell Univ., unpublished M.S. Thesis 1968).

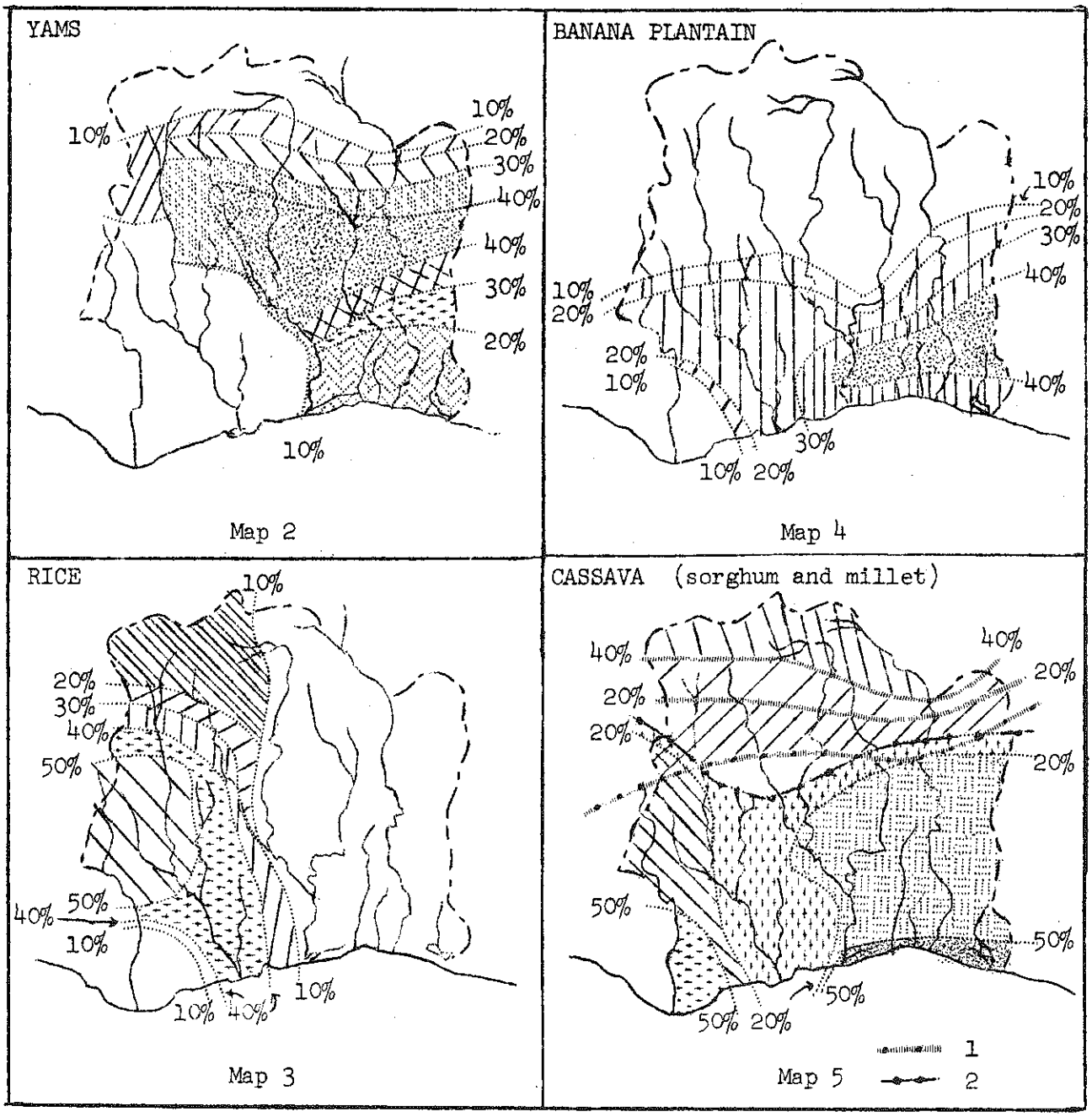
TABLE 2. ESTIMATED CONSUMPTION OF SELECTED STARCHY STAPLES IN THE IVORY COAST, 1959-61, 1965, and 1975

	Calories/Capita/Day		
	1959-61[a]	1965[b]	1975[b]
Cereals			
Rice	383	452	519
Millet and Sorghum	163	87	81
Maize	34	342	336
Sub-total	580	881	936
Starchy Roots and Bananas			
Yams	719	422	368
Cassava	471	342	300
Banana Plantain	336	216	200
Sub-total	1,526	980	868
Legumes			
Peanuts	64	50	53

a/ U.S.D.A. "Food Balances for 30 Countries in Africa and West Asia 1959-61", ERS-Foreign 119, 1965.

b/ Côte d'Ivoire, Ministère du Plan, "Plan Quinquennal de Developpement Economique, Social, et Culturel 1971-75" 1970, p. 144-145.

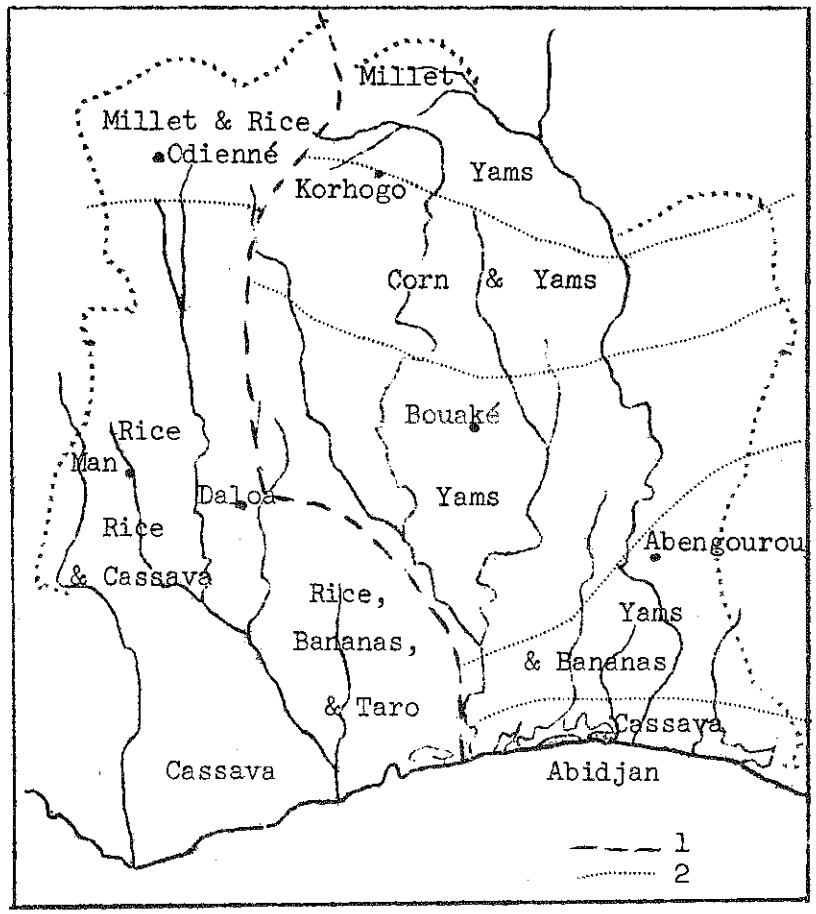
MAPS 2, 3, 4, and 5. RELATIVE IMPORTANCE OF SELECTED CROPS AS OCCUPIERS OF LAND IN FOOD CROPS (1956)*



1 Limit of sorghum.
2 Limit of cassava.

*Source: J. Miege "Les Culture Vivrieres en Afrique Occidentale," Les Cahiers d'Outre-Mer, Bordeaux(Jan.-March 1954), pp. 25-50.

MAP 6. IVORY COAST. STARCHY STAPLE AGRICULTURAL ZONES



1 Limit of rice region (to the West), and of yams (to the East).

2 Limit of sections.

TABLE 3. POPULATION
(in millions of persons)

	1965	1970	1975	1980
Urban Population	950	1.435	2.040	2.760
Rural Population	1.220	1.215	1.140	1.070
Savanna	1.220	1.215	1.140	1.070
Forest	2.130	2.450	2.820	3.230
Total Rural	3.350	3.665	3.960	4.300
TOTAL POPULATION	4.300	5.100	6.000	7.060
Urban Population	950	1.435	2.040	2.760
Abidjan	340	555	820	1.105
Other Centers	610	880	1.220	1.655
Rural Population	3.350	3.665	3.960	4.300
Residential population	3.050	3.220	3.390	3.630
Migrant population	300	445	570	670
European Population	35	40	45	50

(21, p. 79)

is mushrooming and doubles every ten years. According to urban surveys, rice consumption per capita in 1967 had reached the rate of 70 kilograms a year while among the rural people (excluding the Western rice area) consumption was only 10-15 kilograms per year (12, p. 10).

Historical Development of Rice in West Africa

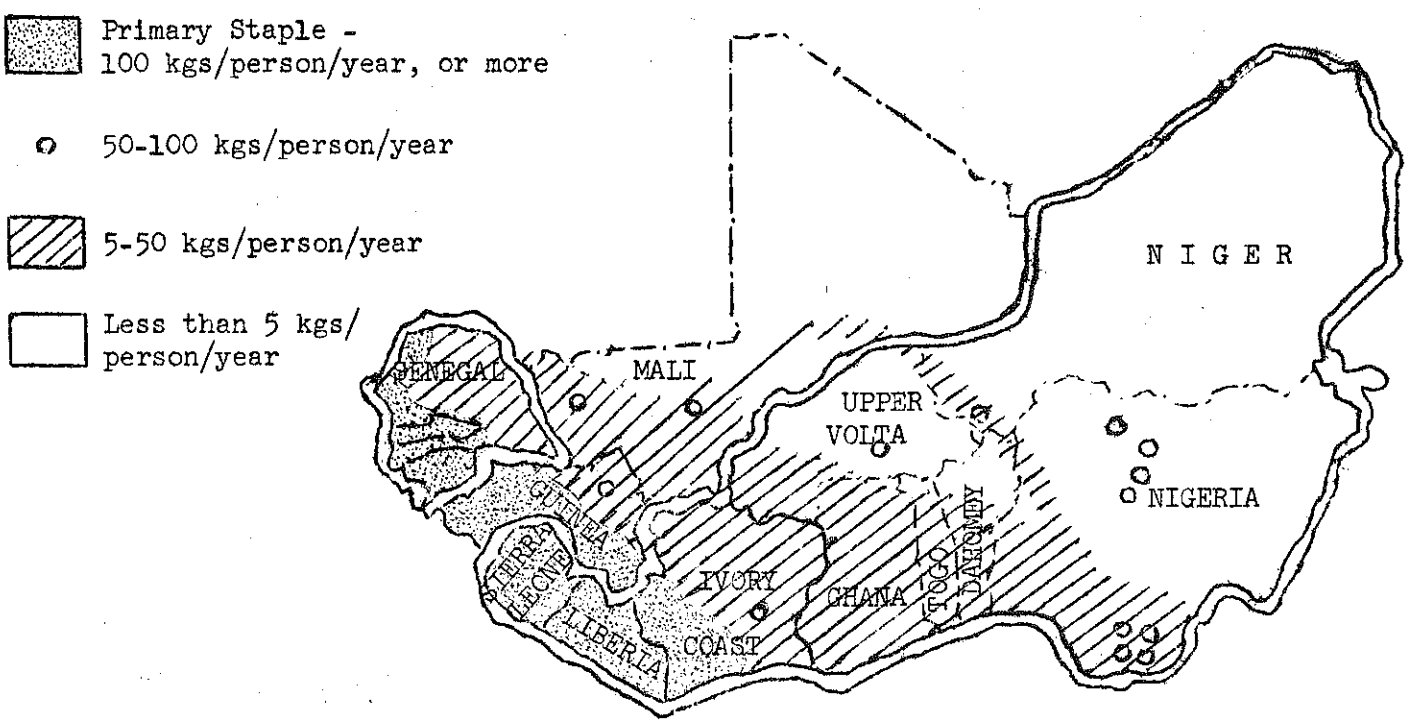
It is interesting to note that the rice growing area seems to halt abruptly halfway across the forest belt and is thereafter superceded by cultivation of yams and manioc. Ecologically, there is no reason for the change, but even as late as 1960 rice production had scarcely crossed the Bandama River. To the East, ranging all the way to Camerouns and across Zaire, the tubers were the cornerstone of the natives' diet.

Indigenous West African rice, Oryza glaberrima Steud., is a native variety differing only slightly from the Asian variety of Oryza sativa. The cradle of African rice culture is thought to have been in the Niger River bend. The yearly flooding of the river brought into development a type of swamp rice culture. Another point of origin, in the Senegal-Gambia River basin, followed much the same pattern. In addition, due to the high yearly rainfall an upland system was also used whereby the crop was planted and harvested much like any other cereal (34, p. 489). Historians have placed these developments some 3,500 years ago. Rice culture spread out from these two points and in 1350 it was reported by the Arab historian Ibn-Datouta that upland rice existed in Northern Nigeria (5, p. 13).

Map 7 shows the general rates of rice consumption throughout West Africa. Along the Guinea coast rice is the major source of calories while elsewhere, except for the urban centers it plays only a minor role.

With the arrival of the Portuguese in West Africa in the early 16th century, a great change in food habits occurred. The introduction of Asian rice from India and Madagascar, and the arrival of manioc and maize from the New World had a profound effect on local diets. But as can well be imagined, the higher yielding varieties of rice were only interesting to those tribes already cultivating the crop.

MAP 7. RICE CONSUMPTION IN WEST AFRICA*



RICE CONSUMPTION IN WEST AFRICA, 1968 - 11 COUNTRIES*

(kilograms)

Country	Milled Rice Per Capita	
Liberia	120 - 155	
Sierra Leone	100	
The Gambia	81	(165 in cities and producing areas)
Senegal	80	(160 in lower Senegal Valley and Dakar area; 80 in Casamance)
Ivory Coast	42	(100 in southwest; 70 in Abidjan area)
Ghana	9	
Togo	8 - 10	
Upper Volta	5 - 10	
Dahomey	3.2	
Nigeria	2.3 - 3.2	
Niger	3	(21 in Niamey and Niger Valley; less than 1 elsewhere)

*Source: U.S.D.A. Rice in West Africa 1968.

In the same way, manioc quickly entered the diet of the tuber-eating peoples of the East. Maize migrated slowly up to the North taking its place alongside the age-old crops of millet and sorghum (7, p. 60).

Types of Rice Grown

Perhaps one of the most important aspects of rice in a developing economy is its wide adaptability. In the Ivory Coast three major types of rice are grown:

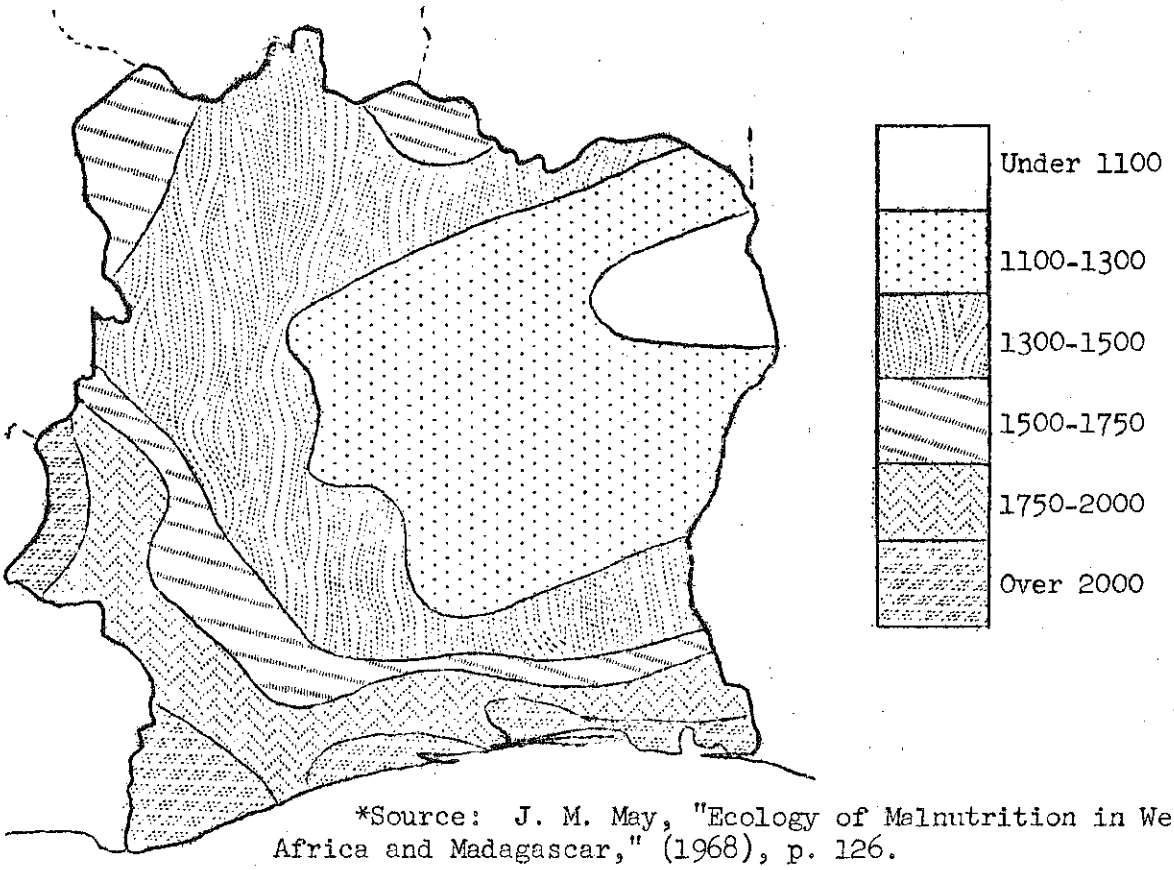
Rainfed Rice (also called mountain or upland rice) - the variety which is grown mainly in the mountainous Western region of the country. Using traditional methods, one crop a year is possible, which yields an average .5 tons per hectare. The crop is planted and receives the usual care (or lack thereof) of any traditional cereal crop.

Although mostly concentrated in the western region of the Ivory Coast (see Map 9), rainfed rice is also grown in the central area near Bouaké, where the sandy soils make irrigation impossible. In the North, following the isohyte indicating annual precipitation of more than 1000 millimeters (see Map 8), upland rice is also grown.

The government promoted rainfed rice method calls for the use of 200 kilograms of ammonium sulfate ($16) per hectare and a four year rotation system with cotton, yams and corn. In addition, the side dressing of fertilizer is urged. If these guidelines are followed yields may reach 1.2-1.5 tons per hectare. One obvious advantage of this system is that it requires no machinery and relatively inexpensive fertilizer. Also, fields can remain in almost continuous use as opposed to the previous 10-15 year fallow period which was required after rice was cultivated by the traditional slash and burn system.

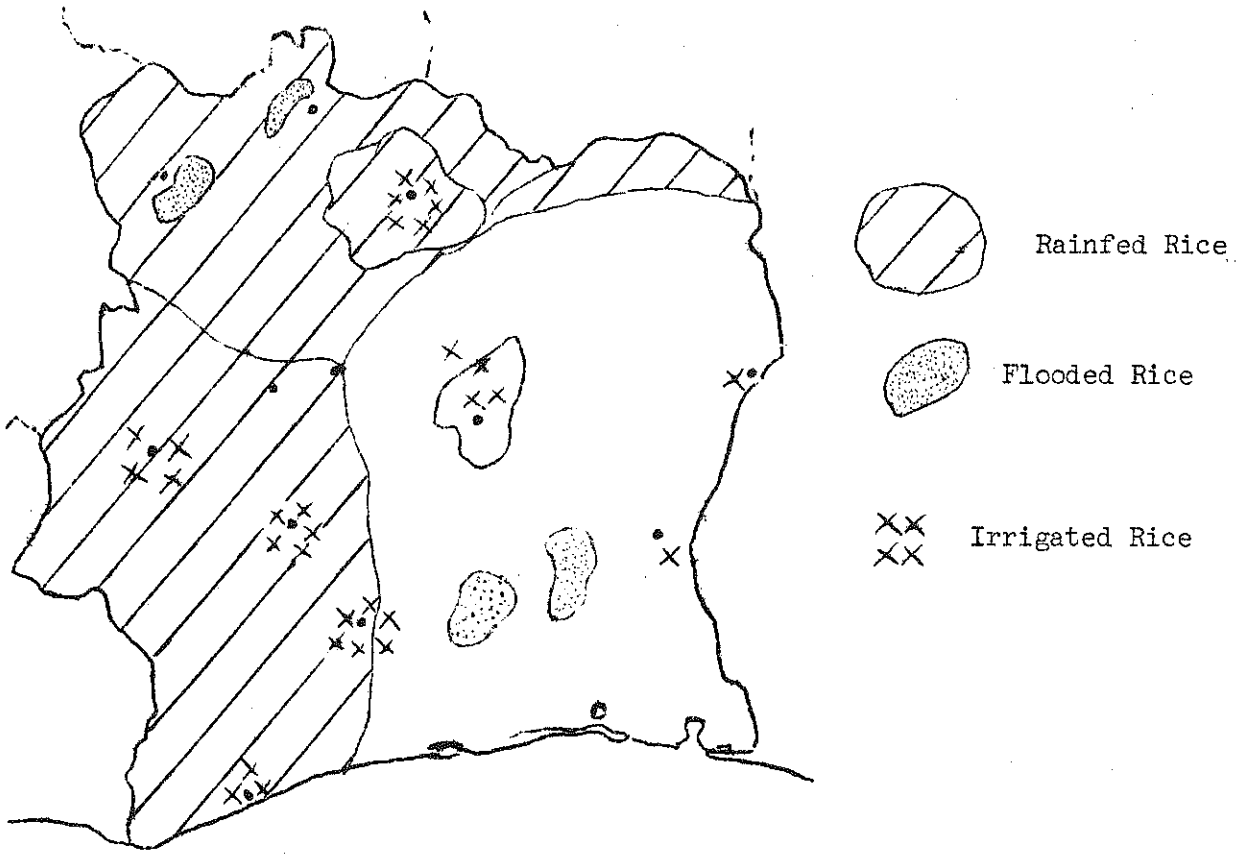
In the central region the suggested cycle begins with rice followed by yams, corn and two years of pasture before beginning with rice once again. This proposal has the added advantage of helping to develop domestic livestock farming. In the north, the cycle simply alternated rice with cotton. Rice cultivation destroys the life cycle of many different cotton parasites, while supplying a prized source of calories.

MAP 8. IVORY COAST, MEAN ANNUAL RAINFALL



*Source: J. M. May, "Ecology of Malnutrition in West Africa and Madagascar," (1968), p. 126.

MAP 9. IVORY COAST: GENERALIZED DISTRIBUTION OF PRINCIPAL RICE PRODUCTION SYSTEM



Flooded Rice - is a variety which grows partially submerged in water, the source of which is often the seasonal overflow of a river or stream It is common in the far North and North-west of the country on the flat savannah plains. As the people of these areas are particularly enterprising, large tracts have been turned over to mechanized agriculture (between 6-10,000 hectares). Yields have ranged widely but 2.0 tons is average per hectare (22, p. 7).

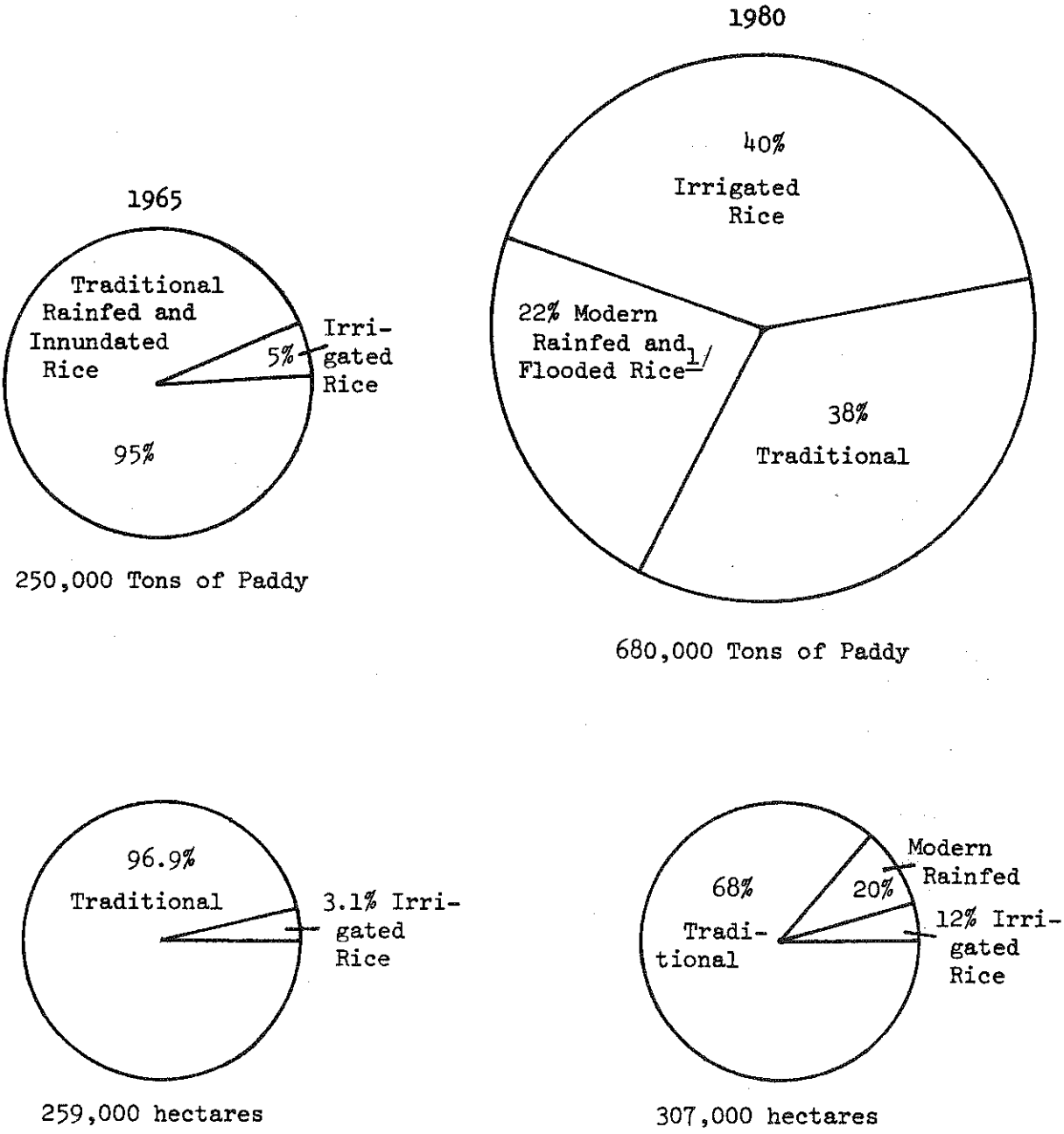
Statistical reports suggest that in West Africa as a whole: 66 percent of the rice is rainfed, 25 percent flooded, and only nine percent is irrigated (12, p. 7). In the Ivory Coast rainfed and flooded rice accounted for nearly 95 percent of domestic production in 1965. In 1980, as Figure 5 indicates, nearly 40 percent of domestic production is projected to be from irrigated fields.

Irrigated Rice - this is the most land and labor intensive method of growing rice. The essential difference between this and the innundated variety is that the cultivator has considerable control over the water supply The growing season (if enough water has been stored) can be lengthened to two and sometimes three crops a year. It is in this type of rice cultivation that the government has shown the most interest--and for very legitimate reasons. It is the method which is the least destructive to the ecology. It represents the highest calorie production per unit area and it offers the greatest potential for raising the incomes of a substantial number of peasant farmers.

The yields range from five tons/hectare on Taiwanese supervised plots, to 2-2.5 tons from the field of an average farmer. These are calculated per harvest. In all cases two and scmetimes even three can be had during a year with normal rainfall if good water storage facilities are available.

Rice then, as of 1965, was an important crop regionally in the Ivory Coast. Its consumption in the urban centers, which are mostly in the South, was also relatively high. At about that time the Government decided

FIGURE 1. IVORY COAST: PADDY PRODUCTION BY MAJOR AGRONOMIC SYSTEM, 1965 AND PROJECTED 1980*



*Source: Côte d'Ivoire, Ministre du Plan, Plan Quinquennal de Developpement Economique, Social et Culturel, 1971-75, p. 147.

1/ "Modern" means with the use of fertilizers.

to launch a rice improvement and increased production campaign. With the help of France, Germany and the United Nations, $550,000 was spent toward this goal in 1965 and that figure grew to $4 million in 1968. Plans from 1970 to 1980 call for outlays of $55 million more with nearly 80 percent of that allotted to the setting up of new irrigated rice schemes (12, p. 94; 21, p. 147). This figure compares favorably with the expected investments in coffee ($18 million) and cocoa ($48 million), two major export crops, over the next ten years (21, p. 161, 165).

Advantages of Rice Production

Rising Demand for Rice

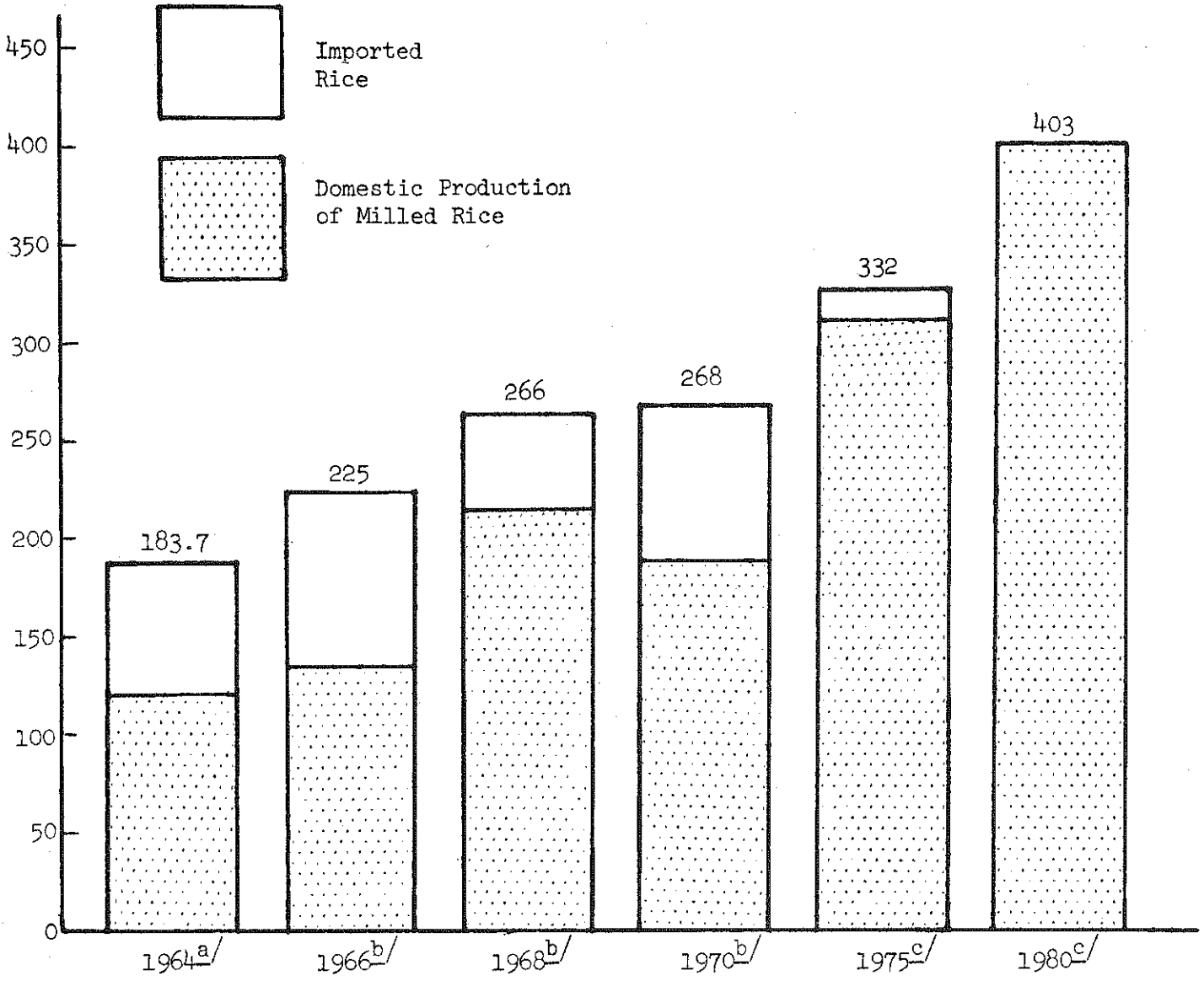
The notion basic to the encouragement of rice rroduction is its preferred position in the diet. Figure 2 shows that rice consumption in the Ivory Coast has been growing yearly by the extraordinary rate of almost ten percent. If one allows for a three percent increase due to population growth, there remains a gross seven percent yearly increase in consumption. This is a result of substituting rice for other starchy staples. This preferred position of rice in the diet as incomes increase and people move into the cities has frequently been documented. FAO's "Agricultural Commodities Projection for 1975 and 1985" anticipates for West, Central and East Africa an average yearly increase in rice consumption per capita of nearly 1.5 percent (14, p 114). The Ivory Coast is already far ahead of this projection and the other nations are following suit.

An idealized formula may be helpful in placing three of the four major components of predicting demand in proper order (28, p. 3).

$$d = p + gn$$

d = growth in food consumption
p = rate of growth of population
g = rate of growth of per capita income
n = elasticity of demand associated with changing incomes

FIGURE 2. MILLED RICE CONSUMPTION IN THE IVORY COAST, SELECTED YEARS 1964-1980
(thousand metric tons of milled rice)



NOTE: These figures do include rice for seeding and do not take into account wastage. A subtraction of 10% will give actual consumption.

a/ U.S.D.A., Rice in West Africa (1968).

b/ Côte d'Ivoire, Ministère de l'Agriculture, Rapport Annual 1970, p. 19.

c/ Côte d'Ivoire, Ministère du Plan, Plan Quinquennal de Developpement Economique, Social et Culturel, 1971-75, p. 149-50.

In this way, one can see that the Ivorian growth in consumption of rice (d=10%) is due in part to population growth (p=3%), to the growing per capita income (g=4%) and high elasticity for rice (n=.6). The remainder of the change is due to urban migration which places yam and cereal eaters in contact with rice for the first time.

Elasticity of Demand for Rice

A closer look at the various values for "n" in West Africa is enlightening. Table 4 from the FAO projections shows that rice and wheat are more desired by those with rising incomes than the coarse grains or tubers. This fact alone bodes well for any rice producing project.

The functions found that fit the empirical evidence for elasticities are very informative. As Figure 3 shows, in their pure form these functions imply certain types of demands for certain commodities. In a logarithmic function such as this, a constant ratio between percent of increase in per capita consumption and income is implied. This seems to be the case throughout West Africa for wheat, rice, and sugar. In the United States and France, countries with much higher incomes, those three commodities follow semi-log or log-inverse functions. The former implies a decline in the relative value of income elasticity proportional to the changes in quantity consumed. The latter indicates the same trend except that a situation point is attained and elasticity then drops to zero. A log-log inverse function reflects the long term evolution of per capita consumption of staple foods which reaches a maximum intake, followed by a decline. This seems to be just the case with the coarse grains and starchy roots throughout the world. In summary then, wheat, rice, and sugar have rising elasticities concordant with income while coarse grains and roots will rise to meet a particular demand but then drop off again.

Urban Consumption Surveys and Food Elasticities

Urban consumption surveys done in the yam-growing regions of West Africa indicate that as urban income improves, rice begins to supply a larger part of the carbohydrate intake of the people. In Nigeria, in Lagos,

TABLE 4. COEFFICIENTS OF INCOME ELASTICITY

	Per Capita GDP in 1965	Wheat		Rice		Coarse Grains		Starchy Roots		Sugar		Animal Proteins	
		Elast.	Function	E	F	E	F	E	F	E	F	E	F
	(in $U.S.)												
United States	$2,912.	-.2	LI	.2	SL	-.3	LI	-.1	LI	0		.05	LI
France	1,453.	-.3	LI	.2	SL	0		-.5	LI	.3	LI	.29	LI
Japan	662.	.3	SL	-.1	LI	-.5	LI	-.1	LI	.7	SL	.51	SL
Cuba	399.	.4	LLI	.2	LLI	.2	LLI	.2	LLI	-.1	LI	.49	SL
WEST AFRICA: Savannah Zone[a/]	145.	.8	LL	.6	LL	.2	LLI	.2	SL	1.5	LL	1.03	SL
South Zone[b/]	100.	.7	LL	.6	LL	.5	SL	.2	LLI	1.4	LL	1.44	SL
Kenya	81.	.8	LL	.7	LL	.4	LLI	.3	LLI	1.0	LL	.77	SL
Ceylon	134.	.4	LLI	.6	LLI	.3	LLI	.2	SL	1.0	SL	.87	SL
Thailand	102.	.3	LL	.2	LLI	0		.1	SL	1.0	LL	.79	SL

a/ Mali, Mauritania, Niger, Senegal, Upper Volta

b/ Dahomey, Ghana, Ivory Coast, Togo

LL - logarithmic $\log_e y = a + b \log_e x$

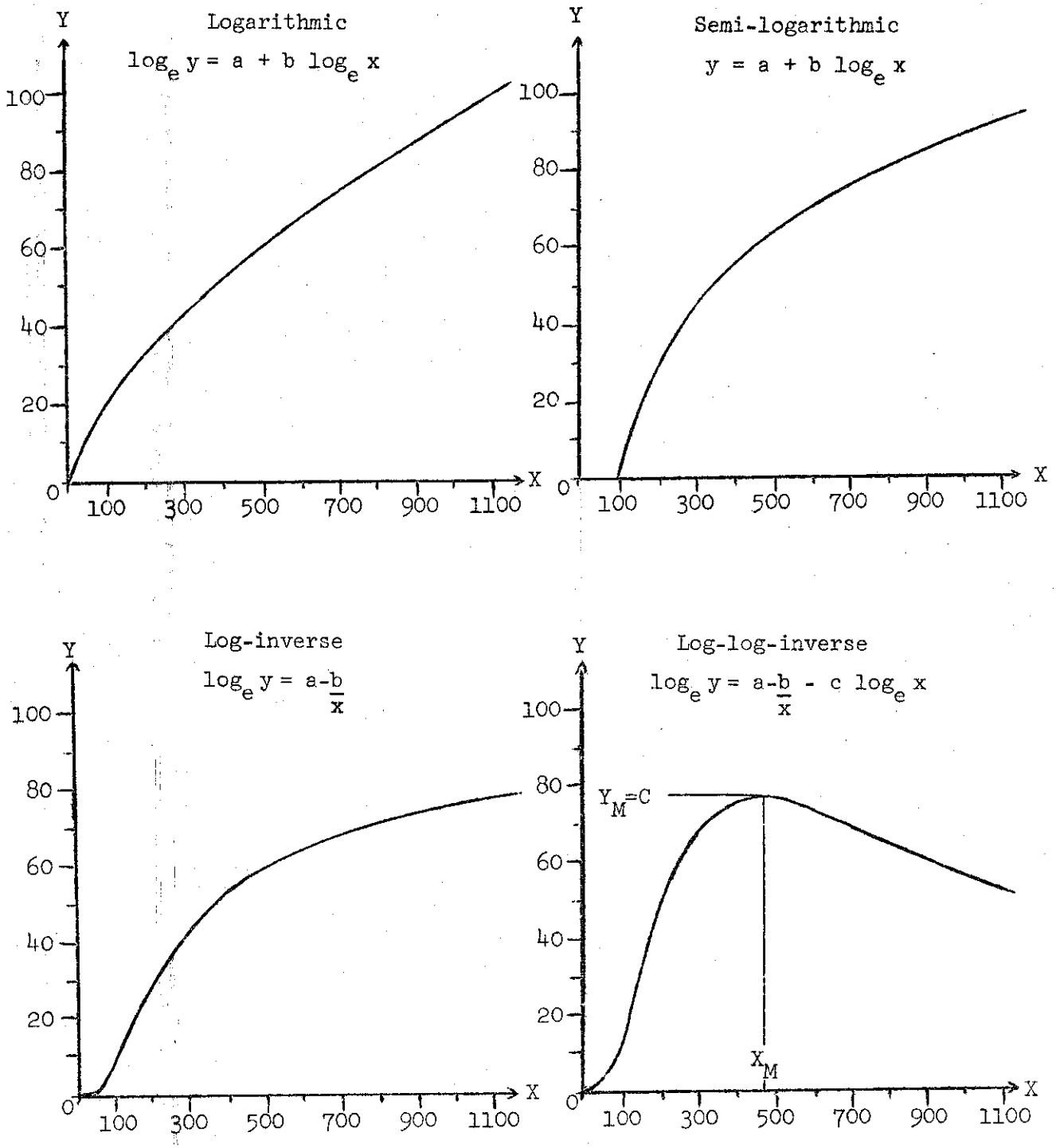
SL - semi logarithmic $y = a + b \log_e x$

LI - log-inverse $\log_e y = a - \frac{b}{x}$

LLI - log-log-inverse $\log_e y = a - \frac{b}{x} - c \log_e x$

*Source: FAO Agricultural Commodities Projections for 1975 and 1985, (1967), p. 27-33.

FIGURE 3. CURVES REPRESENTING THE FUNCTIONS USED IN THE DEMAND PROJECTIONS



y = per caput demand
x = per caput GDP or Private Consumption Expenditure

*Source: J. M. Due, "Agricultural Development in Ivory Coast and Ghana," Journal of Modern African Studies, Vol. 7, 4:637-60.

Zaria, and Kaduna, federal statistics indicate an increase in expenditures on rice in the range of 14-20 percent as people move from low income households (15-650 shillings per month) to middle income households (650-1,550 shillings per month) (38, p. 65, 66).

A study conducted by T. Poleman on three urban centers in Ghana, reveals that as incomes increase, the percent expenditure on starchy staples remains about the same (30 percent of total food expenditure). What is highly elastic, however, is the demand for particular sources of calories, be they in the form of fresh tubers, maize or rice. In Ghana rice was not a very highly preferred staple, but government estimates do project that per capita consumption will grow by nearly 120 percent between 1960 and 1975 (10.2 pounds per capita to 22.2 pounds per capita) (27, p. 58).

An important part of the growing demand for rice, is the high elasticity for food in general among low income countries. According to Engle's Law, as income increases, percent expenditure on food decreases. While this trend seems to hold true across all income levels, in the case of the low income nations, as per capita incomes begin to rise, the major part of the increased spending continues going into foods. In Accra, capital of Ghana, the food-income elasticity ratio was found to be .98, in Kumasi (the second largest city), it was .86. In some of the Middle Eastern countries it ranged between .6 and .9 (10, p. 49; 11, p. 146). What these figures suggest is that with continuing prosperity, the people in these countries will be spending more and more money on foodstuffs. Since an individual can normally consume only a certain number of calories, the increase will obviously be directed toward more preferred foods.

With this proven high elasticity for food and for rice in particular, it is safe to assume that in the Ivory Coast the demand will continue to grow for quite awhile and perhaps at rates faster than ten percent.

Figure 4 sums up this trend. It shows total and urban population growth and projections in relation to total domestic paddy production. As can be clearly seen, the slope of rice production is steeper than that of total population indicating a rising absolute per capita consumption. The steep rate of urban growth is undoubtedly pushing the demand for rice upward even more quickly than simple population growth or rising incomes. In the bar graph below the actual per capita consumption figures are shown. In the figures for 1969 and those projected for 1977, one can see the breakdown on the average figures into urban and rural consumption.

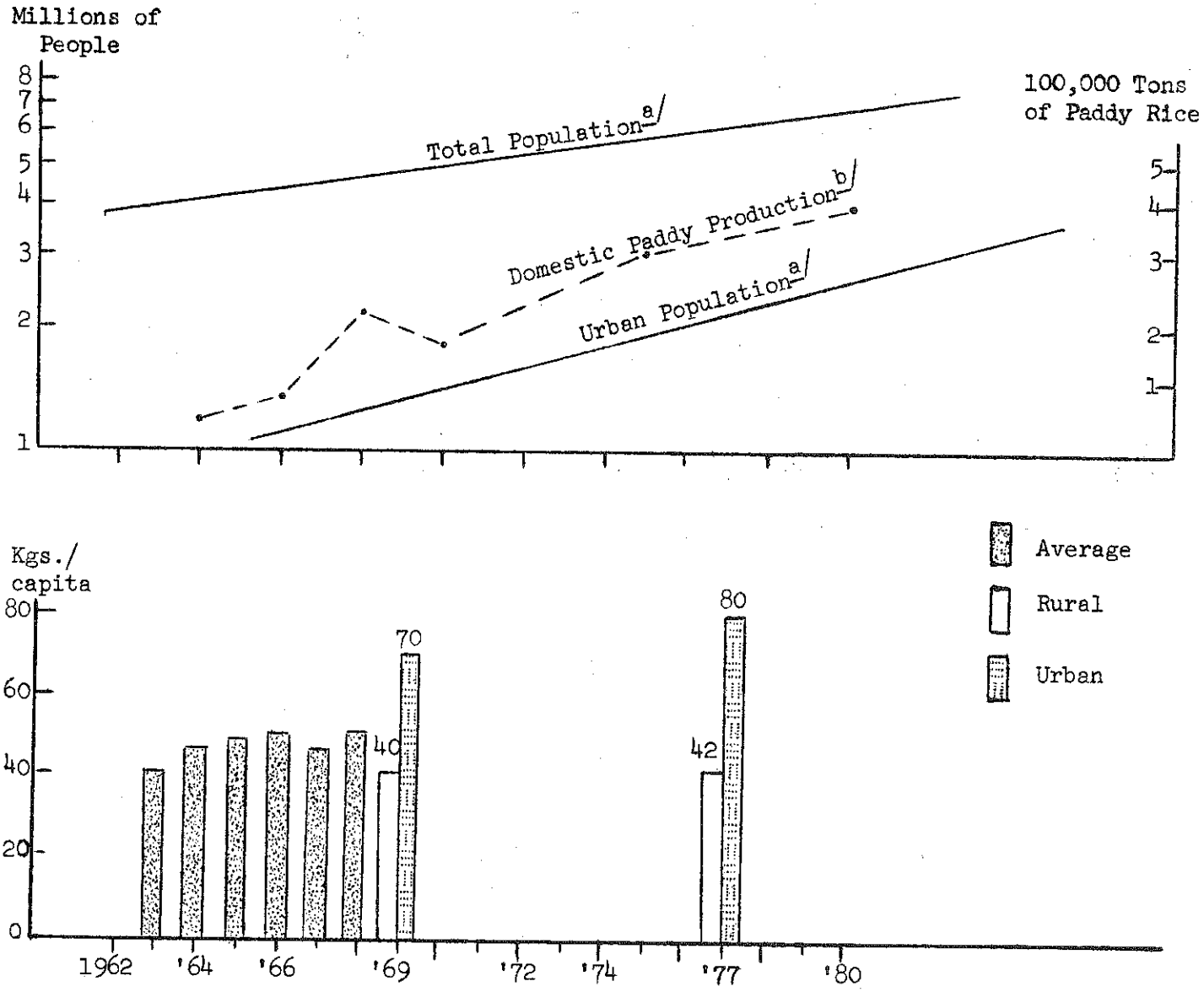
Import Substitution

Every signal then indicates a rapidly increasing demand for rice in the Ivory Coast. To meet this demand the Government has two choices--to increase imports or to increase domestic production. Since the former means the outflow of hard-earned foreign exchange which could be used for more employment or capital generating purposes, it has not been chosen. Throughout the 1960's Ivorian rice consumption has counted on between 10-35 percent of its total to be imported at a cost of almost $60 million between 1962-69. This figure is equivalent to almost the entire value of the 1969 coffee crop, which indicates its relative importance as a drain on foreign exchange (12, p. 19; 19, p. 82).

Perhaps it could be argued that the planters of the forest region could earn more money from export crops so it would be economically foolish to promote self-sufficiency at the expense of coffee, cocoa or timber production. Fortunately, as will be discussed later, rice culture would not necessarily be in competition with the major cash crops. It can be grown as far north as the Mali border, and in the forest intensive culture along unfarmed stream beds can economically vie with cocoa and coffee as cash crops.

Finally, and of great importance is the fact that Ivorian sources of foreign exchange are somewhat limited. Table 5 shows that well over 75 percent of Ivorian exports comes from coffee, cocoa and timber. The

FIGURE 4. IVORY COAST: POPULATION, PADDY PRODUCTION AND PER CAPITA RICE CONSUMPTION 1962 TO 1980*



*Source: a/ Côte d'Ivoire, Ministere du Plan, Plan Quinquennal de Developpement Economique, Social et Culturel, 1971-75.

b/ Figure 2.

c/ Developpement de la Riziculture en Côte d'Ivoire--1970-76, Document de SODERIZ.

TABLE 5. IVORY COAST EXPORTS--PERCENT COMPOSITION*

Commodity	1960	1967
Coffee	48	33
Cocoa	22	18
Timber and logs	16	27
Banana	4	4
Pineapple	2	3
Manganese	0	1
Other	8	14
TOTAL	100%	100%

*Source: J. M. Due, "Agricultural Development in Ivory Coast and Ghana," Journal of Modern African Studies, Vol. 7, 4:637-60.

precarious position of these commodities on the world market further stresses the need of the Ivory Coast to become self-sufficient in this basic starchy staple. If the government's estimate of 370 thousand tons of milled rice to be consumed in 1981 is correct, it is equivalent to 66 million dollars in 1967 prices, money which could almost entirely remain with the domestic economy if self-sufficiency is reached.

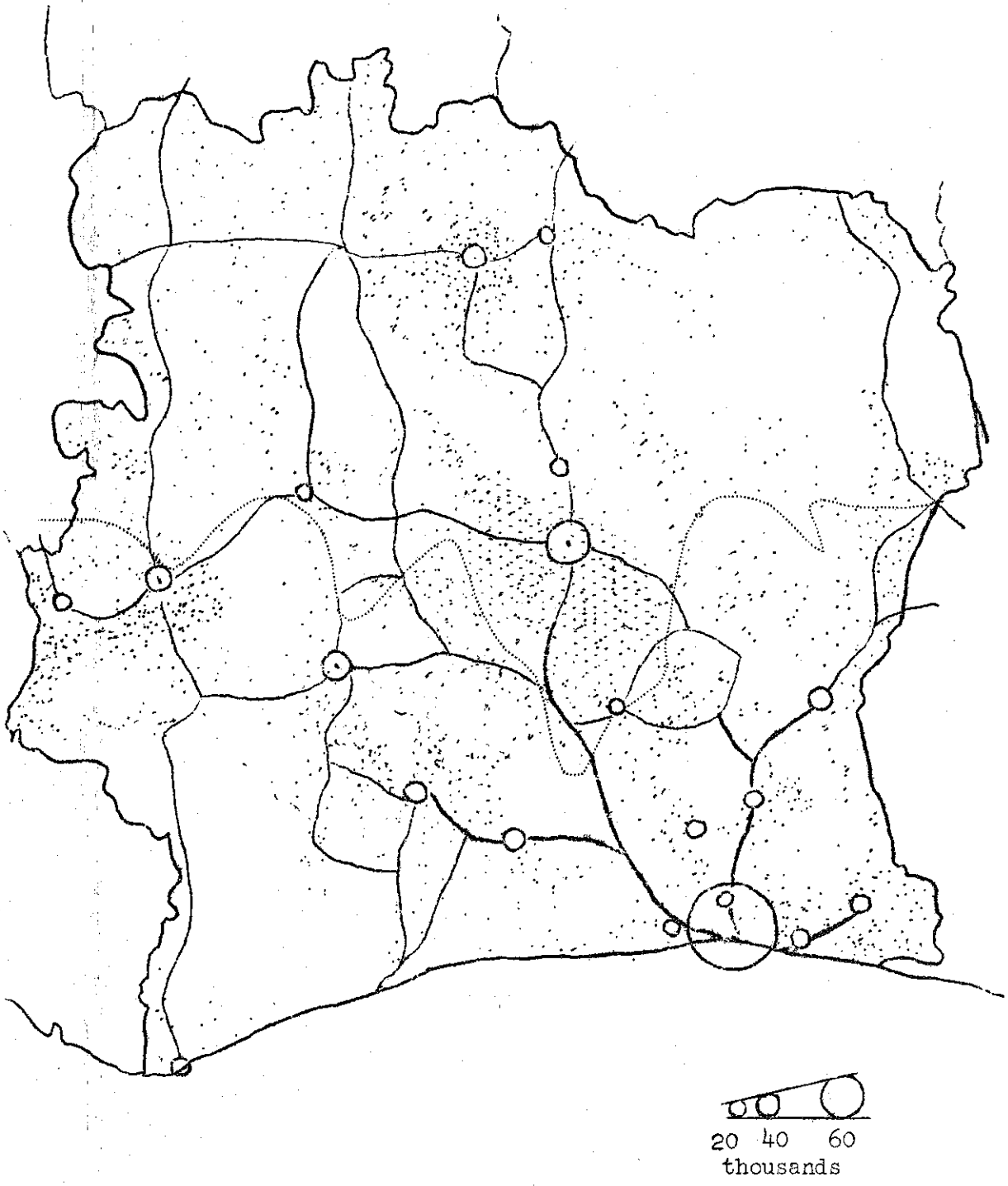
A Stable Alternative to Shifting Cultivation

Within recent years, as a result of the great adaptability of rice, its production has spread far from its original source in the mountainous western region (see Map 9). Also, with the use of fertilizers, crop rotation, and irrigation when possible, rice can easily be transferred from the traditional repertoire to the modern scheme of non-shifting agriculture. This last point is very important as population is growing at a rate of 2.8 percent per annum and there is great pressure to reduce fallow time in traditional slash-and-burn cropping cycles.

Population Pressures

Map 10 presents a rough picture of population distribution in Ivory Coast. The heavily populated regions in and around Korhog and Bouaké have been the scenes of experimental irrigated and rotated plots. Other areas that have participated in similar efforts surround Gagnoa, Daloa and Man. The East has seen little promotion of rice despite adequate soil and climate and dense population. With population pressures increasing, man either adopts new agricultural methods which give greater yields--as in the case of irrigated rice fields--or he retains the slash-and-burn method but reduces the fallow time. Historically, the second option has been only a temporary solution. Cutting short the fallow time wears out the soil and reduces yields further with each attempt. The first method is the only one which is really viable and must be the one chosen by the Ivory Coast and other developing nations.

MAP 10. POPULATION DISTRIBUTION IN THE IVORY COAST



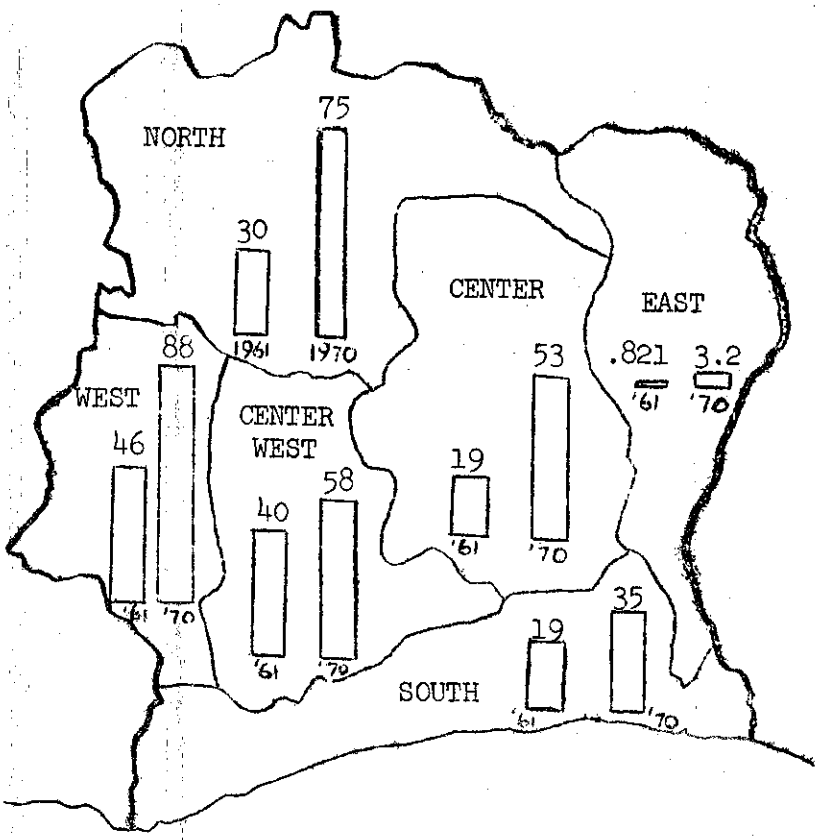
*Source: Côte d'Ivoire, Ministere du Plan, La Participation Populaire Au Developpement National.

A closer look at regional yields and areas under rice production shows the slow trend toward modernizing and intensifying rice farming in process. Map 11 indicates the rapid increase in paddy production between 1961 and 1970, the largest jumps occurring in the Western and Northern regions. Whereas total production has slightly more than doubled, the average yield per hectare has increased by less than ten percent. What has happened is that the land under rice cultivation has grown rapidly in response to the high prices received for the crop. Map 12 breaks down the nearly 290,000 recorded hectares of rice land in 1970, first by region, and then by agronomic system. As can easily be seen, only 23 percent of the land was in some way monitored by the Government; of that only five percent was irrigated.

Although these figures were compiled only five years after the Government program was begun, they pinpoint a major stumbling block to any hopes of reaching self-sufficiency by 1980. Extension work must be pushed to the limits if increased rice production is also to imply more modern use of the land and a stable, rather than slash-and-burn agriculture. If average yields remain about one ton per hectare through 1980, self-sufficiency will necessitate planting nearly twice as many hectares in 1980 as were planted in 1970. Considering that the demand for rice is growing at a rate of ten percent per annum, the Ivory Coast has no choice but to concentrate on methods of improving yields. In fact, (look back to Figure 5). it appears as though Ivorian agronomists are projecting that by 1980 irrigated fields will yield 3.5 tons per hectare each harvest and upland fields that have had some fertilizer will average 2.5 tons per hectare. Both these estimates represent a 100 percent improvement over the 1970 figures and are therefore highly optimistic. Perhaps with increased efforts, these goals can be partially realized, but this depends largely upon the interaction between extension workers and the farmers with whom they come in contact.

MAP 11. RICE PRODUCTION BY REGION, 1961 AND 1970

(thousand tons of paddy)

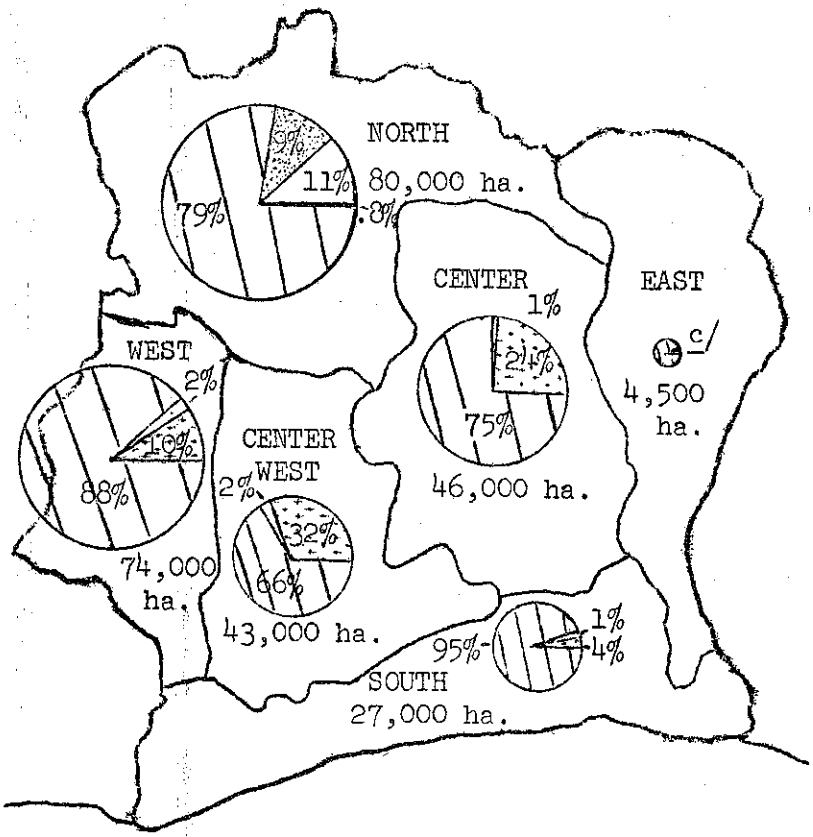


1961: 155,000 Tons

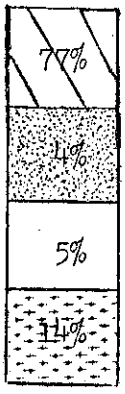
1970: 312,000 Tons

289,100 hectares

MAP 12. TYPES OF RICE CULTURE BY AREA



Totals



Area in traditional rice culture a/

Area in "improved" b/ flooded rice

Area in irrigated rice

Area in "improved" rainfed rice

a/ Not supervised by SATMACI. b/ Improved - fertilizer added.

c/ 90% rainfed, 10% irrigated.

Source: Riziculture en Côte d'Ivoire 1971 and 1976 Document de SODERIZ.

In a micro-study of a single village in the South, the economic possibilities of a small irrigated rice paddy were found to be very promising. Due to the development of coffee and cocoa in that region, people have been growing less and less rice. Diets are adequate from September to March, when the rice harvest is in and even if rice has not been cultivated it can be bought with the money obtained from the coffee and cocoa crops. During April, May and June, however, the people eat manioc as cash has been spent and rice stores are empty. An enterprising group of people with only 20 hectares of irrigated rice yielding 2.5 tons per hectare and getting two harvests a year could more than satisfy the local needs (35, p. 266). In fact, a moderately well managed rice field compares favorably with the typical coffee plantation in that area. Coffee sells at $360 per ton and paddy rice at $120 per ton in the village. The former averages one-third ton per hectare per year, while the latter often yields five tons per hectare per year. Rice is much more labor intensive than coffee but the value per hectare serves to offset the increased labor that is necessary. Government statistics suggest that a peasant growing irrigated rice can earn nearly 320Fr CFA a day during two harvests (nearly eight months), while the coffee planter can earn about 400Fr CFA per day once the trees have reached full maturity. Considering the fact that this may take four years and that coffee and cocoa lands are not available to newcomers, irrigated rice on the unused lowlands, bordering the forest streams, has a particular attraction for some of the local villagers and migrant laborers.

In the North, the most serious obstacle to irrigated rice is the potential lack of water. While experience has shown that three crops are difficult to obtain, well built dams can store enough water to insure at least two harvests. Due to an absence of other options many farmers in the North have been turning to rice as a profitable alternative to extensive slash-and-burn subsistence farming. One advantage in setting up projects in this area is that land clearing is fairly simple due to the lack of large trees.

Also, the development of rice projects in the North is very much in tune with the government's proposed objective for balanced regional growth throughout the country (21, p. 144). In addition to climatic conditions that are adequate for rainfed and irrigated rice, the North has the supply of labor necessary to man an intensive agricultural scheme. Even more important is the agricultural tradition among the tribes in the area. Unlike the extensive farmers of the forest region who historically have faced no population pressures, the savannah peoples have been forced to become more conscientious farmers as a result of a harsher, more populated, environment. With the advent of cash crops in the South the motivation to turn to labor intensive projects like rice farming has been slight.

Regional Development Plans

The plans for the next ten years call for an integrated regional approach for the increase of rice production. In the forest region nearly 7,300 hectares will be brought under irrigated rice cultivation. Approximately two-thirds of these will be in the Southeastern (Man, Daloa, and Gagnoa) area of the country. The Government realizes that it is in this region that a great demand for rice exists, and that irrigated rice has a much greater potential there than dry land rice farming.

In the North, the centers of Korhogo and Bouaké is expected to produce 2,500 hectares each of irrigated rice in shallow river beds. Flooded rice in Odienné and Gbon will be brought under more intensive, mechanized culture, as will the dry land variety around Mankono. Throughout the cotton-producing areas of Seguela, Boundiali, and Tengrela, rice will be planted in rotation with cotton.

This balanced overview of rice development is the most advantageous to adopt. It encourages regional development in the oft forgotten savannah areas. It takes into account the fact that the great demand for rice in the near future is in the South. And, most important, it introduces the modern concept of intensive agriculture into the areas of major population density.

Limited Infrastructure Demands

As was mentioned earlier, the Ivory Coast has projected an investment of nearly 55 million dollars during the 1970's for rice development. This large sum reflects more the country's unique position as an aid-rich nation than it does the implicit demands of rice production. With support from France, Germany, and the European Fund for Development, six major milling stations have been built and 13 sub-stations have been constructed for storing the newly harvested paddy rice.

However, a great advantage of rice development as a food crop is its lack of demand for storage facilities or processing plants. Unlike sugar cane, cotton or vegetable plantations, rice need only be dried down to about 11 percent moisture before it can be stored. As for processing, Table 6 indicates only small amounts of paddy rice found its way back to the Government milling stations to be cleaned and ground. If domestic production in 1969 was 260,000 tons of paddy, then the Government's slice of 11,200 tons marketed was equivalent to only four percent of the total.

Figures imply that nearly 75 percent of the rice crop was consumed by the farmers at home while the remaining 20 percent of the total was marketed by small private businessmen in the villages and administrative centers. This suggests the supportive role that the Government rice agency can and should play in local development. Certainly its work with extension workers, seed and fertilizer is indispensable in upgrading yields. Also its base price for rice ($80 per ton) serves to ensure the peasant a fair price for his crop even if local businessmen try to lower prices at the farm gate to lower than eight cents per kilo. What the Government should not do is become too deeply involved in processing and transporting rice, as the private sector seems to be more than willing to take on this responsibility.

TABLE 6. IVORY COAST, GOVERNMENT EXTENSION WORK WITH RICE, 1965-1970

	1965	1966	1967	1968	1969	1970
Extension						
Ext. workers	65	194	666	707	630	569
Assistants	17	12	49	100	100	110
Supervised Farm Area						
Rainfed and flooded rice (in ha.)		2,500	15,000	35,000	45,000	47,500
Irrigated rice (1 or 2 cycles)		800	2,000	6,600	8,500	12,000
Sub-total		3,300	17,000	41,600	53,500	59,500
Seed						
Distributed (in tons)	145	261	575	1,162	843	823
Fertilizer furnished (in tons)	398	521	689	1,033	1,413	1,500
Paddy rice marketed by SATMACI (in tons)	-	1,500	14,000	21,600	11,200	

Source: Cote d'Ivoire, Ministere d'Agriculture, "Dix Ans de Developpement Agricole 1960-69", p. 63.

Employment Generation

The heavy labor inputs that rice culture demands, is one of its greatest advantages in the context of rural stagnation. With Ivorian urban unemployment growing, as in the rest of Black Africa, a labor intensive agricultural scheme has several appealing points. It serves to reduce urban migration, it increases the size of the market for fledgling domestic industrial products and it helps to halt the drain on foreign exchange for imported foodstuffs.

Ivorian planners are well aware of these facts and as a result have been pushing irrigated rice projects throughout the Savannah. (Table 7 points out the surplus of available labor in the North as compared with the South.) Of key importance is the need to make rice production competitive with the other options open to the farmer.

Government statistics, reproduced in Table 8 show the relative place of rice in the hierarchy of crops. While it appears as one of the least remunerative, the alternatives are usually much worse, for example a day laborer on a southern plantation earns only 200 FcFR per day.

Return to Labor

This general hierarchy of returns to labor has three explanations. First, the official value of rice paddy ($80 per ton) is 20-30 percent below the unofficial prices that peasant farmers receive from small local businessmen (12, p. 89). Therefore the estimates offered in Table 8 for rice may be nearly 100 FcFR per day below what the farmer is actually earning.

The second and most important explanation is that rice culture demands heavy labor inputs compared to the market value of the product. Studies show that the necessary seed and fertilizer for one hectare of rainfed rice yielding 1.2 tons is $18 while in irrigated rice yielding 2.5 tons of paddy the cost is $22. In the former, capital inputs per metric tons total $15 while in the latter, capital outlays amount to only $9.60 per ton produced (12, p. 102).

TABLE 7. REGIONAL SURPLUSES AND DEFICITS IN LABOR SUPPLY, 1965-1980

(in thousands of workdays)

	1965		1970		1975		1980	
	Forest	Savannah	Forest	Savannah	Forest	Savannah	Forest	Savannah
Labor needed	156.8	76.1	187.1	86.1	213.2	103.0	238.9	121.2
Labor available by resident rural population	145.2	93.9	157.2	95.4	174.5	90.6	198.3	85.4
Deficit	11.6		29.9		38.7	12.4	40.6	35.8
Surplus		17.8		9.3				

TABLE 8. IVORY COAST: ESTIMATED RETURNS TO LABOR FOR 12 MAJOR MONEY CROPS 1970.

CULTURES		Revenue F/day
1. Rice - irrigated at 1 cycle	4 t/ha	290
- irrigated at 2 cycles	8 t/ha	320
- irrigated at 2 cycles	10 t/ha	400
- improved rainfed	2 t/ha	300
2. Corn - hand labor cycle	1 t/ha	90
- improved hand labor cycle	2 t/ha	235
3. Coffee - traditional cycle at	350 kg/ha	475
- selected varieties at	700 kg/ha	640
- intensive cycle of selected varieties at	1.500 kg/ha	560
4. Cocoa - traditional cycle		525
- cycle in regeneration at	700 kg/ha	730
- selected varieties at	1.600 kg/ha	815
5. Oil Palm village plantations at	12 tons/ha	665
6. Coconut - selected village plantations at	2,7 tons/ha	870
- hybrid at	3,2 tons/ha	930
7. Rubber - village plantations	1.500 kg/ha	1.500
8. Pineapple for canning at	65 tons/ha	530
9. Bananas for export at	33 tons/ha	735
10. Allen Cotton at	1,1 tons/ha	215
11. Tobacco - without fertilizer	1 ton/ha	215
- with fertilizer	1,5 ton/ha	250
12. Cashew at	1 ton/ha	220

*Source: Côte d'Ivoire Ministère du Plan, Plan Quinquennal de Devèloppement Economique, Social et Culturel 1971-75, p. 216.

It is obviously the heavy labor inputs which, while serving a purpose in reducing unemployment, make the crop only marginally profitable. Table 9 compares inputs under several different rice cultures and it is clear that several bottlenecks exist. In both improved upland and irrigated rice fields the work of preparatory tillage, weeding and harvesting serve to limit the amount of land a family can bring under cultivation in a particular season.

The introduction of kerosene-powered and pedaled milling machines have greatly decreased the labor inputs in the post-harvest handling of the grain crop. By the same token, the use of animal traction, herbicides and mechanical threshers could serve in reducing labor inputs per ton of paddy produced. Also, rather than bring unemployment in their wake, modernizing rice farming along these "inexpensive" lines might increase substantially the family income of peasant farmers.

Parity of Upland Rice

In addition to highlighting the major labor expenditures in rice production, Tables 8 and 9 suggest that upland and irrigated rice are equally productive in terms of man-days worked. At estimates of 1.2 tons per hectare of rainfed rice and 2.5 tons per hectare of irrigated rice, or at high estimates of 2.5 tons and 4 tons per hectare the revenue per man-day remains equivalent. This is highly significant as it indicates that improved upland rice can remain competitive with irrigated rice under moderate to high yields. Thus the Ivorian "Green Revolution" in rice culture need not only favor the few who live on good bottom land that can be easily irrigated.

Another reason why rice rates relatively low as a money producing crop is that is is competing with coffee, cocoa, coconut and rubber. These export crops, although subject to wavering prices on the world market in recent years, still fetch high prices compared to rice. As a result, the Ivorian economy is booming, and the forest planters are experiencing relative prosperity.

TABLE 9: LABOR INPUTS PER HECTARE; DIFFERENT TECHNOLOGIES
(days)

	Traditional Upland	Improved Upland	Mechanized Upland	Irrigated
Preparatory tillage	0	20	0	60
Sowing	10	15	0	-
Nursery preparation	-	-	-	11
Transplanting	-	-	-	25
Weeding	0	36	36	35
Water control	-	-	-	10
Plant protection*	0	3	3	6
Repair of dikes, etc.	0	0	0	18
Harvest	30	20	20	30
	40	94	59	195

* Does not include measures taken against rodents and birds (Quelea quelea).

*Source: U.S.D.A., Rice in West Africa, (1968), p. 107.

Nutritional Implications

A final question to be dealt with is that of nutrition. While rice certainly has many economic and social advantages, its overall nutritional contribution is open to question. As Table 10 indicates, in order for the reference Ivorian to obtain 70 percent of his daily calorie requirement from rice, he must eat a 430 gram portion that only contains 32.6 grams of protein. In the savannah areas, the people usually eat cereals other than rice, and in an equivalent portion (430 grams) they get as much as 43 grams of protein. In the tuber eating areas in the East, people need approximately 1,400 grams of yams or 1,000 grams of manioc to supply the necessary 1,500 calories (70 percent of the daily intake). These two staples would supply only 33.6 grams and 12 grams of protein respectively. Fortunately these two tubers have proteins made up of almost all the essential amino acids while rice and the other cereals are lacking lycine.

In short, by trying to develop rice as the main staple, as is the case in nearby Liberia or throughout the monsoon area of Asia, protein intake may actually be reduced. In Ivory Coast, if that which has traditionally been eaten in the North and East is exchanged for rice alone, a corresponding protein deficiency will result. While there is no reason to believe the Ivory Coast will become a completely rice-eating,nation, development planners should be made aware of these facts and more government interest turned toward vegetable, above all legumes, production to offset this impending deficit.

Conclusion

It is hoped that this paper, by examining rice in the Ivory Coast from the point of view of several disciplines, has highlighted some of the true advantages of this crop. It appears to be a highly preferred starchy staple which is in growing demand due to rising incomes and the rapid migration of the rural population into the cities. As a high yielder of calories per unit area, the crop has an important role near the burgeoning urban centers around the country.

TABLE 10. IVORY COAST, STARCHY STAPLE CONSUMPTION NECESSARY TO SUPPLY 1500 CALORIES A DAY*

Commodity	Weight of Edible Portion (grams)	Percent of Fat	Grams of Protein
Cereals			
Wheat, corn, sorghum, millet	430	1-2	43
Rice	430	1-2	32
Roots & Tubers			
Manioc	1,030	.3	12
Yams	1,430	.2	33.6
Sweet Potato	1,290	.4	16

* 1500 Calories is approximately 70% of the calories needed by the reference Ivorian according to FAO standards.

*Source: FAO, Food Composition Tables for International Use (1953).

Its wide adaptability allows rice to be grown under several different regimes, making its development useful to the entire country. Its heavy labor inputs insure increased gainful employment in the years to come, while the immediate introduction of good management, irrigation systems, good seed, animal traction and fertilizer can bring about striking yield increases.

Within the realm of development, however, the most outstanding advantages of rice are its responsiveness to capital and labor inputs while at the same time being able to flourish under completely traditional management practices.

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