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RICE IN WEST AFRICA

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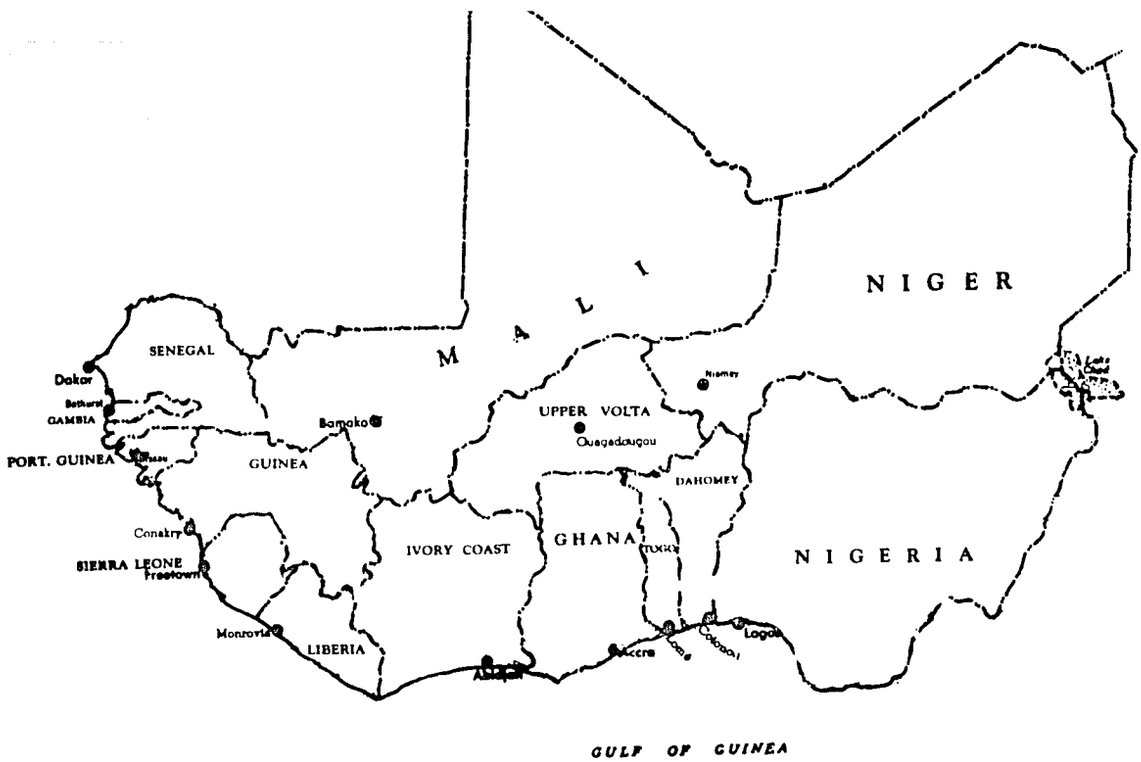
WEST AFRICA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Section Two: COUNTRY REPORTS

A NOTE ON TERMINOLOGY AND UNITS

Most numbers that are considered useful for comparative purposes are presented in metric units and in U. S. dollars.

In this report, one U. S. dollar equals:

250 CFA francs (Dahomey, Ivory Coast, Niger, Senegal, Togo, and Upper Volta),

1 Cedi (Ghana),

1 Dollar (Liberia),

0.42 Gambia Pound (1 pound = $2.40) (The Gambia)

0.30 Nigerian Pound (1 pound = $2.80) (Nigeria)

0.83 Leones (1 Leone = $1.20) (Sierra Leone)

Paddy is what Americans call "rough rice". Upland refers to rain-fed culture; swamp, to culture where rice stands in water during much of its life and the farmer has little or no control over the water level; irrigated to situations where the farmer has water control.

Section One: REGIONAL REPORT

RICE IN WEST AFRICA

INTRODUCTION

This report presents the findings and conclusions of a fact-finding and diagnostic study of the rice economy of 11 West African countries --- Dahomey, The Gambia, Ghana, Ivory Coast, Liberia, Nigeria, Niger, Senegal, Sierra Leone, Togo, and Upper Volta. The study was conducted during August and September 1968, under a grant by the United States Agency for International Development (A.I.D.).

The Team had eight economists and agronomists from the United States Department of Agriculture (U.S.D.A.) under the leadership of an A.I.D. specialist in African agriculture. Acknowledgment is hereby given to the information and logistical assistance received from host government officials, farmers, representatives of international assistance organizations, and United States Missions located in the 11 countries.

The purpose of the study was to gather more comprehensive and up-to-date information than was previously available on the nature of obstacles inhibiting increased rice production and marketing in West Africa. Despite apparently favorable ecological conditions for indigenous production of rice, the region has been importing rice in increasing volume to meet growing consumption demands. Many studies have been made of one or another aspect of the rice situation in West Africa. The Team took advantage of these resources to check its own conclusions and to incorporate many of the previous findings into this report. Of the countries investigated, Liberia and Nigeria received less coverage than the other nine. Liberia had been studied in depth by an A.I.D./U.S.D.A. team in early 1968. Nigeria which was disrupted by civil war, had a great deal of documentation on its rice situation.

The results of this study will provide guidance to the United States and other governments and to international development organizations interested in the establishment of a regional rice production and marketing project for West Africa. Section one of this report first presents an overview of the main problems and the related opportunities offered for regional solutions. The detailed findings follow. Then come suggestions, first, on specific objectives for coordinated regional approaches and, second, on specific actions that can be taken unilaterally by countries before a regional program becomes effective or even without assistance from a regional program. Section two contains reports for each of the 11 countries. An appendix to section one offers a very rough approximation of the cost of producing rice in certain of the countries.

SUMMARY OF CONCLUSIONS

1. The Team found ample areas well suited to rice production and identified situations where techniques could be substantially improved with consequent increases in yields.

2. At present production and marketing costs, West African rice is not competitive on the world market and cannot compete with imported rice in most of West Africa. However, the adoption of better techniques both in production and marketing could change this situation and might give West Africa a comparative advantage in the market place at least for its own needs.

3. Consumption is growing rapidly, particularly in cities. Part of this increase is met through rice imports.

4. These circumstances justify a modest effort to improve the efficiency of the West African rice industry to enable local production to compete in price and product acceptability with imported rice. Such an effort should be tailored to fit the problem and must recognize the relative priorities of rice development and of other agricultural opportunities in each country. The justification for an effort on rice lies in the sizeable foreign exchange being expended for imports plus the evident opportunities to apply proven technology which would represent substantial advances over technology now used.

5. While primary effort on rice needs to be applied through national programs, many actions are amenable to regional approaches as follows:

   - Research on the techniques and economics of production and marketing; on varieties, fertilizers, soils, pests and diseases, tools, and labor efficiency; on the facilities for drying, storage and processing.

   - Technical Advisory Services to disseminate the findings from research; to advise on extension, price policies, milling, storage, marketing, and other factors which have been researched adequately for initial application.

   - Training of country scientists, extension specialists, and personnel concerned with policy and administration.

   - Seed Multiplication of a small number of proven varieties to make available breeder and foundation seed stocks for country multiplication and distribution to farmers. Fruitful steps could be taken immediately to provide farmers with pure seed of certain presently available varieties.

6. A regional rice center should be established to coordinate research, training, and advisory services that will benefit countries desiring to utilize the results in national rice programs.

7. Obviously, the fundamental stimulus for increasing rice production must be the provision of an overall incentive to individual farmers that will bring forth the production volumes required by each country. In a number of countries, particularly Ivory Coast and Nigeria, such incentives are present and significant quantities of rice are produced for market.

REGIONAL FINDINGS

Background

West African countries recently have been spending about $50 million a year to import rice. Demand has outstripped supply under existing production and market conditions. Upper-income consumers, largely in cities and towns, have accounted for most of the increase in consumption by replacing other, cheaper staple foods with rice. The $50 million of foreign exchange allocated to fill this new demand may serve to brake overall economic development.

This does not necessarily mean in every case that rice imports are unsound economically. It has been suggested that the importation of rice frees farmers to grow more profitable crops; also, that the stimulation of high-cost local rice production might succeed at the price of interfering with the expansion of crops with higher economic returns.

The 11 countries studied represent a variety of rice situations. In some, rice is the major staple; in others, it has minor importance. Varying degrees of national self-sufficiency in rice are represented but all have imported some rice during the last five years.

Their combined land area is equal to approximately one-third the continental United States, and the combined population is about 85 million, of which about 50 million are in Nigeria. Total rice production amounts to about 1.5 million metric tons of paddy (called "rough rice" in the U.S.) on about 1.3 million hectares. Nigeria and Sierra Leone are the largest producers, accounting for one-half of the total. Senegal imports two-thirds of its rice supplies and accounts for one-half of all the imports into the 11 countries.

Several countries have rice programs under way with varying degrees of effectiveness. All countries have received assistance from one or more foreign donors. These efforts, however, generally have been piecemeal and have not solved the rice problem for any country.

Our findings confirm earlier suggestions that some obstacles to increased rice production can be dealt with most efficiently and expeditiously through coordinated regional approaches. None of the countries individually has the capability to mobilize the research, training, and specialized expertise necessary to address all of the critical factors.

The Team has attempted to look at the regional rice economy as a whole and to treat it as a system. In general, we focused on the possibilities of increasing rice production at reasonable cost, adapted to the conditions peculiar to each country.

Note should be made of the paucity of information on many key factors of rice economics. This deficiency was especially evident for production volume and costs. Therefore, many of our findings are inferences based upon first hand observations and talking with knowledgeable people. Yet this deficiency, in our opinion, does not detract from the validity of our main conclusions and, in fact, emphasizes the need for definitive research under a regional project.

Production

Trends

Local production has not kept up with the new demand for rice, but it has managed to meet much of the demand. For the most part, this has been done by expanding acreages using traditional techniques. For example, most of the expansion in Ivory Coast production, which has increased an average of 7.5 percent annually for 15 years, was achieved in this way. Although land is not scarce, the production of rice for sale has demanded more labor and a marketing system that did not exist previously.

More or less traditional cultures have responded relatively satisfactorily to meet the increasing demands for rice in Nigeria, Sierra Leone, and, to a lesser extent, in Ivory Coast. By contrast, most of the new demand in Senegal, Ghana, and Liberia has been met by imports.

Reasons for the failure of local production to respond are not always clear. In Ghana, producers in the north sell parboiled, hand-milled rice, while the consuming cities of the coast demand unparboiled, white rice. In Liberia, the cities prefer parboiled rice, but the up-country product is hand-milled and not parboiled. Moreover, roads are scarce and transport is expensive.

The failure of Senegalese production, particularly in the Casamance, to meet urban demands is harder to explain. Farmers apparently have found it more lucrative to grow peanuts just as many farmers in Liberia and Sierra Leone have found non-agricultural alternative employment preferable to rice-growing.

TABLE I

PADDY RICE PRODUCTION IN WEST AFRICA - 11 COUNTRIES

	1962/63	1963/64	1964/65	1965/66	1966/67	1967/68 (Est.)
	(Thousand Metric Tons)					
Sierra Leone	330	330	310	400	390	400
Nigeria	330	400	350	350	400	385
Ivory Coast	219	250	250	250	274	300
Liberia	180	180	184	180	150	152
Senegal	106	110	110	122	110	137
Ghana	33	43	41	29	42.5	43
The Gambia	31	37	37	35	33	36
Upper Volta	25	34	36	34	35	35
Togo	23	28	17	20	23	25
Niger	10	12	12	12	19	27
Dahomey	1	1	1	1.5	1.5	1.5
Total	1288	1425	1348	1434	1481	1542

(Source: U.S.D.A./E.R.S., U.S.A.I.D.'s; some adjustments by Study Team)

Not all increases in production are the result of farming more land using traditional methods. Sierra Leone and Nigeria have made progress in increasing yields from upland and swamp rice-growing. At present, Ivory Coast is engaged in diffusing a promising formula for improved upland culture. Indications are that these methods substantially improve the efficiency of rice-growing. While the improved upland system in Ivory Coast does not reduce the amount of labor needed to grow a ton of rice, it makes it possible to use cleared land longer and thus increase the efficiency of investments in land development.

Methods

Production within the region has not expanded enough to meet the increased demand of the past two decades, even though constantly rising world rice prices (up to early 1968) should have made rice-growing more lucrative. In part, this is because in many localities rice is produced almost exclusively for family consumption.

Existing production takes a number of forms. The dominant method, which accounts for at least two-thirds of the 11-country production, is upland culture. It is practiced in areas where rainfall is heavy and regular for at least five months. Practices involve land clearing, direct seeding and little weeding; then turning the land over to other crops; and finally abandoning it for long periods as natural fertility declines. A more extensive description of this form of culture may be found under production techniques in Ivory Coast and Sierra Leone country reports.

In areas of lesser rainfall, traditional rice-growing can be practiced only in poorly drained bottom lands, and then only in flooded areas, as rainfall becomes insufficient to grow upland rice. Farmers growing rice in these areas may have good knowledge of local conditions, but they have little or no control over the water level and are at the mercy of the unpredictable rainfall which may submerge crops during part of the growing season.

The cultural situations just described are referred to as swamp rice whether the plant is grown along a river bank or in a sink that fills periodically with water. Particular situations are described in the reports on Sierra Leone, Upper Volta, and Niger. Probably, about one-fourth of the production of the region comes from swamp culture.

The area of modern irrigated rice production is small. It is confined almost entirely to the Taiwanese demonstration farms that have been established in most of the countries. In nearby Mali, the French developed a sizeable area under controlled irrigation to produce rice for export to Senegal. The French also established a large irrigated project in northern Senegal. Neither project appears to be economically successful.

The interest in irrigated rice in West Africa today stems largely from the Taiwanese demonstrations. Since 1961, Taiwanese technicians have been demonstrating how to grow irrigated rice using the transplanting and other techniques developed in land short Asia. In 1968, the government of the Republic of China had over 300 technicians in nine of the 11 countries studied. They are moving into extension phases in some countries.

The Taiwanese have stressed yields per unit of land in a region where land is not scarce. It is alleged that the heavy input of labor required to grow rice by the irrigated, transplant method has caused West Africans to reject this system. It is true that production with controlled irrigation accounts for only a minor share of the total production, that few African farmers have adopted the technology, and that they continue to need technical assistance in the irrigated system. However, findings indicate that some African farmers are learning irrigated techniques quickly, and that the recurring costs for growing irrigated rice are probably lower than for other methods commonly used. Even in irrigated rice, labor is the principal input. More labor is used per unit of land under irrigation than under traditional systems, but no more labor is involved per ton of rice. (See comparison of techniques in Ivory Coast report.)

While irrigated methods are competitive on the basis of recurrent costs, preparation of land for irrigation does involve considerable capital cost. In Ivory Coast, these costs were low enough to be written off against the increased production generated in ten years. In some areas, however, the capital costs are probably so high as to render the operation uneconomic. Designation of land for irrigated culture should be highly selective and subject to thorough feasibility analysis.

Another innovation is mechanization of upland and swamp cultures. Application of power-driven machines to various operations is being tried or practiced in Sierra Leone, Liberia (LAC - Uniroyal), Senegal (S.A.E.D.), and Ivory Coast (MOTORAGRI). In general, these schemes to date have been either unprofitable or more costly than alternative technologies.

Varieties

Many varieties of rice have been introduced into West Africa and tested for commercial production. Field observations lead to the conclusion that varieties are badly mixed and little rice that can be classified as pure is being commercially grown. Mixed varieties have created production, milling, and marketing problems:

- Mixed varieties of uneven maturity date result in uneven ripening. Some over-ripe grains shatter before harvest or suncheck, and the result is milled rice of low quality. Other grains are immature and result in low yields per acre and a low milling outturn of chalky rice.

- Milling of mixed varieties is inefficient because of differences in seed size, shape, and hardness. This lowers the milling outturn and decreases the mill capacity.

- Mixed varieties lower field yields of paddy rice, delay the harvesting period by waiting for the late maturing varieties to mature, and also lengthen the period when rice is subject to bird and rodent damage.

- Rice of mixed varieties often is not attractive to the market. Especially objectionable are the frequently observed red kernels. If locally produced rice is to compete with imports in the urban markets, it is imperative that a well milled, uniform product be produced.

Diseases and pests

The Team observed that bacterial leaf blight, helminthosporium, and rice blast disease are present in West Africa. Certain virus diseases also were observed but were not identified specifically. Insects, birds, and other pests are present, especially rice stem borers. White tip was observed, which points to the presence of nematodes.

Tools and equipment

Most West Africa rice farmers use only all purpose axes, hoes, and knives as implements for rice operations. These tools should be improved and supplemented by picks shovels, sickles, scythes, hammers, chisels, saws, and simple harvesting machines. At present human labor provides nearly all the power.

In one Ivory Coast locality, it takes about 28 days for one woman to cut one hectare of rice, one stalk of rice at a time. Still less efficient harvesting was reported in other countries. The Taiwanese have introduced a small hand sickle which greatly speeds the harvest, permitting the cutting of a whole clump of rice stalks at one time. Using this tool, a woman might be able to harvest one hectare in five days.

Simple machines like foot pedal rice threshers, knapsack sprayers, and small, power rice hullers have proven useful where they have been tried. In only a few instances has any country set up a program for introducing these machines on a broad scale.

Oxen power has proved feasible in several local areas and could be used more widely.

Health hazards

While the human disease risks from working in stagnant water are an apparent inhibition to the adoption of the irrigated system, these risks can be controlled. (See Ivory Coast, Niger, and Upper Volta country reports).

Costs and rice prices

Data on West African rice production are not sufficient to permit other than general statements on production costs. The Team was able to gather data upon which to base a few local comparisons of different techniques. (See production techniques sections for Ivory Coast, Nigeria, Sierra Leone, Upper Volta, Niger, and appendix). Costs even using the same techniques vary greatly from place to place, even within countries. Labor is the chief input, and few studies of days or hours of labor expended have been conducted, let alone studies considering trade-offs of labor between rice and other crops and the effects of seasonal work bottlenecks.

The accuracy of even the meager available data is often suspect. The figures collected are no more than orders of magnitude. These data seem to indicate that (1) recurrent production costs for irrigated rice are as low as or slightly lower than those of other methods, (2) mechanized operations raise the cost, (3) improved, hand-labor upland methods reduce the cost per unit of output, and (4) land-clearing by hand is cheaper than by machines.

Whatever the true production costs may be, prices being paid for paddy (in conjunction with other incentives) in certain areas were sufficient to stimulate farmers to increase production and commercialization. Official prices for paddy were quite uniformm ranging from 6.6 cents per kilogram in The Gambia to 8.4 cents per kilogram in Senegal. However, the prices the farmer actually received were another matter. They ranged from 4 cents per kilogram in Senegal right after harvest to 14 cents per kilogram in certain instances in Upper Volta.

The most effective government price program seemed to be in Ivory Coast. There the government buying price was probably below the free-market price for most farmers, but the assurance that farmers could actually sell at the official price has spurred production.

Producer prices in West Africa are comparable to those in countries which sell rice without subsidy on the world market; higher than in Burma, but lower than in the United States and Italy. However, given the present state of milling and high transport cost, paddy bought in West Africa at the present prices cannot compete with imported rice in West African cities. The retail price for the most common type of milled domestic rice in cities ranged from $180 to $250 per ton including subsidies. Temporarily, to liquidate stocks, the Niger price has been dropped to $140 per metric ton. The imported grade most commonly sold (25 percent broken) was priced, cif West African ports, at about $165 per metric ton.

TABLE II

PRICE OF PADDY RICE IN WEST AFRICA, 1968 - 11 COUNTRIES

	Received by Farmers		Remarks
	Official	Actual Range	
	(U.S. Cents Per Kilogram)		
Dahomey	-	-	Practically none marketed
The Gambia	6.6	4.4 - 6.6	
Ghana	7.5	9.6 -10.8	At local market towns
Ivory Coast	8	7.2 -12.	At farm, anywhere in country. Practically none marketed. Hand-milled parboiled - 11.7 - 14.3.
Liberia	None	5.9 - 6.2 1/	
Niger	6.8	6.8 - 8	In 1968, GON bought above official price to capture larger share of paddy hand-milled, parboiled.
Nigeria	-	-	No information
Senegal	8.4	4 - 10	"Black market" exists.
Sierra Leone	7.25		At buying stations, average of 20 kilometers from farm.
Togo		9.2 - 9.6	
Upper Volta	7.6	7.6 - 14	Government buyers pay more than official price.

1/ No paddy is marketed in Liberia. Figure is derived from price of hand-milled, parboiled rice by deducting 2.8 cents/kilogram for parboiling and pounding, with 68 percent outturn.

TABLE III

RETAIL PRICES OF MILLED RICE IN WEST AFRICA, 1968 - 11 COUNTRIES

(U.S. Cents Per Kilogram)

	Common Grade, Milled Rice	Brown Rice	Other
Dahomey	23 - 25 (25% broken)	-	higher quality to 30 cents for 4% broken
The Gambia			
Ghana	20.7 - 26	16.5 (parboiled in north)	
Ivory Coast	22 (25% broken)	cu. 16	
Liberia	23.7 (parboiled)		small lots - 29.3 local milled parboiled 21.5 - 22.6
Niger	14 1/	14 mixed	hand-milled parboiled from 18 to 32, 8 to 8.8 broken
Nigeria	-	-	-
Senegal	22 - 24		100% brokens for minimum of 18 cents
Sierra Leone	-	-	-
Upper Volta	20 (25% broken)	14	14 cents brokens 26-8 cents imported milled

1/ "Normal" price is 18 cents; see country study.

Consumption

The West Africa rice problem stems from the need to meet local requirements. For the moment, exporting rice from or within the region is not being considered. As the accompanying map shows, rice consumption throughout the region is unevenly distributed.
Rice is not the region's leading staple food, ranking well behind yams, manioc, sorghums, millets, and cooking bananas. Yet it is the largest source of calories for a part of the region and demand is increasing elsewhere. Rice consumption can be divided into two categories:

- Rural consumption in the heavy rainfall areas where rice has long been the staple food, and

- Consumption by middle and upper income groups in urban centers.

Of the 11 countries, Sierra Leone, Liberia, The Gambia, parts of Senegal, and Ivory Coast, lie in the rice-staple zone. Here, high rainfall throughout much of the year and acidic soils make upland rice culture relatively attractive. In this zone, rice has been the chief food crop since men began to give up a life of hunting and gathering to begin cultivated cropping. Population pressures upon the land are low, and bushfallow cropping or "shifting" cultivation is practiced.

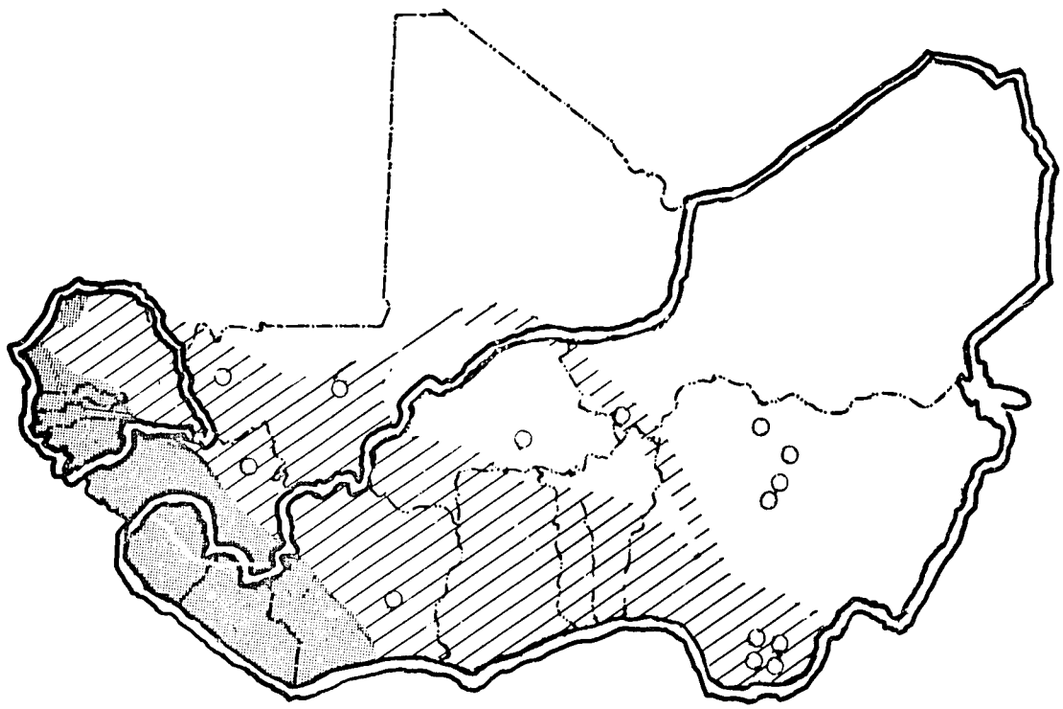
In the traditional rice zone, the average yearly consumption is over 100 kilograms per person. There is little current potential for increases in consumption per capita. Most families produce the rice they eat. Consumption is growing at about the same rate as population (2.6 - 3 percent per year). In the Ivory Coast, total consumption has increased at the rate of 10 percent a year for the past two decades.

West African cities are the source of most of the increase in consumption. Since World War II, there has been rapid urbanization. In some countries, more than one-fourth of the population now lives in cities and towns. For reasons that are little understood, rice is considered a high-prestige food. Families with sufficient cash incomes prefer to buy rice, even though it is much more expensive than the substitutable staples.

Growth of urban population is closely related to growth of income per capita. Cities and towns are the principal centers of government and administrative services, and governments put a substantial percentage of national income into such services. Therefore, growth of the new rice market is closely related to rate of urbanization; and demand is highly income-elastic. The reports on individual countries illustrate this graphically.

Yet all the increase in consumption is not found in cities and towns or in the traditional zone. New consumption habits have filtered down to the people in the countryside in certain other areas. But the overall effect is slight.

RICE CONSUMPTION
IN
WEST AFRICA



KEY

Area Studied

Primary Staple -
100 kilograms/ person/ year, or more

50-100 kilograms/ person/ year

5-50 kilograms/ person/ year

Less than 5 kilograms/ person/ year

TABLE IV

RICE CONSUMPTION IN WEST AFRICA, 1968 - 11 COUNTRIES

(Kilograms of 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: Team estimates; local statistics; U.S.D.A./E.R.S. estimates; these figures are orders of magnitude.)

In rural Niger outside the river valley, in Upper Volta east of the Black Volta, in much of rural Nigeria, Togo, Dahomey, and Ghana, rice consumption per person amounts to less than five kilograms per year.

Imports

No one knows with any precision how much rice is consumed (or produced) in West Africa. The best barometer of the relationship between consumption and production is external trade. Trade statistics are quite accurate, although small to significant lots cross political boundaries unreported.

Imports are the buffer between local production and demand. They vary considerably from year to year as rainfall or other conditions affect production in the region or as countries have varying availabilities of foreign exchange. For instance, 1967 imports for the 11 countries studied were down about 15 percent from the previous year; in 1964, imports were up 60 percent from 1963. However, the trend of imports has been distinctly upward. For all of West Africa, rice imports increased from 200,000 metric tons in 1950 to 800,000 metric tons in 1965. Local production has not kept pace with demand despite considerable economic protection in some countries. In Ivory Coast and Upper Volta, equalization taxes bring the price of imports up to or above the government's desired price for local rice. In Ghana, prior to 1966, foreign exchange licensing made rice-importing difficult. On the other hand, some governments pursue a consumer-oriented price policy without particularly favoring local rice (e.g. Senegal and The Gambia) and others act to favor imports over local production (e.g. Liberia). Senegal accounts for most of the imports into the 11-country area --- from 40 to 60 percent depending on the year. Senegal has experienced the greatest expansion of rice-eating beyond the former traditional rice-staple area. But Senegal is short of foreign exchange and the prospects for its principal export -- peanuts -- are discouraging. In an effort to reduce its costs, Senegal has imported almost all broken rice and has used administrative controls to hold down imports. Still, it spends $10 - $20 million annually for rice imports.

Four other countries -- Ghana, Liberia, Sierra Leone, and Ivory Coast -- account for most of the remaining imports. The volume imported annually by each country varies with the size of the local rice harvest and with restrictions on rice imports. Each of these countries accounts for about 10 percent of the region imports, and usually spends from $3 million to $9 million annually on imported rice. However, imports for any one of the four in a given year might be considerably more or might virtually disappear, as in Sierra Leone in 1964.

In recent years, imports for Ghana, Sierra Leone, and Liberia have held fairly steady. Ivory Coast imports increased steadily and rapidly until 1967.

The remaining six countries together account for 5-10 percent of regional imports. In recent years, only The Gambia and Dahomey have imported more than $1 million or 7,000 metric tons of rice in any year. Yet, even these sums are significant for countries with meager foreign exchange earnings. In Nigeria, rice imports represent only a small percentage relative to domestic production but cost $397,000 in 1967.

In 1967 domestic production in Niger caught up with and passed demand. In 1968 that country ceased to import rice, though it has not yet been able to export any of its small surplus. The absolute magnitude of a country's rice imports sometimes does not indicate their importance to its economy. The table below gives the degree of self-sufficiency and a comparison of rice imports to foreign exchange earnings.

TABLE V

MILLED RICE IMPORTS IN WEST AFRICA: 1962-1967 - 11 COUNTRIES

	Volume (Thousand Metric Tons)						Value (Million Dollars)					
	1962	1963	1964	1965	1966	1967	1962	1963	1964	1965	1966	1967 1/
Senegal	118.1	100.5	184.5	179.2	159.3	189.0	12.0	11.1	19.9	18.1	17.5	22.7
Ghana	71.8	26.8	38.9	30.1	43.0	36.0	10.5	4.2	5.3	5.1	9.0	5.3
Liberia	27.6	35.9	35.2	22.3	46.3	33.2	3.9	6.0	5.6	3.5	7.5	6.3
Ivory Coast	43.2	25.6	58.1	77.9	83.2	28.7	5.7	3.2	7.9	9.0	12.6	4.8
Sierra Leone	27.3	21.2	0.6	18.9	38.0	22.0	3.8	2.6	0.1	2.6	4.8	3.6
The Gambia	10.6	8.2	9.0	6.8	8.6	9.0	1.3	1.0	1.1	1.0	0.8	1.3
Dahomey	4.8	4.3	5.3	7.0	6.0	7.0	0.8	0.6	0.8	1.0	0.9	1.1
Upper Volta	2.5	3.1	3.5	3.3	4.1	3.9	0.4	0.4	0.4	0.5	0.6	0.7
Togo	3.1	3.0	3.1	2.4	3.7	2.7	0.5	0.3	0.4	0.4	0.6	0.4
Nigeria	1.6	1.3	1.0	1.4	1.3	1.5	0.4	0.3	0.3	0.3	0.3	0.4
Niger	1.3	2.1	0.9	2.3	1.2	1.3	0.2	0.2	0.1	0.3	0.2	0.2
Total	311.9	232.0	340.1	351.6	394.7	334.3	39.5	29.9	41.9	41.8	54.8	46.8

1/ Preliminary estimates.

Source: U.S.D.A./ E.R.S., corrected and completed by Team from local sources.

TABLE VI

RICE IMPORTS: RANGES, 1964 - 1967

	(Thousand M.T.)	(Million Dollars)	Percent of Consumption from Imports	Value of Imports as Percent of Foreign Exhange Earnings
Senegal	519.3 -189.0	17.5 -22.7	69-73	12-16%
Ghana	30.0 - 43.0	5.1 - 9.0	55-70	N.A.
Liberia	22.3 - 46.3	3.5 - 7.5	15-25	2½-5%
Ivory Coast	28.7 - 83.2	4.7 -12.6	10-35	1½-4%
Sierra Leone	0.6 - 38.0	0.1 - 4.7	0-10	0-16%
Dahomey	5.3 - 7.0	0.8 - 1.1	75-90	7-9%
The Gambia	6.8 - 9.0	1.0 - 1.3	20-30	N.A.
Upper Volta	3.3 - 4.1	0.4 - 0.7	7-13	2½-4½%
Togo	2.4 - 3.7	0.3 - 0.6	15-25	1-2%
Nigeria	1.0 - 1.5	0.2 - 0.4	0	less than 1%
Niger	0.9 - 2.3	0.1 - 0.3	0-25	less than 1%

Marketing

The chief reason that West Africa rice is non-competitive with imports is not the high price paid the farmer for his paddy. Rather, it is (1) the poor quality of local paddy, (2) the low efficiency of milling, (3) transport difficulties and costs, and (4) storage problems related largely to poor quality of rice offered.

Drying and storage

The highest outturn of milled rice from paddy can be obtained only if it is properly dried, stored in a manner that will maintain good quality and condition, and milled at a relatively narrow optimum moisture range. When paddy is dried too rapidly, by either natural or artificial means, the kernels will check and break. When such rice is milled, the result is an abnormally high percentage of broken rice. In extreme situations, rapid drying causes heat damage to rice kernels. On the other hand, when paddy high in moisture is not dried, or is dried too slowly, it may ferment, sour, or mold, or it may heat and the kernels suffer heat damage.

Some parts of West Africa, especially toward the north, are so hot and dry at harvest time that rice kernels are damaged in the field partly because of the slow rate of harvesting. Use of improved tools would speed up the rate of harvest and would reduce the amount of damage caused by hot, dry weather during harvest. Even in these localities, if paddy is bought directly from the field, some may be delivered at moisture levels too high for safe storage without additional drying.

In certain other localities, especially in the southern portions, rainfall and humidy are so high at harvest time that high quality and good condition cannot be maintained for either paddy or milled rice over an extended period of time without some drying.

Paddy often is stored under the roof of the producer's home. This is probably the most practical storage for rice hand milled and consumed by the producer. Other storage facilities usually are small buildings similar in material to the home with little or no ventilation and no artificial drying attached. Such storage is generally satisfactory for the less humid portions of West Africa. On the other hand, storage for commercial operations is completely inadequate in humid areas. Paddy cannot be stored in large volume in the humid areas without much deterioration in quality.

Buying systems

Lack of appropriate market institutions sometimes discourages commercialization of local production. Where urban rice markets were first supplied by imports, the facilities for transporting local production to markets have had to be established. In Ivory Coast, local truckers and traders filled the void. These are now being supplemented by a government marketing corporation.

It seems that entrepreneurs in Senegal and Ghana have not shown the same initiative. Reportedly, marketable surpluses exist in farming regions, while unfilled demand exists in the cities. In Liberia, there is no market for paddy. A farmer usually must head-carry hand-milled rice long distances to find a buyer. Part of this paradox is explained by the fact that "surpluses" in the production area -- in northern Ghana, for instance -- are not in a product form for which there is unsatisfied demand in the cities. Yet part of the paradox is unexplained.

Some countries have taken steps to develop marketing structures for handling rice on a commercial basis. However, generally throughout the region marketing facilities and systems are deficient. In a number of countries, cooperative marketing associations have been formed for handling peanuts and some other farm commodities, but cooperative organizations have rarely been extended to marketing of rice. Niger is an exception. There, cooperative rice buying has stimulated more than enough paddy marketing to fill local demand, but paddy quality is still low.

Milling

Most of the rice produced in West Africa is milled by producers by hand pounding with mortar and pestle. This is a slow process. It is inefficient because rice is lost in the pounding process and in winnowing or separating kernels from bran and chaff and the quality is poor. In certain localities, it has been estimated that 100 man hours are required to produce 100 pounds of milled rice from paddy by use of the mortar and pestle. Because of this labor input, the production of rice is not well accepted in some areas. Further, time is not available for more intensive production efforts because of the time required to mill the rice for home consumption.

Generally, no distinction is made between different lots of paddy bought and delivered to modern mills. As a result, farmers are paid the same for non-uniform paddy mixed with straw, dirt, and stones as for clean, uniform, and even parboiled paddy. The lack of grades leads to low milling outturns with high percentages of brokens. Since whole-grain rice retails at a premium over broken rice (except in Senegal), this practice raises the margins necessary for profitable milling and marketing operations.

Even though most of the poor mill outturn is due to the mixed character of paddy delivered, the milling systems are often less than efficient in location, machinery, or operation.

Transport

High transport costs within West Africa deter rice movements just as they affect the rest of the economy. Vehicles and fuel are imported, and are taxed heavily. Roads are often poor or non-existent. Population is sparse. Where the Team gathered information, the movement of goods by full trucks along primary roads cost from 3 2/3 cents to 6 cents per metric ton per kilometer. In Upper Volta, Niger, and Dahomey, a near monopoly of major transporters appeared to impose artificial cost structures. While major truckers and the railroads in Upper Volta have rates of 6 cents per ton/kilometer, rates of 4.4 cents per ton/kilometer could be negotiated with some truckers.

The real cost problem for transport comes not on primary roads but before they are reached. For rice, this pertains to the movement from farm to mill or to the initial market. Where secondary roads exist, trucking rates were several times higher than on primary roads. Moreover, few farmers can guarantee a trucker a full load. Rates for moving smaller quantities by truck along back roads or trails ranged from 9 cents per ton/kilometer in Ghana to 27 cents per ton/kilometer in Ivory Coast. In some countries, notably Ivory Coast, these costs are borne by the government which stands ready to and actually does buy paddy from the most remote farmer at the same price as from one near the buying point. In other countries, a rice farmer generally bears the cost of his isolation. Either way someone in the economy must bear the excessive cost of economic distance.

Throughout West Africa, paddy moves by head portage not only from field to farm, but also for considerable distances from farm to mill or market.

Services

All governments offer services in varying degrees to rice farmers. In practice, these usually reach only a few producers. The services include research; sale on credit or at subsidized prices of improved seed, fertilizer, pesticides, and tools; technical assistance through demonstrations, extension, and training; support for cooperatives; subsidized machine operations for land-clearing and plowing; and buying at fixed prices and other marketing aids.

The most effective and widespread services are provided in Ivory Coast. In 1967 the Ivory Coast government spent $2.2 million for rice development through a state corporation, plus investments in subsidies for research and land-clearing. Certain countries have offered little in the way of services to rice farmers and also may have furnished a disincentive to increased production by holding down the rice price to urban consumers.

Research

Research has been inadequate and the results meager although every country finances programs under the name of research. The work has been scattered among small stations, each without a "critical nucleus" of researchers. Much research is duplicated, not having been coordinated with work being done elsewhere. One old-established station, Rokupr in Sierra Leone, is located in a mangrove-swamp region not typical of most of West Africa's rice-growing areas. Recent reports indicate Sierra Leone may limit the activities of this remote station to seed multiplication. Nigeria has extensive and active research on varietal development.

While many research workers in the region are competent, lack of coordination prevents attention to the essential broad range of problems. Most effort is devoted to varietal research, and important findings have resulted but have been little used beyond the research station. There has been no significant research directed to other critical factors such as small machines and tools, the economics of production and marketing, fertilizers, soils, pest and diseases, farm management, and marketing matters.

Given chronic shortages of money and personnel, it is unreasonable to expect any single country to devote adequate resources for research on rice, which is a relatively minor crop for most countries. Yet, even at the current low level of expenditure, regional coordination could improve the benefits.

Extension

Despite its weaknesses, research in West Africa has provided some practical recommendations to increase rice production, but few of the recommendations are being practiced by farmers. This is partly due to the weakness of the existing extension organizations and the lack of adequate liaison between research and extension. Responsibility for extension is frequently divided among several agencies with resultant confusion and dispersal of resources.

Contributing to the weakness of many extension organizations is the fact that extension supervisors are frequently overloaded with administrative chores; for example, petty cash accounts. Irregularity and uncertainty of financial support is sometimes another detriment. Many competent extension leaders do not have the time or logistic support to supervise their local agents. The agents, in turn, feel a lack of support and even interest by their headquarters office in what they are doing.

With certain exceptions, extension workers frequently know little about or devote little attention to rice production. Where rice is a minor crop and rice imports are not a problem, lack of a substantial rice extension effort is understandable. But where rice extension programs exist on paper or in some action, most agents have insufficient training to teach farmers. In some cases, the information taught does not agree with research recommendations set forth by the agriculture ministeries.

Demonstrations to convince and educate farmers are few and poorly organized. Teaching and demonstration aids are usually unavailable. Work programs are sometimes well-organized on paper, but often do not attain their objectives because of the lack of monitoring. Evaluation of on-going efforts and annual planning based on experience and the local environments of farmers is usually inadequate.

It is doubtful that many countries can or should afford agents at the farmer level who will devote full time to increase rice production, though the Ivory Coast is doing this. Therefore, training should be aimed at producing a multi-purpose agent who can promote other crops besides rice.

The Ivory Coast has two schools at Gagnoa and Bouake to train rice extension workers and supervisors. These centers were initiated by the French aid program and the Ford Foundation. Each is run by an Ivory Coast administrative director and has a French teaching director. While the curriculum has too much mathematics, these schools are generally well conducted.

The Gagnoa center has a capacity for training 60 extension agents. The course of study is practical. A problem is discussed in the classroom and the students then spend the next few weeks in the fields and in villages learning how to cope with it. Since the Ivory Coast now has trained its full complement of rice extension workers, the center will henceforth be needed only to train replacements.

Seed

A major factor accounting for poor milling outturn is the heterogenous paddy delivered to mills, which condition in turn stems primarily from the lack of uniform seed.

Use of uniform seed of varieties now planted would be preferable to the present situation. But none of the countries has an adequate program for multiplication and distribution of pure seed. Most countries have produced improved seed at research stations, but the quantities available are usually small and distribution is limited. The most nearly adequate program is in the Ivory Coast.

Some of the inadequacy of multiplication programs is explained by weakness on the demand side. Due to lack of effective extension and the non-availability of fertilizer, farmers do not know what pure seed can do. Because buyers do not pay a premium for uniform paddy, growers have no incentive to use improved seed and go on producing mixed paddy from an impure seed saved from the previous harvest. If demand for pure seed were stimulated, supplies probably would increase to meet it.

Fertilizers

Few governments have realized the potential gains from using chemical fertilizers on irrigated and improved-upland rice. In Nigeria, Ghana, and Niger public agencies are aiding in small programs of fertilizer distribution and subsidizing the price. The Ivory Coast program is more extensive.

Although insufficient research has been devoted to fertilizer trials, it is beyond doubt that use of chemical fertilizer on rice is profitable where rice is being produced under irrigated or improved upland conditions. Under swamp culture without water control, fertilizer washes away. Where traditional upland practices are followed, fertilizer is as likely to nourish weeds as rice.

In situations seen by the Team, response to fertilizer was good. This is particularly true of nitrogen fertilizer. Near Bouake in the Ivory Coast, the Team saw applications of ammonium phosphate of up to 250 kilogram/hectare on IR-8 rice. The return was ten times the cost of the fertilizer. The upper limits of profitable fertilizer application are not known. Neither are side effects on soil with high aluminum and iron content, nor the returns from using phosphate and potassium, although there are indications that these probably pay too. In Ghana, experiments have shown increases of 50 to 60 percent in rice yields from application of 200 pounds per acre of 15-15-15 fertilizer.

At present, only a small amount of fertilizer is applied to rice in the countries studied. Most of that small amount of fertilizer is used by farmers associated with Taiwanese demonstrations or in close touch with research and extension teachings.

Because fertilizer is little used on rice, its availability to farmers is highly irregular. In Upper Volta, fertilizer was not available to most rice farmers. When it was available, the supply was irregular and the price variable. In Ivory Coast, fertilizer is an important part of the government's rice program but most farmers could not buy it because of the lack of credit.

Price policies

Most governments have set official prices for paddy, but there is a wide range in degrees of effectiveness of these announced prices. Some buying programs announce the support price too late to affect planting decisions; in other cases, the farmer has no opportunity to sell to the government at the announced support price. In Upper Volta, government agencies must pay more than the official price to obtain paddy.

Policies in setting retail rice prices and restricting imports are extremely variable. Most countries tax imports and keep the local price above what a free market would dictate, thereby helping local production. In others, government price policies discourage local rice growers. In Senegal, the government essentially restricts rice imports by quotas, but will not permit the retail price to rise to levels that would balance supply and demand. With excess demand, rice marketing goes underground --- a situation not conducive to orderly marketing by local producers trying to break into urban markets.

Credit and cooperatives

Credit available to rice producers is inadequate and the problems of administering credit programs are great. No government has succeeded in giving rice-growers credit in cash and getting it paid back. Some extend credit in kind, usually repayable in paddy at harvest with 25 percent interest. The credit goes for seed, fertilizer, pesticides, chicken wire, mechanized clearing and farming operations, and small machines. Repayment of credit in kind has been less of a problem.

Regional investigations should develop recommendations to governments on adequate credit programs for both producers and traders. The principal factor governing agricultural credit success is whether the credit can be profitable and repaid. Systematic training of credit agents and strengthening of organizations is required. If improved practices and prices make rice profitable to producers, a credit program could be carried out with relatively few difficulties, assuming adequate fiscal and manpower resources are allocated to it.

Expansion of farmer cooperatives in commercial rice producing areas should be attempted. In commercial producing areas where cooperative marketing does not appear to be feasible, government and private agencies should be strengthened to purchase rough rice from producers and to bring seed and other production inputs.

Taiwanese Demonstrations

The most effective service provided to rice farmers in West Africa has been the demonstration of irrigated and improved upland techniques by technicians provided by the government of the Republic of China. However, only a small proportion of the region's rice farmers has received these services.

This assistance began in 1961 and is provided to Liberia, Ivory Coast, Senegal, Sierra Leone, Niger, Upper Volta, Dahomey, Togo, and The Gambia of the countries embraced by this study. It will be initiated in the near future in Ghana.

Production results from these projects have varied depending upon the soil and climatic conditions of the various demonstration sites. The results have been generally good with yields ranging from 2.5 to 4 metric tons per hectare for upland rice and from 3 to 6 metric tons per hectare for irrigated rice. The average yield of all the Taiwanese projects has been about 5 metric tons or strikingly above the yields from other systems in the region. Yields from experimental plots under irrigation have ranged as high as 9 metric tons per hectare.

Results by selected countries follow (in metric tons per hectare):

	---Field Yields---		---Experimental Plot Yields---
	Upland	Irrigated	Irrigated
The Gambia	2.5-3.5	4.5 - 6	9
Ivory Coast	3-4	5 - 6.7	8
Dahomey	3-3.5	3.5 - 6.2	8
Upper Volta	N.A.	3.5 - 7	8.9
Niger	N.A.	5	N.A.
Senegal	N.A.	5	N.A.

The IR-8 variety from IRRI has yielded somewhat better than other varieties tried.

National Planning and Administration

Planning and administrative capabilities of the countries surveyed will be crucial for any rice development program. Most important is the governments' willingness to commit resources to a sustained campaign effort. Fiscal and manpower resources are scarce; how these scarce factors are allocated and used is important. Outside knowledge and resources can assist but the stimulus must come from within West Africa.

As reflected throughout our technical and economic findings, critical obstacles must not only be identified and evaluated but their solutions fitted into a planned program that considers priorities and inter-relationships.

Planning is not an end in itself but sets the stage for implementation. The files of African governments are full of eminently sound plans --- technically and economically --- but with objectives unrealized because they have not been translated into action.

A campaign must include recording and evaluation of results for modifying on-going courses of action. In particular, an unbroken two-way flow of communication should be maintained to and from the rice producers for effecting timely reaction to changing biological and market conditions. The peculiarities of the local socio-economic environment of local producing areas must be taken into account in planning. Provision of credit, fertilizers, and other outside inputs must be planned ahead and delivered on time. Likewise, provision must be made for timely purchase of the rice produced at the farm gate or at buying stations accessible to producers.

As indicated previously, rice does not have a high economic priority for agricultural development in all countries of the region, and all governments cannot be expected to devote major resources to rice campaigns. However, if outside assistance is available for rice campaigns, governments may wish to take advantage of it for a tangible payoff (i.e., saving of foreign exchange for rice imports). Capabilities developed in a rice campaign can be used simultaneously or later for promoting other objectives of agricultural development. These capabilities will be in research, organization, training, and services to farmers.

OPPORTUNITIES FOR REGIONAL ACTIVITIES

The Team is firmly convinced that there are solid opportunities to increase rice production in West Africa. One difficulty for individual countries and donor organizations interested in this potential is to determine the priorities and timing of improvement actions to fit into a rational program framework. They must identify those actions to be undertaken regionally and those actions to be undertaken in country programs and then coordinate them. The problems are closely inter-related. We feel that the tools of research, training, and advisory services should be applied in combination from the beginning of a regional program.

Action programs and research need to focus on marketing problems, grading, milling, storage, transport perhaps even in advance of efforts on production factors. The improvements needed and possible in marketing are likely to be more influential in the short-run in stimulating increased production than improved production practices. If efforts to increase production directly are not accompanied by attention to marketing, farmers who respond to them may be disappointed, to the disadvantage of the program.

The Team believes enough is known about the common problems of the rice economy to structure a regional program immediately. The initial operations probably will require fact-gathering and diagnoses in greater depth on many factors treated in this study, particularly more refined economic analysis. The problem could best be carried out by a regional rice development center with headquarters in the region. The contents of such a program are described below.

It is outside the mandate of the Team to recommend a location or an organizational structure for this center but we do offer criteria for the location as follows:

- Accessibility to international and in-country transportation facilities as well as to the countries participating.

- Ample land for experimentation that represents ecological conditions fairly typical of the rice producing areas of the region as a whole.

Three or four countries offer sites that should be able to meet these criteria.

The International Rice Research Institute (IRRI) in the Philippines could contribute experience and results for application in West Africa.

Free exchange of ideas, research information, and personnel should be arranged.

Research

The Team agrees that primary research emphasis for rice development should be given to applied research concerned with practical problems at the farm or at related industry levels. Considerable useful information is already known or could be derived through relatively simple testing in the case of production technology. Such adaptive research should be coordinated with extension and training programs for early payoffs on rather elementary cultural practices. The possibilities for early adjustments in marketing systems also should be explored.

The following discussion identifies factors offering opportunities for regional research, with both short and long-run payoffs:

Production

Farm production research in a regional program should include evaluation of soils, fertilizer, cultural practices and weed control; varietal improvement and foundation seed production; diseases, insects, rodents, and other pests; and power, implements, and labor. These studies should be designed to develop methods for testing in individual countries as well as developing basic information and varieties for use at local levels.

Research on soils, water, fertilizer, culture, and weed control should cover all basic agronomic and engineering research pertaining to rice culture. This would involve soil classification; seedbed preparation and land leveling; development of simple irrigation and drainage systems; trials to determine optimum seeding or planting rates and dates; cropping systems and green manure crops; fertilizer application including rates, ratios, and timing of nitrogen phosphorous and potassium as well as trials to determine the needs for other elements; irrigation water; studies on weed control including an evaluation of the losses caused by various weed species and comparison of cultural practices on prevalence of weeds, and comparison of mechanical, hand, and chemical control methods.

Varietal improvement research should seek to test indigenous varieties and the purification of mixed varieties; to introduce and test varieties from areas with similar climates in other tropical countries; and to develop new types of hybridization in cooperation with other international rice research programs.

These breeding studies should consider all factors that pertain to production, quality, and consumer acceptance such as seedling vigor, straw strength, plant type, time of maturity, resistance to disease and insects, non-shattering of grain, yield, milling quality, and cooking characteristics. Methods should be developed for the maintenance and production of pure seed for distribution to farmers.

Research on diseases, insects, rodents, birds, and other pests should have these phases: (1) the extent of loss; (2) the possibility of control by a change in cultural method or cropping system; (3) screening varieties to find those less susceptible to the pest; (4) possibilities of biological control; and (5) the development of chemical control methods. Long range research should include the breeding of resistant varieties as required.

Initial research on power, farm implements, and labor may need only to involve the collection and testing of available tools from other rice-producing areas.

Family and village tradition is a strong determinant in a family choice of enterprises. For crops that are produced for market, the dependability of a market (at prices in a range of those received in previous years) is important. Commercialization of agriculture in the rural areas should be accompanied by the realization that income can be influenced by the choice of enterprises and other adjustments. A systematic sample recording of the cash and non-cash inputs necessary to obtain varying levels of rice production, under different rotations and production techniques, would be useful to extension advisors and to small holders in bringing about change. Particular attention should be given to the inter-relationships of various production activities (for rice and other crops) as they affect labor requirements for the entire farm operation.

Such research would have special implications for agronomists, agricultural engineers, and other scientists in their joint efforts to raise the output per worker through improved cultural practices and innovations in equipment. The cost analyses also are needed to guide program administrators in the choice of areas and types of production schemes which are economically feasible for priority attention as well as the determination of national levels of productions that are economically feasible.

Marketing

Research in marketing will require fact-finding investigations difficult to carry out. Once the facts are known about the marketing system, analyses leading to recommendations should be relatively easy.

Such recommendations in most cases should be submitted directly to the individual governments concerned (see Advisory Services below). However, many problems can be investigated regionally for application in more than one country.

Because of the paucity or unreliability of existing information, the methodology primarily should be direct observation and inquiry. Price series for major markets and for selected secondary markets should be established in order to determine seasonal and geographical characteristics as well as the influence of different price levels on production. The elements in the marketing "chain" from producer to consumer should be identified and analyzed to determine where inefficiencies exist.

Investigative research to improve the marketing infrastructure should be concerned with the location and nature of rice-buying points, storage and milling facilities, and transport.

Although national pricing policies will vary to fit the individual situations of each country, regional research on price structures should yield results to assist country policy makers. In particular the degree of cost subsidization, if any, that is justified in setting consumer prices for rice and the cost to farmers of fertilizers, implements, credit, and other production inputs should be under continuing review by governments. Ideally, subsidies should not continue indefinitely and should be reduced progressively. The problem of keeping consumer prices low and producer prices high ultimately can be minimized or may even disappear when production and marketing efficiencies take hold. It is at least possible that the introduction of improved technology and infrastructure will reduce the cost of delivering indigenous rice to consumers to the current retail price levels for imported rice.

Studies should be made to determine the nature and ways of improving the bargaining position of producers, possibly through the dissemination of market news and producer cooperative marketing associations. The latter also might buy and distribute seed, fertilizer, tools, and other production inputs.

As West Africa increases the commercialization of rice, there is growing need for following uniform standards to identify quality to sellers and buyers. Regional research could develop quality standards for paddy, brown, and milled rice.

There is need for research and a program to encourage the construction in humid areas of commercial storage facilities with ventilation and drying equipment. Such a program would reduce losses in quality of rice due to excessive moisture and permit orderly milling.

Research recommendations should permit setting up demonstrations in villages for the construction and use of inexpensive rice drying techniques and equipment. In commercial rice-producing areas, demonstrations of commercial-scale rice drying equipment and operation should be carried out.

There is need for more detailed investigations of milling requirements to pinpoint the location and size of multi-stage rice mills. Such mills would increase the amount of milled rice produced and save labor. Single-stage mills can be set up in villages distant from commercial mills. Single-stage milling units are manufactured in Taiwan, Japan, and Italy. Milling operations should be self-supporting, charging roughly one-tenth of the paddy milled to cover costs. The minimum amount of rough rice required for the installation of the single-stage milling unit would have to be calculated.

At present, millers usually get a fixed fee per unit of paddy milled. Even with impure and variegated paddy, the outturn of whole rice can be improved by segregating batches of rice that are more uniform from those that are mixed and by regulating the mill to suit the sample. Improvement of this sort might increase outturn of whole rice by 10 percent or more. The mill should be paid by unit of outturn, with the remuneration per unit of whole rice 20-50 percent higher than that for brokens.

Training

In connection with and in addition to research activities, a regional center should conduct regional training programs and advise and assist countries with in-country training programs. African scientists need training in the methodology as well as the subject-matter of production and marketing research. In many cases the trainees can fill regular staff positions at the center and later return to their respective countries for assignments.

Extension agents need training in the methods most feasible to induce change by farmers. Consideration should be given to having them "grow a crop of rice", a technique that has been successful at the IRRI in the Philippines.

Another part of training methodology should be the preparation and use of films, film slides, flannelgraphs, posters, flip charts, and leaflets for extension and other programs.

All training should stress the importance of working cooperation among researchers, teachers, and extension agents.

The methodology of planning, administration, and evaluation should be extended to all trainees coming to the regional center. In fact, every subject-matter objective pursued by the center should have a training component to permit progressive assumption of staff positions at the center by Africans and to upgrade the capabilities of Africans to conduct research, extension, and marketing activities in their respective countries.

Advisory Services

A regional program should offer advisory services to individual countries on activities conducted by the regional center and also on other factors critical to rice programs. The latter factors might include pricing policies; transportation systems; the location and operation of milling, storage, and other marketing infrastructure; and the design of extension campaigns to influence farmers.

The regional center could provide consultants for short periods of time in individual countries. These advisors will have regular assignments at the regional center in their individual disciplines and would advise countries upon request.

The center should serve as a focal point for exchange of technical and economic information among participating countries and with other rice regions of the world. Improved planting materials and improved equipment should be exchanged freely among the regional center and the participating countries.

OPPORTUNITIES FOR COUNTRY ACTIVITIES

Many opportunities for improving West Africa's rice production could be best realized by individual countries. Suggestions for specific countries are made at the end of each country section in Section Two. Here, we discuss a few opportunities for unilateral country actions which apply to all countries.

Producers' Prices

The effective price a farmer receives for his rice is probably the most decisive factor influencing the supply of rice. Each country should determine how much rice it should produce and what level of farm price is required to get that volume. Countries with severe trade deficits and foreign exchange shortages (all except Ivory Coast and possibly Liberia) may want to set the price high enough to achieve self-sufficiency. Countries with foreign exchange to allocate will want to weigh the cost of shifting resources from other production to rice through tariffs and other means against alternative uses of foreign exchange. Countries that have achieved self-sufficiency will need to find out if the farm price for rice is low enough to compete on foreign markets and if not, to what extent it could be lowered and still generate enough rice production for local needs. Regional research in rice economics would assist national planners adopt sound policy positions with respect to prices.

Several countries of the region soon may be in a position to export rice though inland countries could only do so profitably if paddy rice could be bought cheaply, milled efficiently, and transported in bulk. At present, high transport costs keep Niger from selling its rice surplus. On the other hand, the cost of ocean freight on a bulk basis to Monrovia or Dakar from other West African ports is low.

Consumer Prices

Expansion of rice consumption should not be a development objective for the region. There is no calorie shortage and rice is not a cheap source of calories or protein. Therefore, the consumer price of rice should not be fixed to subsidize rice consumption. Within the dictates of political practicalities, rice consumers should be made to pay the costs of developing rice self-sufficiency. Presumably, the most effective policy tool to achieve this end will be a tariff on imports.

Transportation

Poor transport facilities and high transport costs limit the development of efficient marketing. The problem affects all the countries surveyed but it is most acute in inland countries, such as Upper Volta and Niger, which must ship their agricultural commodities long distances to port cities.

A related marketing deficiency is a shortage of collection points and buying stations with storage facilities. Truckers, who haul imported items inland, could take advantage of these centers to load up with agricultural commodities for the return trip. Roads are a major factor in developing production in new areas in determining marketing costs. Countries need to determine those areas where present or potential production warrants the construction of new road links and the type of road needed to assess the proper location of collection points and buying stations; and to determine to what extent present transport costs may be excessive because of cartel agreements.

Other

Seed

An early action could be to produce and distribute more pure seed to farmers of better varieties now available pending time-consuming breeding and field testing of still better varieties.

Within the mixture of varieties now being grown in each county, there are some well adapted rice varieties. These should be isolated and pure seed multiplied. There is no evidence to support the frequent belief that a dozen or more different varieties are necessary in each country allegedly to meet local conditions in each. For seed increase, a country should select one, two, or three varieties that best fit its principal production areas and which are acceptable to consumers.

Programs to produce pure seed will require cooperation working agreements between plant breeders, the seed farms, and the agricultural extension services. A total program consists of producing and distributing seed of four classes: breeder seed, foundation seed, registered seed, and certified seed.

Weed Control

More attention to weed control, primarily through hand-weeding, probably ranks second to the use of pure seed as a practice with an immediate payoff in higher yields.

Irrigation

Some swamp rice areas could be converted to irrigated rice producing areas rather easily and at moderate expense. Where this is possible, it should be done, thus enabling the production of more than one crop a year. The shifting from a swamp rice to an irrigated rice system should be gradual, confined to areas most suitable ecologically, and at a rate where education of farmers can keep pace with the transition.

The Taiwanese demonstrations should be supported to develop the maximum technical and economic information related to production methodology. Investigations should be initiated on the sociological factors, and extension programs modified accordingly, that impede widespread adoption of the irrigated system as demonstrated by the Taiwanese. These demonstrations also have shown that fertilizer can be applied with profit on upland rice culture in combination with improved seeds and weeding.

Soils

Overall assessment is needed to identify soil resources suitable for rice production in each country. Such an assessment will be one determing factor in opening up new land areas for cultivation, the location of improved roads, location of industries related to rice, and drainage development. A soil reconnaissance survey would be adequate in the early stages of decision-making. Later, more detailed soil surveys will be needed.

The problem of rapid decomposition of soil humus associated with leaching under high rainfall and temperatures can be alleviated by working out better rotation among crops being grown, possibly including cover crops for plowing under.

Soil erosion presents a universal problem on much of the upland in the region, especially when tree and brush growth is removed for crop production in a shifting agriculture. Studies are needed on soil problems and the relationships of rainfall and soil nutrition, organic matter, and PH changes.

The beneficial effects of commercial fertilizers have been demonstrated for many localities. Such findings would be expected in areas of high rainfall and high temperatures where humus is rapidly decomposed. It should be stressed that rates of fertilizer recommended should not be static but may require later changes in relation to the use of other improved technology. Changes in cultural practices and changes in varieties are examples of practices that may change the recommended rates of fertilizer.

Prices, both of fertilizer and crops, may well change the economic basis for the fertilizers and rates recommended.

By and large the same soil deficiencies occur throughout the region, but the differences in fertility requirements may be as great within countries as between countries of the region. For this reason, each country will have to determine its own fertilizer recommendations but methodology and other standards can be developed regionally.

Tools

The limited performance output of farm labor and consequent small acreage that the resident labor force can effectively handle is a serious limitation to production. More effective hand tools (including improved quality and longer life) for brush cutting, weeding, and harvesting could materially raise the putput of labor. Testing is needed to determine what improvements could be made on existing tools and how they would be accepted by farmers. For selected items that prove feasible, establishment of small manufacturing plants for their production and/or assembly may be economical. A farm implement factory already is located in Senegal.

Intensive mechanization for rice production should be approached cautiously only after research. Problems in power mechanization include lack of capital, absence of trained personnel, importation of spare parts, cost of fuel and oil, and, finally, the unknown reactions of soils to mechanized operations.

APPENDIX

THE ECONOMICS OF RICE PRODUCTION

A First Appraisal

Whether or not West African rice can expect to compete on the world market and even whether it pays to grow rice locally instead of importing it depends, in large measure, on production costs. The Team tried to identify these costs, particularly to find the relative profitability of different rice-growing techniques. It was not possible to study the farmer's returns from rice relative to those from alternative crops.

Those familiar with West African agriculture will recognize that production-cost data are few. The Team economists collected the information available and, in some cases, tested it for general plausibility, but the results are far from definitive.

Labor is the dominant input. Yet, there are not sufficient studies to show how much labor is required to produce a ton of paddy under specified conditions, and to decide an accounting wage for labor.

The data gathered are presented in the following table for rough comparisons among systems and among countries. The table was designed to expose anomalies of which several are evident, one example indicates that one hectare of swamp rice in Sierra Leone requires twice as much labor if the farmers sows directly than if he transplants.

Obviously some or probably much of the data were wrong. One purpose of this exercise is to pinpoint the universal need and to suggest a methodology for more accurate research on this important element crucial to decision-making both by national planners and individual farmers.

In developing the table, we did the best we could working from primary data on such items as:

> Under recurring costs - land preparation, sowing, seed bed preparation, transplanting, weeding, fertilizer application, pest control, irrigation, and harvesting under labor; seed, fertilizer, pesticides, and use of machinery.
>
> Under capital costs - the annual amortization of investments in land development and machinery.

These detailed data do not appear in the table. Not included in the total hectare and metric ton costs are post-harvest expenditures for threshing, drying, guarding, carrying home, bagging, etc., which were only available even as rough estimates for a few of the numbered situations.

We would like to call attention to the following points:

- The data were gathered by many different people. In some cases, we are not able to disaggregate them. Also, some of the data (numbers 1,2,3,4,7,8, and 12) are results of attempts to generalize about costs in "typical" situations; the rest are the results of very narrowly based surveys, i.e. of a few fields in a given year.

- Although most labor is contributed by members of the family, we assigned to it the value a farmer probably has to pay hired labor. Even this varies widely. It is usually less than the legal minimum wage, although in the labor-short Ivory Coast it was higher.

- Team economists disagreed on the amount of labor for bird-scaring and its cost. Some members believed that birds are an equal menace to all rice regardless of cultural method. Others believed that bird-scaring is necessary in traditional culture but not in irrigated culture, thus affecting the comparison of cultural methods.

- Figures on land-development costs are not very exact, where they exist at all, yet these clearly are a decisive cost. Extraordinarily high land-development costs in Niger and Upper Volta are the actual figures on a small number of irrigation projects.

It should be clear, as a result of the many gaps and uncertainties, that the figures in the accompanying table are orders of magnitude at best, and much less in many cases. For purposes of comparing different methods of production, those for the Ivory Coast are undoubtedly the most reliable.

It is hoped that these first indications will inspire more investigations of the costs of rice production in West Africa, particularly into the actual labor input and its true cost and into comparison with alternative cropping enterprises.

ESTIMATED COST OF RICE PRODUCTION

--- Selected Countries of West Africa: 1968 ---

System	Production Methods: Source of Water	Control of Water	Seeding	Fertilizer Used	Partial Mechanization	Cost Per Hectare (Dollars): Recurring Labor Only	Recurring Total	Capital Total	Total	Cost Per Metric Ton (Dollars): Recurring	Capital	Total
IVORY COAST												
1. Traditional Upland	Rain	No	Direct	No	No	32	38	28	66	38	28	66
2. Improved Upland	Rain	No	Direct	Yes	No	75	91	12	153	46	6	52
3. Mechanized Upland	Rain	No	Direct	Yes	Yes	47	111	12	123	55	7	62
4. Swamp	Flow	Yes	Direct	No	No	86	92	4	96	37	2	39
5. Irrigated	Flow	Yes	Transplant	Yes	No	156	178	24	202	36	4	40
UPPER VOLTA												
6. Irrigated	Flow	Yes	Transplant	Yes	No	165	236	158-308	395-544	59-67	38-186	97-153
NIGER												
7. Floating	Flow	No	Direct	No	No	51	59	3	62	30-74	1-4	31-78
8. Other Swamp	Flow	No	Direct	No	No	51	59	3	62	30-74	1-4	31-78
9. Irrigated	Pump	Yes	Transplant	Yes	Yes	106	150	381	531	31-44	75-108	106-152
SENEGAL												
10. Irrigated	Flow	Yes	Transplant	Yes	Yes	181	227	32	259	57	8	65
LIBERIA												
11. Irrigated	Flow	Yes	Transplant	*	*	91	148	*	*	34	*	*
12. Irrigated	Flow	Yes	Transplant	No	No	285	291	49	340	104	73	177
13. Mechanized Upland	Rain	No	Direct	Yes	Yes	5	86	43	129	64	28	96

Continued

ESTIMATED COST OF RICE PRODUCTION

--- Selected Countries of West Africa: 1968 ---

System	Production Methods: Source of Water	Control of Water	Seeding	Fertilizer Used	Partial Mechanization	Cost Per Hectare (Dollars): Recurring Labor Only	Recurring Total	Capital Total	Total	Cost Per Metric Ton (Dollars): Recurring	Capital	Total
SIERRA LEONE												
14. Upland	Rain	No	Direct	No	Yes	157	164	48	212	159	46	205
15. Swamp	Flow	No	Direct	No	Yes	158	165	4	169	99	2	101
16. Swamp	Flow	No	Transplant	No	Yes	69	76	8	84	35	3	38
NIGERIA												
17. Irrigated - North	Flow	Yes	Transplant	Yes	*	126	187	*	*	106	*	*
18. Irrigated - East	Flow	Yes	Transplant	Yes	Yes	135	197	42	239	88	17	105
19. Irrigated - East	Flow	Yes	Transplant	No	No	117	163	*	*	96	*	*
20. Irrigated - Norcap	Flow	Yes	Transplant	Yes	No	162	179	*	*	80	*	*
21. Irrigated - Uzo-Uwani	Flow	Yes	Transplant	Yes	No	108	148	*	*	88	*	*
22. Irrigated - West	Flow	Yes	Transplant	Yes	Yes	94	136	47	183	62	22	84
23. Swamp - Midwest	Flow	No	Direct	Yes	No	205	208	16	224	92	7	99

* Not available.

NOTE: Bird-scaring costs included only for System Lines numbers 12, 14, 15, 16, 19, 20, 21, 22, and 23.

SOURCES: Lines 1-9. Compiled by Team; irrigated figures are from Republic of China mission; labor requirements under 8 are from SEDES, Les produits vivriers au Niger; production et commercialisation, Paris, 1963.

Line 10. Frank Lee, Taiwanese Rice Specialist, the Casamance, Senegal, August 1968.

Line 11. Ken Li, Chief, Taiwanese Agricultural Mission to Liberia, August 1968.

Lines 12-13. C. Roy Adair, Herschel B. Ellis, Fred T. Cooke and Armin Grunewald, Rice Production and Marketing in Liberia, U.S.D.A./A.I.D., Washington, 1968.

Lines 14-16. Developed by Team from information furnished by Sierra Leone Government.

Lines 17-23. Taken from information compiled by U.S. AID Mission, Lagos.

WEST AFRICA

Rainfall Distribution

Section Two: COUNTRY REPORTS

DAHOMEY

The Rice Economy

Corn and grain sorghum are the main food grains for the people of Dahomey. Corn production in 1966 was estimated at about 218,000 metric tons or about eighty-seven kilograms per capita. Rice production the same year was estimated at 1,800 metric tons or about seven-tenths kilograms per capita. Rice imports increased from 2,000 metric tons in 1957 to about 6,800 metric tons in 1965 and 1966. The 1966 imports represent less than two and one-half kilograms per capita. The government is less concerned about rice than about major food grains and cash crops such as palm oil and kernels, coconuts, coffee, cotton, and tobacco. Dahomey's population as of January 1, 1967, was estimated at 2.5 million, with a growth rate of 2.8 percent annually. Eighty-eight percent of the people live in rural areas. The urban population is concentrated around Cotonou and Porto-Novo, with 119,400 and 76,000 inhabitants respectively. The population density is greatest in the south and least in the northeast.

The Physical Environment

The coastal lagoons of the south are hot and humid, with an average of about 30°C and with three seasons -- a rainy season from mid-March through mid-July, a short rainy season from September through November, and a dry season from November through February. From about ninety kilometers north of the coast, the topography rises to a plateau of more than 500 meters. Here the rainfall is about 750 mm. and the temperature is cool.

The three chief waterways that traverse Dahomey are:

1. The Oueme, 450 kilometers long and navigable for 200 kilometers, with its source in the Attacora. South of Zagnanado, the Zou joins the Quoeme. This river runs into Lake Nokoue, near Cotonou.

2. The Mono, 350 kilometers long, and navigable about 100 kilometers, has its source in Togo and empties into the Gulf of Guinea.

3. The Couffo, 125 kilometers long, flows from Savalou area, feeds Lake Aheme and forms a network of lagoons.

Each river has fertile valleys which could be developed into rice land. There is enough water in the rivers and lagoons for irrigation. In some areas it would be necessary to use a pump, in others gravity flow.

The five geographical zones are:

1. A coastal zone, low and sandy, rectilinear, running southwest to northeast, two to five kilometers deep, limited on the north by lagoons.

2. A series of clayey plateaus limited to the north by the rocky foothills of Savalou and Dassa-Zoune. Between Allada and Abomey, about seventy kilometers from the sea, this zone is crossed by a marshy depression extending from west to east to the Holli country. In this zone of lower Dahomey, some plateaus are 400 meters high.

3. A silico-clayey tableland is found between Savalou and the hills of Attacora. This zone is characterized by a patchy forest.

4. The mountain mass of Attacora with an altitude ranging between 500 and 700 meters.

5. The fertile plains of the Niger river.

Production

The amount of rice production is small and scattered. Production data is difficult to collect. Of 11,262,200 hectares total in Dahomey, 908,170 hectares are in cultivation. About 646,000 hectares are under a two cycle per year cultivation with corn, peanuts, and beans.

Data for the designated six regions are:

	Total surface (hectares)	Area double cropped (hectares)	Cultivated (hectares)
Northeast	5,100,000	123,130	123,130
Northwest	3,120,000	121,100	121,100
Central	1,870,000	83,910	126,660
Southwest	380,000	88,615	138,740
Southeast	470,000	152,260	266,360
South	322,200	76,730	132,180
	11,262,200	645,745	908,170

Corn is the principal crop, followed by sorghum, millet and rice.

The following production data are available:

Year	Corn	Sorghum	Millet	Rice
	--thousand metric tons--			
1956	142	60	14	1.5
1957	183	71	17	1.7
1958	135	41	3	0.7
1959	221	64	6	1.8
1960	197	64	7	2.1
1961	220	61	7	0.7
1962	222	53	6	0.7
1963	206	63	7	0.9
1964	228	57	6	1.0
1965	218	59	5.5	1.5

The production of rice is increasing, but not fast enough to supply demand. In 1965, the northeast district was reported to have 1,307 hectares in rice with a production of 807 metric tons. The northwest district reportedly had 1,477 hectares and produced 672 metric tons. Yields are low, averaging about one-half metric ton per hectare. The amount of rice grown in the south is small.

Varieties are 437, Congolese R-46, and R-66. The yields are about the same from all improved varieties.

Marketing

Almost all local rice is consumed in villages where it is produced. There is no commercial marketing of locally produced rice. Likewise there is no equipment for mechanical processing (other than a small mill at the Taiwanese project), drying, or storing rice. Roads are poor in most rural areas where rice could be produced.

Dahomey is not producing enough rice to fill the demand. Therefore, the government allows private firms to import rice. Imports, 1956 through 1966, were:

Year	Metric Tons	Value (million CFA francs)
1956	3,054	89 ($ 356,000.)
1957	2,009	59 (236,000.)
1958	3,297	109 (436,000.)
1959	2,582	97 (388,000.)
1960	5,952	168 (672,000.)
1961	2,689	85 (340,000.)
1962	4,846	196 (784,000.)
1963	4,305	150 (600,000.)
1964	5,300	186 (744,000.)
1965	6,864	244 (976,000.)
1966	6,814	297 (1,188,000.)

Imports are not restricted, but there is a nominal port charge of 40 cents (100 CFA francs) per metric ton. The legal fixed margins of profit on rice are ten percent for wholesalers, and four percent for retailers. Retail markets in Cotonou offerred rice on Aug. 29, 1968, at the following prices:

Grade	Price CFA francs per kilogram
U.S. No. 2 Medium Grain - 4% Brokens	75 (30 cents)
U.S. No. 3 Medium Grain - 4% Brokens	70 (28 cents)
U.S. No. 5 Medium Grain -10% Brokens	65 (26 cents)
U.S. No. 5 Medium Grain -25% Brokens	58-62 (23-25 cents)

Imported rice is consumed mostly by French residents and government functionnaires in Cotonou, Porto Novo, Abomey, and Parakou.

Services

The most significant rice production project in Dahomey is operated by the Taiwanese about 160 kilometers north of Cotonou and northeast of Abomey. Rice is included in the extension work at some "pilot" villages, but little supervision is given to this work. The United Nations has a small rice project in the southeast district.

The Taiwanese project near Bohicon, on the Zou river, consists of land development and rice growing. In 1967, fifteen hectares of paddy rice and about 200 hectares of upland were cultivated under Taiwanese supervision with paid labor. This project seeks to build a levee along the Zou river to keep the flood waters off the land. When completed, it will have effective water control on 1,500 hectares. A good portion of the levee has been built; however, it was broken by local people, when the water began to rise because there was fear that the water would flood the villages.

The Taiwanese have averaged five metric tons per hectare on the paddy rice; some experimental plots have yielded eight metric tons. Upland yields have been 3.5 metric tons per hectare. IR-8 is planted under upland and paddy conditions, with yields of three metric tons per hectare for upland and 6.2 metric tons per hectare for paddy. The total annual yield for the paddy was 12.4 metric tons per hectare since the land was double cropped. The 700 metric tons produced on the Taiwanese projects constitutes about thirty-three percent of the total rice produced in Dahomey in 1968.

If the targets are realized, this project should produce more than 18,000 metric tons per year on the 1,500 hectares. The main problem in achieving the target is a shortage of labor. Either more people will need to be resettled in the area or a greater percentage of the work will have to be done with machinery.

Since it is not envisioned that the Taiwanese will remain indefinitely in Dahomey, the eventual fate of this rice plantation depends on whether the government can maintain this project with sufficient capital and technical staff. At the present time, two technicians supplied by the government are working as trainees with the forty-six Taiwanese.

An eventual goal may be land distribution, whereby individual farmers will receive irrigated plots for rice production. It is understood that the Taiwanese have been concerned about the lack of a decision on the land distribution proposal.

The farmers in the Bohicon region, site of the Taiwanese project, do not appear to be traditional rice growers. No plots of rice planted by local farmers were observed. The major rice producing areas of Dahomey are located in the northeast and northwest. Although there has been an increase of local production from 756 metric tons in 1961 to approximately

1,500 metric tons in 1967, the average yields do not exceed three to five metric tons per hectare.

The French have done rice production research in the Niger River basin where there are said to be 500 hectares available for paddy production. The sousprefet of Malanville said that rice trials in that area last year were not successful. It would appear that rice production in the Niger River area would find a ready market since truck transportation is available. Malanville is on the road connecting Niamey with the railhead in Parakou, Dahomey, and eventually with the port of Cotonou.

The obstacles to increasing rice production in Dahomey are not of a physical nature. The Taiwanese have demonstrated that rice can be produced at high enough yields so that the total rice production for Dahomey could come from alluvial soils near its various rivers. These soils are generally heavy in clay and not particularly subject to excessive leaching, such as is found in latosols under upland conditions.

Suggestions for Improvement

1. The government should take immediate measures, to enable individual farmers to own rice paddies in the Taiwanese demonstration project at Bohicon.

2. The Taiwanese should reduce their emphasis on the single area near Bohicon and start demonstration plots in the Mono Valley and perhaps on the Niger River. The development of the Bohicon area is limited by the local population.

3. Thought needs to be given to the Bohicon project when the Taiwanese complete their contract. The two Dahomeans being trained are not enough to continue the operation when the Taiwanese leave.

4. The two varieties, IR-8 and Tachung Native No. 1, planted in the Taiwanese project, should be multiplied and distributed through the government extension service. The number of varieties being used should be reduced with emphasis upon the two just noted.

THE GAMBIA

The Rice Economy

Rice is a food staple in The Gambia. It is grown on swamplands by the Gambia River and on the upland primarily for local subsistence. In order to meet the demand for rice, it has been necessary to import between 8,000 and 11,000 metric tons yearly. Last year, the majority of the imports came from Burma. Early in the year, the cost for imported rice ranged from thirty-eight Gambian pounds (about $91.20) to fifty-eight Gambian pounds (about $139.20) per metric ton. This price was for seventy-five to 100 percent broken milled rice. At the higher cost, imports would constitute a drain on foreign exchange of about $1,392,000 a year. Rice imports were about ten percent of all imports in value.

The Gambia has about 350,000 people or thirty inhabitants per square kilometer. The rate of population growth is two percent annually. Eighty-seven percent of the population lives in the rural areas, leaving thirteen percent in the urban areas.

Total milled rice consumption is estimated at 30,000 metric tons annually. Consumption per capita averages about 81 kilograms per year. In some rural villages, very little rice is consumed, but in the producing areas and in urban centers, rice consumption is estimated at about one pound (0.45 kilogram) per person per day.

The Physical Environment

The Gambia has a land area of 10,000 square kilometers or one million hectares. It forms a land strip sixteen to fifty kilometers wide and 400 kilometers long, bisected by the Gambia River and is surrounded by Senegal. The river is navigable to freight boats or barges for almost the nation's entire length.

The Gambia is composed of four divisions, three of which, Lower River, Central, and MacCarthy, comprise respectively the north and south banks of the lower, middle and the upper reaches of the river. The fourth, Western Division, comprises a triangular southward extension along the coast below Bathurst, the capital. Of the total area, sixteen percent consists of tidal and fresh water swamp.

The salt flats (33,000 hectares) and about fifty percent of the mangrove areas (22,000 hectares) are saline throughout the year. From the mouth of the river upstream about 130 kilometers, the water is saline. Above 390 kilometers upstream, the water is fresh.

The Central Division has 20,000 hectares under swamp rice cultivation. It is estimated that an additional 4,500 hectares of low-lying upland and true upland rice are cultivated elsewhere.

Production

The area under rice cultivation covers about 24,000 hectares. An estimated 65,000 hectares are potentially suited to rice growing. Most of this land is in the MacCarthy Island Division. Extensive rice growing in the east of MacCarthy Island Division is precluded by high floods. West of this Division, salinity is the greatest problem. Generally, yields in the salt-water swamps are below optimum because of the poor drainage conditions and lack of water control. On the upland rice areas, a shortage of water and poor soils are limiting factors.

There are three classes of rice culture in The Gambia: (1) low upland rice, (2) fresh water (rainfed) swamps, and (3) salt water swamps, including mangrove areas.

The soil is prepared by hand hoes. The soil is worked to a depth of two to three inches. Deeper cultivation would produce higher yields. Land preparation begins in late April or early May. Hoes are used in the upland and rainfed swamp areas. The ridging method in salt-water swamps requires a long handled spade.

Seeding or planting of upland and rainfed swamp areas takes place in June and early July. The broadcast method is used in most of these two areas. However, in the Jola tribal areas,hand drilling in rows is practiced. Hand hoes are used to cover the broadcasted seed with soil. Rate of seeding varies from 110 to 170 kilograms per hectare (about 1/3 more than government recommendations). Children drive birds away until the green plants emerge. Broadcast rice usually yields less than drilled rice because the latter can be weeded during the growing season and there is more plant tillering.

Nursery beds are used for transplanting in the salt-water swamps and some of the rainfed swamps. Rice is usually broadcast in the beds at the rate of about 335-450 kilograms per hectare. Transplanting from bed to field occurs in thirty to as many as seventy days after the nursery bed is seeded.

Farmers are beginning to use commercial fertilizer on nursery beds and some upland rice fields. Animal manure is also used on these lands where available. Salt-water and rainfed swamps are generally not fertilized. Rates of commercial fertilizer application, where used, are low, ranging from twenty-eight to ninety kilograms per hectare. A few farmers use up to 225 kilograms per hectare where

fertilizer is donated or subsidized. Usually, fertilizer is applied as a top dressing to a crop that is not doing well.

Transplanting from nursery beds takes place in late August or early September, depending upon rainfall. Usually, rice is transplanted at the rate of one plant per hill (instead of two to five plants as in the Far East). Spacing between plants ranges from fifteen to thrity centimeters.

Weeding is neglected in most rice fields. Some farmers weed once or twice during the growing season. Farmers are not trained to identify weeds from rice when the latter is in early growing stages.

Pests affecting rice include grasshoppers, army worms, case worms, rice bugs, fishes, birds, hippopatamus, wild hogs, and sometimes babcons. Efforts to control pests generally have been inadequate. The most serious disease is blast, which affects many fields.

Harvesting begins in October, which causes competition for labor with the peanut harvest, and continues into January and February for late maturing varieties. One rice head is cut at a time with a small knife or sharpened piece of steel. It takes sixty to one hundred man days to harvest one hectare. The rice heads are tied in small bundles and dried in the field. After drying the rice is carried home and stored in small buildings or in the rafters of the farmers' house.

Rice is usually threshed by beating the grain heads with sticks and winnowing out the chaff. It is mostly milled by the mortar and pestle method, which requires about one hour per pound to mill out the bran. There are twelve single stage hullers used mostly in connection with experiment stations and not by local farmers.

Estimates for national rice production are:

Year	Hectares (Thousands)	Production Metric Tons (Thousands)
1964/65	27.0	37
1965/66	26.3	35
1966/67	25.5	33
1967/68	28.4	36

Yields were reported at 0.45 to 1.7 metric tons per hectare for upland rice, and 1.1 to 2.8 tons for swam-grown rice. However, yields on Taiwanese demonstration plots ranged from 2.2 to 3.9 tons for upland rice and 4.5 to 9.0 metric tons for fresh water irrigated fields.

Production costs per hectare provided by the Department of Agriculture are:

Input	Upland	Rainfed Swamp	Tidal Swamp
Hoeing	$5.93	$4.95	-
Seeding	3.70	2.96	$2.96
Transplanting	-	11.88	11.88
Weeding	9.65	6.82	3.56
Harvesting	5.93	5.93	5.93
Transporting	2.96	2.96	2.96
Fertilizing and manuring	17.80	17.80	10.00
Total	$46.00	$52.90	$37.30

Many farmers use no fertilizer or manure. All other cost items are thought to be conservative. Cost of harvesting alone could equal the grand totals listed above.

Marketing

Marketing of imported rice is handled by a rice consortium, under government control. The rice is sold by the consortium with the government subsidizing it, if necessary, to hold the retail price at eight cents a pound (17.5 cents per kilogram) in Bathurst. Actual cost this past year was reported to be about eleven cents a pound. (ca. 24 cents per kilogram). The fixed retail prices outside of Bathurst range from eight and a half to ten cents per pound (18.75 to 22 cents per kilogram). The government subsidy has taken the form of waiving certain customs duties and drawing from a rice stabilization fund which was built up during a period of lower world prices. The stabilization fund is nearly exhausted.

There is little storage available for milled rice. No complete multi-stage rice mill and no commercial drying facilities have been established.

The United Nations estimates 20-22,000 metric tons of milled rice comes from domestic production. Most of the domestic rice is consumed by the families of producers or their neighbors. Farmers in the Lower River Division sell about fifteen percent of their production and the MacCarthy Island Division sells about twenty percent of its production to other areas.

In 1967, the government initiated a pilot rice marketing scheme. Four village buying stations were established in the main rice producing areas and rice buying agents were appointed. Paddy rice was bought from the growers at three cents per pound (6.6 cents per kilogram) and was transported by road to Safu where it was

milled for the Department of Cooperation. The Department sold the rice through the rice consortium. Last year the Department bought 107 tons of paddy rice and sold sixty-five tons of milled rice. Members of the consortium are reluctant to buy this rice because of its low quality. The Department of Agriculture hopes to establish ten new buying centers next year.

Most local paddy rice is sold to private traders for a reported two cents a pound (4.4 cents per kilogram). Some rice is bartered for items such as soap, sugar, salt and kola nuts.

To stimulate greater production, twelve engine-operated rice hullers provided by A.I.D. in 1965 have been operating under the Department of Cooperation in the main rice producing districts. Payments for the cost of milling are made mostly in kind, usually ten percent of the rice milled.

The average yield or total milled rice after processing usually is from fifty-eight to sixty percent. Without proper supervision, it was stated that yields would sometimes drop to forty-fifty percent. After observing the processing, it seemed that about ten to fifteen percent of the broken rice remained in the bran and hulls produced by these rice hullers.

There are plans to construct two or three modern multi-staged rice mills in the main rice producing districts. With mills of this type, yields of milled rice could be increased ten to twenty percent.

Twelve simple hullers have been provided by India. In addition to these hullers, a small rice mill with a capacity of two tons per hour, is located at the government experiment station of Safu.

Services

Tractor plowing service

The Gambian government operates a tractor-plowing and discing service available to farmers in the MacCarthy Island Division. Most of the land is plowed for members of cooperative societies sponsored by the Department of Cooperation on a credit basis. Other farmers are required to pay cash in full before plowing. The cost is $7.20 per acre ($17.80 per hectare) for plowing and discing. This price is subsidized by the government at about fifty percent. Therefore, the actual cost for plowing and discing is about $14.40 ($35.60 per hectare).

The acreages mechanically cultivated during the past six years are given below:

Year	Plowed (Hectares)	Disced (Hectares)
1962	289	219
1963	578	472
1964	990	745
1965	1,367	1,188
1966	1,430	1,422
1967	1,896	1,888
(est.) 1968	2,342	2,161

Community development

Much of the effort of community development is directed towards the construction of causeways and simple bridges to make suitable sites for rice growing accessible. While bridges and causeways have been constructed in many swamps by the Colonial Development Cooperation (CDC), followed up by local Area Council funds and more recently by community development funds from the Netherlands, the problem is the annual recurring construction since these bridges and causeways wash out during flood periods. Making them permanent will add another milestone in overall production.

Improved seed distribution

The government, in order to increase production, has introduced improved varieties of seed, such as: Taichung Native No. 1, Taichung No. 178, IR-8, and Soavina.

Only small quantities of improved seed are distributed each year because the program, as presently organized, is not effective. More progress is made by Taiwanese rice teams in distributing seed to their cooperating farmers.

Fertilizer distribution

The West German government has donated fertilizer to encourage increased production of rice and peanuts.

Quantities of fertilizer for rice imported during the past eight years, compared to fertilizer used on peanuts, are:

Year	Fertilizer on Rice (Metric tons)	Fertilizer on Peanuts (Metric tons)
1961	200	100
1962	10	100
1963	-	200
1964	-	100
1965	10	750
1966	100	1900
1967	500	2000
1968	100	3212

Taiwanese rice mission

The forteen-member Taiwanese team has been in The Gambia for two years. Their project is located near Sapu. With controlled irrigation, the team is investigating local varieties, along with Taiwan varieties, for adaptability to both rainy and dry season cultivation. Fungicides and herbicides are now on trial at the Taiwanese demonstration farms. A number of the introduced varieties have produced well and yields of 5.5 to 6.6 metric tons per hectare, at least four times, the annual average yield, have been recorded.

During our tour of the Taiwanese projects and the surrounding areas, we were impressed not only by the success of their demonstrations but also with their extension programs. Farmers in the villages near the demonstration sites are now growing rice under instruction and supervision from the Taiwan technicians. Taiwan has extended its contract for two more years and has agreed to furnish twenty-two technicians and build a rice mill. The objective of the team is to extend the Taiwanese techniques to 800 hectares by 1970 of which 600 hectares will be upland rice and 200 will be paddy rice.

College of Agriculture training program

The College of Agriculture is involved in the selection and training of new staff for the Ministry of Agriculture. These training programs seemed to be very effective.

Suggestions For Improvement

Unless rice becomes a cash crop with organized marketing and a guaranteed reasonable minimum price, there will be little incentive for the grower to produce more than is required for home consumption.

At the present time, The Gambia is importing 10,000 tons of rice per year. This is about one-third of its production in terms of milled rice equivalent. By using the Taiwanese methods and increasing production to 1.7 metric tons per hectare the deficit could be eliminated.

The biggest problem facing The Gambia is to establish an effective marketing system. At the present time, the rice consortium is not willing to market rice because of the low margin of profit. At present, rice is bought by the peanut cooperatives. It will be necessary to expand these co-ops if this method is used.

Following are suggestions for improving the rice economy:

Concentrate on acreage now being cultivated rather than expanding to virgin land at the present time. The Taiwanese methods for improving yield should be extended to more acreage. This will bring about more rapid and economical increases in total production when compared to the higher development costs for reclaiming virgin land, constructing dikes, irrigation ditches, and leveling land to provide water control on new lands.

Establish a program to produce and distribute pure seed of a high yield variety suited to conditions in The Gambia. This program could be organized and carried out in cooperation with the nearby Casamance area of Senegal.

Encourage farmers to plant seeds in rows rather than broadcasting. This will help to control weeds.

Expand the cooperative system now used for peanut production and marketing to rice producers. This will make it possible for rice farmers to obtain credit, fertilizer, and seed and to market surplus rice.

Encourage, through demonstrations, the use of fertilizer to obtain higher yields.

Provide advice and demonstrations in irrigation areas on water control.

Establish a minimum price at which the government will buy or guarantee a price to producers that will be sufficient to produce the desired volume of rice.

Establish a program to provide technical advice on the construction and use of inexpensive rice drying and storing facilities.

Institute a program to encourage use of improved tools and implements as well as animal power in rice culture.

In the MacCarthy Island Division, provide a multi-stage modern rice mill.

Establish standards of quality for paddy and milled rice, and reward producers for high quality so that The Gambia will be in a position to offer higher quality milled rice for export when the country becomes self-sufficient.

Establish a rice marketing board within the government to control imports and import prices until the country attains self-sufficiency and to aid in export marketing.

GHANA

The Rice Economy

During much of Ghana's history, rice has contributed to the food requirements of its people. Prior to independence in 1956, rice was grown generally throughout Ghana and became a part of the diet of much of the indigenous population. However, the level of production varied substantially between different periods of time within local areas.

During the past six years, the average annual production has been about 35,500 metric tons of milled rice, while the imports of milled rice were near 37,000 metric tons. Thus, Ghana is about 50 percent self-sufficient in rice.

The current per capita consumption of rice is about nine kilograms per year. The marked increase in consumption during the postwar period is largely due urbanization and to the probability that rural people eat more rice. The continuing increases in population coupled with likely increases in per capita incomes points to a growing domestic rice demand. Substitution locally produced rice for imports would release scarce foreign exchange for other purposes.

Rice plantings of 42,000 hectare in 1967 accounted for only 4 percent of the total acreage of annual field crops (excluding vegetable) and ranked approximately seventh in value of total field crop production.

Rice, until recently, has not received much emphasis from research and extension. Consequently, production techniques, areas of concentration, and systems of assembling, processing, and marketing, have developed in a haphazard manner.

The Physical Environment

Rice is produced widely in Ghana. However, the biggest production is in the Northern, Upper, and Brong Ahafo regions. No rice is grown under controlled irrigation, except experimentally on the Kpong Experiment Station. Commercially grown rice is dependent upon rainfall and is classified as upland rice. The Taiwanese plan a irrigated rice project on a small acreage during 1969.

Commercial upland rice is grown under a wide range of land conditions, varying from plantings on sloping land, cleared from native brush and timber growth, to lowland areas along streams and in swamp lands. As previously mentioned, upland rice is dependent upon rainfall, the resultant overflow of streams in low-lying level areas, and water collected in swamp lands from hillside run-off. Since all this rice depends on the amount of rainfall during the monsoon season and the timing of these rains, the volume of production is unpredictable. Rainfall varies from near 1,250 millimeters in the three southern regions, 1,000 mellimeters in the northern regions, and 2,000 millimeters in the central regions. This dependancy on the monsoon rains permits one rice crop per year. Only though controlled irrigation can more than one crop a year be grown.

Production Techniques and Costs

Little technology is employed in rice production. Seeding generally is by broadcasting on newly worked soil and sometimes covered by harrowing. In some cases, seed is planted in holes made by a stick and covered by foot. Some rice is broadcast on land plowed by government tractors and followed by discharrow to cover the seed. No attempt is made to prepare a seed bed. Weeds and native grass are not controlled and become a serious problem. In some cases, near Ada, the rice is broadcast on cleared land without any soil preparation other than burning off weeds. The rice is seeded in the ash. As would be expected, rice yields are low. The average national yield is only about 785 kilograms per hectare a year. Many factors other than poor seed bed preparation leads to low yields, including: low-yielding and mixed varieties, pest damage from birds and rodents, weeds, too much or too little water, poor rice processing equipment, poor soil, and lack of fertilizer use.

Commercial rice produced in central and northern Ghana is parboiled as a home industry. The indigenous milled rice is contaminated with small stones. This foreign matter gets into the rice during threshing and the post-parboiling drying. Often these procedures are performed on the ground and there is no way to avoid picking up the stones. Threshing and drying platforms made of cement would solve this problem. Canvas would also help reduce objectionable foreign matter. Parboiling is done in pots, pans, or stell barrels, about one bushel at a time. Variations in the procedures and methods of parboiling often leads to lack of uniformity in milled rice.

A major obstacle to commercial rice production is lack of uniform varieties and pure seed. Even the rice observed growing on the government seed farm at Abidome was badly mixed. This mixture of varieties leads to many problems, such as:

1. The milled product is not attractive due to the admixture of red rice and many grain types.

2. The wide variation in maturity leads to a paddy containing over-ripe grain that is sunchecked, and immature, chalky, green grains.

3. Milling of mixed varieties is difficult and contributes to low mill yields.

4. It is impossible to adjust a mill for maximum efficiency when grain of all types, shapes, and stages of maturity are in the paddy.

5. The maximum potential field yields are not possible when mixed varieties are grown.

The Ministry of Agriculture has begun a program to produce pure seed. In 1968, production of 17,000 pounds of improved rice seed is forecast, compared to an estimated need for nearly five million pounds. Other factors that hamper the rice industry in Ghana are lack of transportation, milling facilities, and credit assistance programs. The present price of $6 per 180-pound bag (7½ cents per kilogram) by the government, is not sufficient to stimulate production. A group of farmers at a meeting held at Yendi said, "Self-sufficiency can be attained if we are guaranteed a fair price, are extended credit, and transportation problems are solved."

The government's attempt to supply tractors for plowing has not been a successful venture. The Agriculture Office in the Northern Region said 385 tractors were on hand, but only 225 were in operating condition. Lack of skilled drivers, mechanics, and spare parts are the principal reasons for the mechanization breakdown.

Rice from the north is a comparatively long grain. If grown in upland sections, its color is white (chalk-like); if grown in semi-swamp areas, the endosperm develops clear and hard characteristics. The parboiling before milling adds to the darkness of the color and a distinct odor. The central and southern regions produce short and medium grain in both white and parboiled forms.

The imported rice is mostly long grain varieties. Some of the U. S. rice is parboiled, but there appeares to be no market preference between parboiled or raw rice. The price of imported U. S. rice is only slightly higher than indigenous rice in the Accra market.

Of the local rice, the public seems to favor it parboiled. Parboiling should be encouraged because of its higher milling yield with fewer broken kernels and its higher nutritional value (Vitamin B, Niacin and Iron). Milled parboiled rice also keeps better in storage than raw rice and is less subject to weevil damage. Parboiling also furnishes a home industry and source of extra income.

There was practically no information reflecting a systematic calculation of rice production costs or alternative crops. One farmer with a commercial rice enterprise of 20 hectares provided fairly complete estimates of total costs. His land, situated along a small stream and originally covered with grass, was prepared and seeded by government mechanization services at the standard rate of $15.40 per hectare. Labor for weeding, bird scaring, and other jobs was hired. Weeding costs were estimated at $17.40 per hectare. The total cost was estimated at $145 per hectare. At an estimated yield of two metric tons per hectare, the cost per metric ton of paddy would average $61.80.

Marketing

Noticeable characteristics of rice, the process, and terms of trade in the marketing system are (1) local rice is not a uniform product, (2) no semblance of grading by grain type or predetermined quality standards is practices, (3) processing and milling is performed largely by trades women as a daily activity, and (4) in retail markets, there is little difference in price between fine milled white rice of uniform grain size and excessively broken, partially milled rice of poor quality. These and other factors contribute to numberous rigidities in the market.

From the farmer;s viewpoint, the effect of the growing market demand for rice has depended upon location and conventional methods of preparing rice for markets. Southern grown rice (which is not parboiled before milling) is accepted in the major trade centers, whereas northern grown parboiled rice sells slowly, even with significant discounts in price. This ridigity in the market no doubt will continue to prevail even though the overall demand likely will continue to expand.

The effects of a strong urban demand for imported rice likely will continue the inflationary pressure on prices, and indirectly exercise a strong influence toward maintaining relatively high import quotas. White rice generally of the medium grain type is imported. One importer in Accra had brought in 2,340 metric tons of U. S. medium grain rice. (No. 5 -2% to 35% broken) at prices ranging from 14.1 - 14.4 cents a kilogram. This importer sells wholesale to "mammy" traders who sell at retail.

After threshing, rice passes through two functional groups in reaching the retail center. First, it moves either to the nearest road or village, where it is parboiled (not applicable in south) and taken to small mills for milling, then winnowed and sacked.

The farmer may sell to a paddy buyer at the farm or village who performs the last function. Second, the bags are either taken to retail markets by the person performing the first stage, or sold to a "mammy" trader who serves as a middleman between the milling stage and the trader in the retail market. Thus, rice moves in small quantities through the various stages, with no opportunity (or apparent need) for systematic inspection and designation of grades. No doubt quality has some effect in moving the rice more rapidly or in price determination, but to establish some measure of its importance would be difficult.

The market areas for rice in the south prefer white rice. Hence, par-boiled brown rice from the north may be unacceptable. It frequently remains in storage for long periods, and must be sold at discounts. The price discount for nothern grown rice in southern markets during March-May 1968 is reported to have ranged 22 to 30 percent below imported rice.

Transportation

Transport of farm produce and supplies is a major problem throughout Ghana. It possibly is more difficult in the case of rice, since production is located in low lying areas which are less frequently traversed by roads. Except for the large producers (those with more than 3.2 to 4 hectares) rice is generally conveyed from the field to the nearest road by head load. The distance often is referred to as by hours of walking time. From the point at which touching service can be obtained to the village mill, the charge is, to a considerable extent, dependent on road condition. Rice from this area to Accra in southern Ghana would carry a transport cost of $39 per metric ton. In contrast rice shipped from the southern U.S. to Ghana normally carries a transport cost of approximately N¢ 27.00 short ton ($29.00 metric ton).

While poor roads are a major cause of high transport costs, the small quantities of rice available from producers for transport is another factor. The average farmer with 1.2 - 2.4 hectares makes several sales in disposing of a crop.

Storage

The problem of storing rice varies between regions. In the south, the crop normally moves through mills and to retail outlets within three to five months after harvesting. Storage requirements for the small quantities at farms are no problem. Most farmers find sufficient space in their family living quarters or nearby huts.

However, in the north, where the entire annual harvest may be held for more than one season, storage becomes a problem requiring additional facilities.

In addition to privately-owned storage, the large government mills have from two to three large storage buildings for sacked grain associated with these plants. Space in such buildings might be rented to larger growers whose private warehouse space is inadequate. Other shed-type buildings owned by government agencies appear to be serving little useful purposes and proably could be converted for grain storage.

Officials do not understand completely what precautions are necessary to keep rice free of insects. For small quantities, frequent moving outside for sun drying is practiced. A few large growers reported that they also applied heat by placing bags of rice on raised platforms under which a slow burning fire is maintained. This process is repeated once each month during the storage period. This poses as considerable labor cost problem, which could be alleviated by expediting the milling of paddy and channeling it through the marketing system.

Milling

Rice milling is carried on mostly in villages where small hullers are available at custom rates. These hullers frequently are installed in conjunction with small maize grinders, which are operated with the same power unit. The efficiency of these mills is variable, depending on the uniformity in size and shape of the grain, the moisture content, the duration of storage prior to harvesting, and whether or not the rice has been parboiled. For un-parboiled rice that has remained in storage for several weeks, the proportion of whole grain may be no more than 35 to 40 percent of the gross weight before milling. For parboiled rice of comparable quality, the whole grain percentage may run 60 to 65 percent. This factor favors parboiling in the north.

The principal customers of the small mills are local trades women who, on a weekly basis, purchase one to two bags of paddy, parboil and dry it before milling, and after milling, winnow the rice in preparation for sale in the local market. From interviews in the northern local markets, we learned that for a bag of paddy (180 pounds) costing $8, the market woman would obtain about 18 to 22 pans (about two-thirds of a gallon) of milled rice for which she received about $9. The milling charge is 45 cents per bag.

The number of mills with larger capacity hullers in operation was not obtainable. Two trade names of other small mills have output capacity of 20 - 40 bags (1.6 - 3.3 metric tons) per day. One small Japanese-make mill which, milled and separated the grain into three gradations, was in operation at the Kpong research station.

About five years ago, the United Ghana Farmers Cooperatives Council (now defunct) purchased 15 German-made mills for $1,500,000. In addition to encouraging expanded production, these mills were to service rice from government farm corporations and members of cooperative societies. These mills have a rated capacity of approximately two tons of paddy per hour, and with accessory units cost approximately &90,000 each. Only two of these mills have been installed and only one has operated. The other 13 are in various stages of installation.

Government policies and regulations

In practice, the policy of agencies dealing with agriculture appears to be directed largely toward keeping food prices low to consumers. This concern seems to underlie the subsidization of fertilizer costs to farmers at about 50 percent and the plowing and other mechanized services to small farmers.

The Ministry of Agriculture is implementing a rice purchase program which it is hope will stabilize the price of paddy at the farm, relieve the farmer of the task and cost of parboiling and milling in order to sell direct to traders, share the cost of transport, and facilitate the movement of rice from the north to the urban markets of the south. The logistics of the scheme involve prearranged buying dates at local villages when the Food Marketing Corporation will provide transport for rice delivered by farmers. A price of $6 per 180 pound bag (1½ cents per kilogram) for paddy of any quality has been announced. Prices for domestic rice are stabilized to some degree by a ceiling price on imported rice. At wholesale, the current ceiling is $10.96 per 100 pounds(23.7 cents per kilogram). The retail levels are $11.20 per 100 pounds (24.2 cents per kilogram) NP 12 per pound 26 cents per kilogram and NP 8 per cigarette tin. The plan had been implemented only in two mill areas and little rice was delivered by farmers.

For 1967 crop, farmers feel that $6.20 per bag (7½ cents per kilogram) is not enough. The current price paid by "mammys" was $8 - $9 per bag (9.6 - 10.6 cents per kilogram). However, as the harvest season for the 1968 crop approaches, it is possible that this price might attract deliveries immediately after harvest. While the $6.20 price seems low, and doubtless will do little toward stimulating production, it is desirable that the government proceed cautiously. Placing the support price at a level that results in farmers delivering most of their rice to the Food Marketing Corporation would present problems of transporting, milling, and marketing beyond the capacity of the corporation to handle.

In connection with the receiving of paddy from farmers, there is no account taken of the moisture content, the amount of foreign matter, grain type, percentage of red rice, or other factors related to quality. No grade standards are applied.

Credit

Credit for production intermediate-term loans is channeled to farmers through cooperative societies. The cooperative movement in Ghana began some 40 years ago, primarily for encouraging cocoa production. A Department of Cooperatives in the Ministry of Agriculture was organized in 1944. In 1960, some 557 cooperative societies were registered. The number increased through 1964; but, in 1965, the Department was abolished and replaced by the Agricultural Credit and Cooperative Bank. This agency continues to service local cooperative societies but a considerable number of experienced personnel were lost in the transition and the cooperative movement has suffered.

When it is necessary for farmers to borrow, they are encouraged to make application through local cooperatives. The availability of funds apparently has been limited, and the chance of most farmers getting loans appears uncertain.

Loans direct to farmers or to firms in allied services are not encouraged, partially due to shortage of supervisory personnel and the high cost of servicing such loans. Some machinery companies extend loans to individuals, but the repayment terms often are difficult to meet.

Some farmers in the northern region had managed to meet cash expenses without borrowing. It seems the general practice is to use savings on hand, or to sell sufficient produce or livestock to meet operating expenses.

Services

A rice breeder is employed at the crops research institute of the Ghana Academy of Sciences. His activities consist of growing small plots of introduced varieties and studying their botanical characteristics, such as height of plant, grain length, glume color, width of leaf, length of growing season, awn type, and diseases.

The University of Ghana has a rice experimental station at Kpong. This station has tested varieties and responses to fertilizers. Some lowland rice is grown under controlled irrigation, allowing more than one crop a year. Tests are also being conducted on upland rice, growing one crop a year of different varieties. At this station, IR-5, from the Philippines, appeared to be doing better than IR-8. IR-5 appeared to be the highest yielding variety of short suration (130 days), while the best varieties of the medium duration (140-150 days) were from Surinam.

The Kpong experimental station has concluded that Stam F-34 is the best weed control chemical and no further tests of chemicals are being conducted. Some further testing of other new weed (grass) control materials should be conducted.

A small rice mill being used at the Kpong station, manufactured in Japan, was impressive and should be looked into as a commercial mill for private operators. The power requirement is relatively small and the capacity would make it feasible in many localities.

Extension

The Extension Service is a part of the Ministry of Agriculture. One agricultural extension officer is in charge of each of the eight regions. These regions are divided into sub-regions, each with an agricultural extension officer, with some of the sub-regions having more than one officer. There are not enough extension officers to serve the rural population. In many cases, lack of transportation vehicles and the inaccessibility to many areas, due to poor or no roads whatever, make contact with farmers even more difficult. Little communication with headquarters makes it near impossible to perform the duties required. It is believed that the staff is doing as good a job as can be expected under the circumstances.

A much larger extension staff is needed and more short-term training should be available for selected staff members. Training is handicapped by inadequate research activity to develop rice recommendations. Sending extension workers to study abroad is not the answer since most of the information they acquire is not applicable to their country. The most satisfactory way to solve this problem is for Ghana to develop the technology adapted to Ghana through practical research.

Suggestions for Improvement

An all-out effort should be made to produce pure seed of some variety, thus making Ghana a one variety producing country. It is an erroneous notion that several varieties are necessary to meet the varying conditions of such a small country as Ghana. This variety should have these characteristice: a long grain that consumers prefer; 130-150 day maturity; resistance to the rice blast disease; vitrous and clean endosperm; and medium height stature, responsive to fertilization, with stiff straw.

Such a variety probably already exists in Ghana and only requires isolation from the mixture of varieties now being grown for increase.

Promising existing varieties are BG 79 from Nigeria, or an early long grain variety from Surinam. Since the Philippine International Rice Research Institute is in the same latitude as Ghana, IRRI can assist in the selection of a variety. The strain of blast disease occuring in Ghana can be isolated and varieties tested at IRRI for resistance to blast.

The country should not wait fro the development of a variety, but should decide upon a variety from data already in existence in other countries of the same latitude, unless, such a variety does already exist in Ghana. Most any pure variety from a country of the corresponding latitude would be superior to the mixture of varieties now being grown commercially. The best variety for the swamp conditions would probably be best for the upland grown rice.

Some of the advantages that would result from a pure variety would be:

1. Paddy of uniform size and shape that would result in rice that could be uniformly and properly milled.

2. A crop of uniform maturity, eliminating paddy with over-ripe and sunchecked kernels or green rice resulting in chalky or blank kernels.

3. A paddy that could be parboiled uniformly.

4. A milled rice product that would be attractive in the market and demand a better price.

5. An increase in field yield.

Seed farms should be established and a seed inspection service should be founded. The more progressive private farmers should be selected for producing pure seed for re-sale to other farmers in their commuity. In addition, the extension service should put on a campaign to encourage and promote pure seed as soon as such seed is available.

More intensive cultivation should be practiced. This starts with land preparation and applies equally to those farmers that are using tractors for plowing and those who prepare their land with hand tools. The importance of good land preparation must be appreciated. Good land tillage would reduce the serious weed problem. Preparation of good seed beds would increase yields substantially.

Upland rice should not be sown broadcast, but should be drilled in rows to facilitate cultivation. Drilled rows should be on the contour arond the hill, rather than up and down the hill. Swamp rice fields should be bunded to hold water where available and the rice transplanted.

Extending credit to farmers would make it possible for farmers to take advantage of improved technology, such as fertilizer, mechanical cultivation, weed control sprays, and the hiring of labor during periods of peak labor requirements. In some cases, credit would eliminate the necessity of having to sell rice during periods of excess supply at below cost of production.

Improved transportation facilities would result in more orderly marketing, better prices for paddy, and possibly, a lower rice price to consumers. The present cost of transporting rice from the principal producing areas to the large centers of population seems excessive.

Private rice milling should be encouraged. Credit to private millers should be given as needed. It appears advantageous to encourage the location of small rice mills close to producers, rather than constructing a few large mills far from production centers.

Studies should be made to determine the best procedures and methods of parboiling on the small home industry basis. This information should then be coveyed to the home industry parboilers. Better parboiling practices would lead to a more uniform and attractive milled rice product and result in a higher mill out-turn.

Fertilizer use by private farmers should be encouraged by the extension service. An extensive campaign should be made through demonstration plots and farmer meetings in order to increase the use of fertilizers. Recommendations on the fertilizer elements needed, rates of application, and time of application should come from the Academy of Sciences and the experimental station at Kpong.

IVORY COAST

The Rice Economy

Rice ranks a distant fourth among the Ivory Coast's staple foods. It constitutes only eight percent of the starchy-food consumption by weight on an unmilled basis. In 1965 the "average" Ivorian consumed the equivalent of seventy kilograms of paddy, compared to 170 kilograms of manioc, 210 kilograms of cooking bananas, and 330 kilograms of yams.

Rice, an Ivorian luxury staple, costs considerably more than other sources of starch. Producing more rice would not be the cheapest way of increasing calories available to Ivorians, and calories are not really lacking now. Additional rice production would not markedly improve the country's protein, mineral, or vitamin diet. Therefore, increasing rice consumption is not a desirable economic-policy objective.

Increasing Ivorian rice production is desirable, provided it can be achieved at a reasonable cost. Although rice is not competitive in price with other foods of similar nutritional value, rice consumption is increasing rapidly and is likely to continue to increase. Since 1950, consumption growth has outstripped increases in production, leading to significant imports. At present, the lack of foreign exchange is not a bottleneck for Ivorian development, but planners expect it to become one in the future.

Consumption

Rice is the traditional staple for that small part of the Ivorian population living in the forest zone west of the Badama River. People there probably eat over 150 kilograms of paddy per person per year, but most of the recent increases in consumption have taken place elsewhere.

From 1948 to the present, Ivorian rice consumption has been increasing at about ten percent per year. Per capita consumption now is three or four times above that of the early 1950's. Rice consumption is increasing by less than three percent as a result of population growth. Substitution of rice for other staples--principally yams, cassava, and cooking bananas--results in an increase of over seven percent. This new rice consumption is by urban people outside the traditional rice-staple area. In 1968, the urban population of 1.25 million or twenty-five percent of the total accounts for about thirty-five percent of the country's rice consumption -- 110-115 kilograms of paddy per person per year. Urban population is thought to be increasing by eight percent per year. Rice consumption per head in rural areas outside the rice-staple zone is much below the national average; but, it too is growing.

Rice is preferred by those who can afford it because it is bought ready to cook and because it has high prestige. Hence, there is a high income elasticity of demand for rice, mostly concentrated in the cities. The

Ivory Coast's high economic growth rate is the major factor responsible for the phenomenal increase in rice consumption. This expansion seems likely to continue, at least for the middle-run. While planners believe that yearly increases in rice consumption will drop to five percent in the early 1970s, continued economic growth and urbanization may expand consumption at a higher rate.

Production

Rice production estimates are tenuous and may vary by forty percent for a given year. However, working from import figures and estimates of consumption, we can make estimates of rice production trends. From the late 1940s to the mid-1960s, production seems to have increased at an average rate of seven and one-half percent per year. This is an impressive rate, but less than consumption. Over two-thirds of production, and most of the increase, stems from upland culture, with most of the rest from swamp culture and perhaps only about five percent from irrigated lands. Hence, production has been highly dependent on rainfall; annual variations in production have ranged up to fifty percent.

As urban rice consumption has grown, it has been changed from a crop grown almost exclusively for home consumption to one that is more apt to be raised for sale. Although there are no records of the amount of rice moving through uncontrolled, private trading channels, it is estimated that about one-fourth of local production was marketed in 1967.

Imports

Data on imports is generally reliable. Imports were negligible before 1950, but increased rather rapidly to 86,800 metric tons of milled rice in 1966. These consumption and production estimates mean that Ivory Coast self-sufficiency had fallen to about sixty percent. It rebounded to about seventy-five percent in 1967 as the government production program began to take hold. Imports dropped to 28,100 metric tons, partly because stocks of imported rice were apparently reduced by about 15,000 metric tons.

Ivory Coast's 1966 rice imports were worth $12.5 million in foreign exchange. This appears relatively small for a country with $311 million of exports and a favorable trade balance of $43 million in that year. Nevertheless, the Ivory Coast protects its relatively high-cost local production from imports and, starting in 1965, began an expensive program to achieve rice self-sufficiency by 1971.

Planners could justify this protectionism and government aid to local rice culture in two ways. First, although it is now expensive to produce rice locally, it is assumed that changes in techniques could develop a comparative advantage in rice production or reduce the country's comparative disadvantage. Second, Ivory Coast cannot count upon an expanding and lucrative market for its major exports, coffee, cocoa, lumber, and bananas. Industrial development will require more imports.

Thus, foreign exchange may become a development bottleneck in the future, and efficient rice culture could reduce it.

The Physical Environment

Much Ivory Coast land is well suited to rice production. Throughout much of the nation's southern half, gently, rolling hills predominate. The soils on these hills appear well-drained and sufficiently fertile and deep to support upland rice culture. Low-lying areas are capable of producing high-yields of irrigated rice once drainage is assured. There are few regions where hills are steep enough to create erosion problems.

The northern half of the country has gently rolling plains and wide valleys frequently flooded during the rainy season. It is a savannah region, while the southern half is typically rain forest, much of it cut over.

Soils

Local experts estimate that perhaps ninety percent of the soils are suitable for rice culture. Where the topsoil is sufficiently deep to support rice, it also usually has good physical structure. Soils on land suitable for rice production are usually low in available nutrients. Levels of pH range from approximately 4 in the south to 6.5 in the north. One is struck by the relative absence of severe erosion and hardened surface soils and by the vigorous growth of rice on newly cleared land. On ground which has been abandoned for agricultural use, secondary cover re-establishes itself quickly, preventing formation of surface hardpan frequently encountered in other African countries.

Technicians report that soils on gentle slopes do not deteriorate even after five years of cropping as long as they are handled in rotation and adequately fertilized. Of course, plowing under straw, stubble, and other crop residue would help maintain soil structure. Bottom land soils seem to support continuous irrigated rice production without deterioration as long as fertility is maintained by regular applications of fertilizer.

Availability of land

The total land area of the Ivory Coast is about 32,246,300 hectares. Less than four percent is planted in crops. Rice may occupy as much as 300,000 hectares.

Rainfall

Rainfall is unquestionably the most important variable affecting rice production there. Total annual rainfall decreases generally from the southern part of the country to the central, then increases to the

north. The rainy periods also vary in frequency and duration with longer rainy seasons in the south and shorter, more-concentrated ones in the north. Roughly, the situation is as follows:

	Rainy Season		
Area	Beginning	End	Annual Rainfall (millimeters)
Southern	March September	July November	1,450
Southwest	March	October	1,760
Central	April August	June October	1,220
Northern	May	October	1,400
Far North	June	October	1,620

However, throughout much of the south and southwest, even the dry periods are sufficiently wet to support rice crops if the clay or loam content of the soil is favorable.

Temperature

Temperatures are favorable for rice production at any time of the year throughout almost the entire country. Taiwanese rice teams are successfully growing three crops of IR-8 rice (120 days) per year under irrigated conditions in widely scattered parts of the country. They disregard the calendar, planting as soon as the paddies are prepared.

By careful timing and use of short-season varieties, the Taiwan technicians have been able to produce two crops of upland rice per year in the south. Upland harvesting is frequently made difficult due to high humidity, a problem also encountered with irrigated rice.

Average temperatures of three areas are:

Area	Average Daily Maximum of Warmest Month	Average Daily Minimum of Coldest Month
South	31°C	22°C
Central	34	20
North	36	15

Day length

All of the country lies between the 4th and 12th parallels north. There is little change in day length throughout the year. Such changes are so

minor that they are not generally thought to be important to rice production.

Production Techniques and Costs

The techniques employed by rice producers may be roughly divided into five categories: traditional upland, improved upland, irrigated, mechanized upland, and swamp.

Traditional upland rice culture

The following description is based on practices in the west. Some variation occurs throughout the country.

The farmer clears the land, either forest or savannah, using an axe and a short-handled, large-bitted hoe called a daba. Frequently, stumps are left in the field, and some large trees are not removed. Neither are anthills, thus, there may be considerable shading and much of a cleared area may not be producing rice. Production statistics are misleading because they are based on area cleared and not on the surface actually producing rice.

As soon as the forest or savannah is cleared and the plant residue burned, the farm women use a stick or a small, narrow-bladed hoe to plant the rice in holes, a few grains per hole. The seed has been saved from the previous crop and stored in a hut under frequently undesirable conditions. There are great variations in the quality of the seed, resulting in uneven stands. No fertilizer is applied. Some weeding is done, usually by the wife. Weeds are seldom a problem in the first year after clearing, but become more so in succeeding years.

Insects are ignored. The children use slingshots and other devices to scare away birds which descend in droves while the rice is maturing. In some areas, agoutis may eat a sizeable part of the crop. Agoutis are sometimes trapped in bamboo fences surrounding the rice plots and eaten.

The paddy is harvested by hand by the women. Each panicle is cut off at the stem with a pocket or kitchen knife held in one hand and placed in the other hand until about a kilogram of rice panicles is collected. A sheaf is then tied and placed on the ground or in a basket. One woman, by working hard, can collect perhaps thirty kilograms per day. The paddy is then taken to the farm's hut, where it may be dried for a few days before threshing.

Paddy is threshed by simply placing it on a mat and pounding it with a stick. Once threshed, it is hand-winnowed.

Then the rice is hand-milled in a stone or wooden mortar. Pounding is labor-consuming and may take up to one hour per woman per day to prepare enough rice for the family.

Farmers have already learned the value of fallowing rice land. The land is allowed to return to bush after two or three crops. A new plot of land is cleared and the process is repeated.

The variety most commonly used is Moroberekan, a 150-day, local variety which is hardy and tolerates diseases and insects. It is long-stemmed, resists lodging, and holds its grain well during ripening. It is usually not found in pure stands, but is mixed with other varieties. Yields, under traditional culture, are approximately one metric ton per hectare.

Rice is planted in April or May, and harvested in August or September. These are rainy months throughout most of the upland rice belt. The farmer has learned to subsist fairly well by respecting this crop year. The rural people appear generally well-fed.

Improved upland rice culture

This method was developed by both IRAT (Institut de Recherches Agronomiques Tropicales) and SATMACI (Societe pour l'Amelioration Technique de la Modernisation Agricole de la Cote d'Ivoire) and, with some variations, is the one generally recommended by SATMACI agents who work with farmers.

This upland rice culture is part of a rotation with yams, cotton and sometimes corn.

Land is prepared in advance by hoeing. Rice is planted as early as possible. Moroberekan should be sown before June 15. The recommendations call for seed to be sown in rows about forty centimeters apart and at the rate of about fifty kilograms per hectare (about one grain every two centimeters). Sowing depth should be about one to two centimeters.

Two weedings are recommended to be coordinated with fertilizer application so that the fertilizer will be worked into the soil.

The recommendation is for 200 kilograms of ammonium sulfate per hectare in split application just before the first cultivation, and at the onset of tillering.

Harvesting should begin as soon as the grains at the base of the panicle are well formed but not so hard that they cannot be scratched with the finger nail (when about three-fourths of the panicles are ripe). The rice should be cut in the morning close to the ground. Then the rice should be tied in sheaves and put into shocks, capped with sheaves to protect it from rain.

If these improved practices are followed, farmers may expect to double their harvest and get yields of up to two metric tons per hectare. In

experimental and demonstration plots, yields of three metric tons per hectare are common. The Taiwanese, using Taiwanese varieties, have produced up to four metric tons per hectare per harvest with two harvests per year in the southern part of the country.

Irrigated rice production

This technique follows practices laid down by Taiwanese teams at work throughout the country's principal rice areas.

The nursery should be prepared two weeks in advance of the paddy and fertilized at the rate of 200 kilograms of ammonium sulfate per hectare. Within two weeks, the plants should be sufficiently large to transplant.

Paddies should be free of all stumps and vegetation. The soil should be plowed, either using a hand hoe (daba) or a rototiller. After plowing, the paddy is flooded and levelled.

Transplanting should place seedlings in rows twenty-four centimeters apart. From five to seven seedlings should be placed at fifteen to twenty centimeter intervals in the row.

Paddies should be fertilized with fifty kilograms equivalent P_2O_5 and 30 kilograms equivalent of K_2O per hectare before plowing. Nitrogen is applied after transplanting at the rate of 100 kilograms per hectare in the case of Taiwan variety Kaohsiung 10, and 200 kilograms per hectare for IR-8. An identical application is made four to six weeks after transplanting, usually when the rice enters the pre-boot stage. The Taiwanese rotary hoe has been found unsatisfactory for some soils.

When insects appear to be damaging the rice, Fieldrine, a general-purpose insecticide, should be applied at the rate of one-half to one liter per hectare. Chicken netting fifty centimeters high should be put around the field as soon as the rice begins to head out to prevent agoutis from eating the rice.

If possible, a team of six men should be organized for harvesting. Four men cut and two men thresh with a foot-powered pedal thresher. Taiwanese sickles are recommended. They are much shorter and lighter than Western-made sickles.

Since irrigated rice is produced the year around, harvest may take place under varying degress of humidity. Therefore, most harvesting involves spreading the rice out, stirring it, and exposing it to the sun intermittently.

Yields of five metric tons per hectare have been frequently reported using this method. Up to three crops have been grown, making an annual yield of fifteen metric tons per hectare.

Mechanized production

A government minister is undertaking an operation in the west central region, where 300 hectares of gently sloping hillside has been laid out in twenty to thirty hectare strips. The land was cleared and has been fertilized, plowed, and planted by tractor-drawn implements. The rice will be combined. In essence, the procedure is the same as for improved upland-rice culture, and differs only in that all operations are mechanized. Results are encouraging and yields have averaged two and one-half metric tons per hectare.

Some individual Ivorian farmers are also using mechanized operations in the Odienne region. There, weeding and harvesting is by hand.

Swamp culture

Swamp rice grows in flood plains where the water level usually rises as the rice grows. But, the farmer has no control over the water level. Under such unpredictable conditions, widely varying yields are obtained. Swamp rice accounted for six percent of the area in rice production in 1965. This figure is expected to decline to five percent in 1970 and to four percent in 1980 as swamp areas are converted to irrigation. Average yields are estimated at two metric tons per hectare. Most swamp rice is produced in the north.

Varieties

IRAT produces small quantities of seed of a number of varieties suitable for upland culture for distribution by SATMACI. The most widespread and best adapted is Moroberekan, mentioned above. Response to increased fertilizer application levels off at about three metric tons per hectare. Other varieties disseminated are OS-6 (125 days, shatters badly) and Pate Blanche (150 days). The desideratum is a hardy variety like Moroberekan with shorter growing season, and ideally, better yield response to fertilizer.

The Taiwan Mission has tested IR-8 (Philippine) against Taiwanese, American, and other Phillipine varieties. IR-8 tillered more (twenty-five shoots per five seeds), was shorter (ninety centimeters) and produced higher yields (average 6.7 metric tons per hectare). An impressive feature of IR-8 is good response to high rates of fertilizer. In one trial, 300 kilograms of additional fertilizer resulted in yield increases of three metric tons per hectare. The control plot yielded five metric tons per hectare. The 300 kilograms of ammonium sulfate cost 6,000 CFA francs and the resulting three tons of rice were worth 60,000 CFA francs. The return was 10 to 11.

Fertilizer

Use of fertilizer to increase rice yields is now accepted by everyone responsible for increasing rice production except farmers. The latter

harbor no antipathy towards fertilizer, but very few have got into the habit of using it on rice. They do use it on cocoa and coffee. The Taiwanese technicians and the SATMACI agents advocate use of fertilizer. Mostly, they recommend ammonium sulfate, which seems to be generally available and is distributed by the agents. Ammonium phosphate and calcium phosphate are the two forms of phosphate most available. Little attention has been given to potassium. The Taiwanese use it in their own plots but it is not regularly distributed by SATMACI.

Taiwanese recommendations for rates of fertilizer application are considerably higher than SATMACI's. However, their recommendations concern mostly irrigated rice, whereas SATMACI's are for upland rice.

The Taiwanese have done little experimental work on upland rice, although they have helped a number of farmers establish plots. They recommend high fertilizer applications, and the results appear excellent. They are also trying IR-8 in upland culture. Though results are not yet available, the rice looked good in the field.

Herbicides

Herbicides are not being recommended because of their high cost. As reported elsewhere, Propanyl has proven effective at the IRAT station at Bouake. Weeds are recognized as the number one problem in upland rice once land clearing has been accomplished.

Insecticides

Rice borer (Dyopsis oryza) is prevalent in both upland and irrigated rice, and may reduce yields by one-half. The borer is controlled by applications of Sevin, an all-purpose insecticide. It is applied at transplanting (irrigated) or booting (upland). IRAT, Bouake, recommends Diazanon for control of insects in irrigated rice, application to be made at transplanting.

SATMACI sells insecticides for $2.40 (600 CFA francs) per liter. One liter is recommended per hectare of improved upland rice and two liters per hectare of irrigated. Insecticides are not universally available.

Disease control

No rice disease is recognized by Ivorian authorities as being of any economic importance.

Tools

A typical farmer has few tools. He possesses an axe, usually with a poor handle; a daba, not adapted to working of level land; and a machete. A number of villages possess rice hullers. The existence of over 650 hullers is recorded, but there are probably more.

Costs

Costs of rice production, even assuming identical cultural practices, will depend on local soil and rainfall conditions, on terrain and vegetation, on nearness to markets,and availability of inputs. There are differences of opinion concerning which types of culture are most efficient when decisions are made on where to concentrate resources to increase rice production. Therefore, it is useful to compare some typical costs of production from different rice cultures discussed. Since swamp rice is grown under such diverse conditions and probably will not be expanded, we delete it from our calculations.

Very little research has been done on the costs and benefits of growing rice. We have collected the data available and cross-checked them for plausibility whenever we talked with rice farmers or the technicians who work with them. While we believe these figures are the best that could be developed, they ought to be regarded as orders of magnitude, and as the basis for future discussion and research. (Our assumptions on production inputs, their cost, and yields are detailed in Appendix A.)

Assumptions on yields are meant to reflect what the average farmer can do, not the results obtainable on experimental plots. Using traditional methods of growing upland rice, under typical climatic conditions, a farmer can average one metric ton per hectare. Improved upland methods, whether mechanized or not, produce average yields of two metric tons per hectare. We are assuming that, once a farmer learns irrigated techniques and applies fertilizer, he can expect five metric tons per hectare per crop.

Irrigated technique uses land more efficiently than any upland technique, and improved upland uses it more efficiently than the traditional way. However, land is not a crucial factor. We assume that it has no scarcity value. The only value attached to land is for the labor to prepare it. This value can be realized only by farming the land, since there is no market for land. It is not sold, leased, or mortgaged.

Labor is by far the biggest cost item in all cases but that of mechanized upland. Except for mechanized upland, the labor costs of producing one metric ton of paddy are of the same order of magnitude for the different methods. Without counting the labor involved in threshing, carrying the paddy to the farm, and drying (which would be independent of the cultural method), and without counting the labor involved in scaring off predatory birds and fencing against agoutis, the labor required to produce one metric ton of paddy is between twenty-five and thirty man-days. Mechanized upland, with hand-weeding and harvesting, requires nineteen man-days of labor per metric ton. But, non-labor inputs are much higher.

The legal minimum wage for unskilled labor is sixty cents a day, but it is usually necessary to pay eighty cents. This wage may seem high for some low-income countries, but Ivory Coast has a labor shortage and

uses substantial amounts of labor from Upper Volta and other countries. Most labor is furnished by the farm family, but Ivorians are well aware of the value of their labor and of their alternatives for leisure.

Observers who wish to demonstrate the superiority of upland rice culture frequently argue that irrigated rice requires excessive amounts of labor, and is inappropriate for sparsely peopled areas like West Africa. Our figures indicate that, although labor per unit of land is greater in irrigated rice growing than in upland culture, labor used per unit of output is not.

For mechanized upland culture, current, non-labor inputs are seed, sometimes fertilizers, insecticides, and rental of machines. We do not consider any other such inputs which might be used such as rental of rototillers and cost of herbicides. Traditional upland uses only seed, but uses it inefficiently. The other methods also use fertilizer and insecticides. Mechanized upland, of course, used machines for preparatory tilling and sowing. Non-labor inputs range from a little less than $4 per metric ton of paddy for irrigated rice to just over $7 per metric ton for improved, hand upland, except for mechanized upland, for which non-labor inputs cost $31.70 per metric ton. The latter includes depreciation of machinery and repair costs.

The third cost element is the investment in converting unused land into farm land. Naturally, such costs vary widely, depending on what you start with and what kind of farm land you need to end up with. We have tried to standardize this element by estimating the cost of putting cut-over forest into production somewhere near the middle of the country.

Traditional upland rice can be grown on summarily cleared land. Trunks and limbs of felled trees are left in the field, and some trees are left standing. Improved upland, whether mechanized or not, requires that most stumps and logs be removed. Irrigation requires still more extensive preparation, including canals, bunding, and drainage.

After discussion with many knowledgeable people, we concluded that land can be prepared as well and more cheaply by hand as/than it can by machine. For instance, the Regional Director of Agriculture at Daloa has developed a system, using hand tools and no cash outlay, for first clearing land summarily and then improving it to the quality of machine-cleared land in two more years at considerable saving of labor.

Using traditional methods, farmed land must be returned to natural fallow after two or three years. With fertilizer and improved or irrigated methods, land can be used almost indefinitely. To figure the cost of producing rice, we spread the cost of preparing land over two years for traditional methods and over ten years for improved upland and irrigated methods. While improved methods permit cleared land to be used for more than ten years, this is probably a longer time than a farmer is willing to plan ahead. It also is probably longer than the

period for which he can get a loan, and he cannot realize any built-up equity by selling, leasing, or mortgaging the improved land.

When more than one crop is grown per year, the land clearing and preparation cost is spread over a greater amount of production. Hence, we consider the cost-lowering effects of multiple cropping. At present, most upland rice growers are getting one crop per year and most irrigated rice-growers get one or two. However, a few of the latter are now growing three crops. A few farmers who are using improved, hand-upland techniques are growing two, and other upland techniques could produce two crops under favorable conditions. Therefore, these possibilities are considered.

Estimated "Typical" Land Preparation Costs
(dollars per hectare)

	By Hand	By Machine
For traditional upland	56	--
For improved upland	120	200
For irrigated	240	400

SATMACI sets the maximum it considers economic to spend for the preparation of irrigated rice land at $400 per hectare; for upland rice land, $240 per hectare.

The costs of producing rice by the different methods described under four typical classes is given below. It is assumed that land clearing and preparation is done by hand. By our estimates, machine operations would cost two-thirds more.

Typical Costs of Producing One Metric Ton of Paddy
(dollars)

	Traditional Upland	Improved Upland	Mechanized Upland	Irrigated
Current labor	32.00	37.60	23.60	31.20
Current non-labor	6.00	7.40	31.70	3.90
Investment in land preparation assuming hand labor				
(one-crop)	28.00	6.00	6.00	4.80
(two-crops)	(14.00)	(3.00)	(3.00)	2.40
(three-crops)				(1.60)
TOTAL (one-crop)	66.00	51.00	61.30	39.90
(two-crops)	(52.00)	(48.00)	(58.30)	37.50
(three-crops)				(36.70)

These costs are all less than the government price paid for paddy at the farm, $80 per metric ton (20 CFA francs per kilogram). It is important to note that these cost elements are not comprehensive. They do not include the cost of carrying the grain home from the field, threshing, drying, and protection against predators. They also do not include the cost of dabas, machetes, and cutting knives. A farmer growing rice is assumed to be growing other crops and to have these tools as a matter of course.

Furthermore, this analysis simplifies drastically by assuming that only rice is grown on the land in question and by ignoring the farmer's other crops. In fact, in all upland culture, rice is part of a complicated and varying rotation. Also, rice is not the farmer's sole interest; hence, his labor may be more precious to him at one time of the crop year than another. Factors such as those influence a farmer's decision of whether to grow rice, how much to grow, and by what techniques. They fall under the heading of farm-management analysis, an important subject on which virtually no research has been done.

For the reasons mentioned above, the figures cited are merely indicative, certainly not definitive. Nevertheless, they bring out interesting facts.

1. There is a high cost resulting from the inefficient use of cleared land under traditional upland culture, even where no scarcity value is attached to the land. The principal improvement in profitability of improved, hand upland over the traditional methods comes from its more efficient use of land-clearing labor, by using fertilizer, and by keeping land under cultivation longer, not from sowing in line, weeding, and using improved seeds.

2. While mechanized upland rice-growing is apparently profitable, it is less so than other methods. This might not bother a farmer with large quantities of capital or access to credit, but such a person would be better advised to grow rice by another method, hiring more labor, always assuming that management is equally or less expensive under the other methods. There are few Ivorians with access to large amounts of capital.

3. Even where land scarcity is not a problem, irrigated techniques seem to be the cheapest way to grow rice. Since irrigated rice in the Ivory Coast can be started at any time of year, irrigation enables a farmer with other interests to "work around" his peak labor requirements for other crops, and to trade off labor with neighboring irrigation farmers when their peak labor requirements for irrigated rice do not coincide. However, irrigated rice-growing assumes access to technical assistance and to capital which most Ivorian farmers do not yet have. For many, traditional upland rice is the only alternative. Furthermore, those who invest their own or hired labor in irrigated

land are taking a hidden risk. They cannot realize that investment except by growing rice, and they are gambling that the current favorable market for paddy will continue.

Disease as a cost

Growing irrigated rice means working in standing water, which, in the absence of control measures, leads to almost certain infection with malaria, schistosomiasis (liver fluke disease), and onchocerciasis (river blindness) if the vectors are present.

Malaria vectors are present, but the disease is already endemic. Since almost everyone is exposed, a little more irrigated rice culture will not increase the incidence.

Onchocerciasis vectors are present in parts of northern Ivory Coast. The effects of this serious disease will be discussed in the Upper Volta section.

Schistosomiasis vectors are present in most of the potential irrigated-rice area of Ivory Coast. The disease does not now appear to be widespread. Many Ivorian peoples, such as the Bete, systematically avoid the marshes and streams. If they practiced irrigated rice farming, they would be likely to contract the disease. What would be the social cost if schistosomiasis became endemic? What would it cost to prevent this? What would it cost to cure the disease?

The cost of having a farm population which is generally debilitated is difficult to estimate. Most Ivorians are already suffering from one or more debilitating diseases. Our medical informants felt that, after a certain initial period of debilitation on contracting schistosomiasis, most adults manage to function normally. However, it was considered that the effect of the disease on children and on their learning capacity is serious.

The cost of materials to rid an irrigated area of the snails that are the secondary host to the schistosomiasis organism is modest. About 100 hectares of such land outside of Gagnea were rid of snails by treatment with 150 kilograms of Molurame, a product whose active ingredient is zinc dimethyldithiocarbamate. This product is available in lots of one metric ton for $1.32 per kilogram CIF Abidjan. Thus the cost of materials is $2 per hectare. Of course, the costs of organizing and implementing the program would be far higher, particularly when trying to clear small, isolated paddies. Also, the danger and rapidity of reinfection of a treated area are not known.

Schistosomiasis of the West African variety can be cured in ninety-five percent of the cases by administering Ambilhar for seven to ten days. The cost of the medicine is from $1.18 to $1.68 per person. Again, the costs of setting up and administering the program might be higher than the cost of medicine. Furthermore, it is useless to cure the disease

unless an eradication program is undertaken. The cured person will be quickly re-infected on returning to the contaminated water unless such steps are taken.

Government production services

Ivorian farmers will invest their labor in a farming operation, but most of them will not invest cash. Yet some of the inputs necessary or useful to more efficient rice culture must be purchased. Most of these can be acquired by most farmers only on credit. Most farmers cannot obtain credit in cash.

In principle, SATMACI will provide many production inputs against harvest credit. The effective interest rate is twenty-five percent. In practice this program has experienced difficulty. Farmers sometimes disappear after the harvest, making collection difficult. The SATMACI posts we visited were distributing improved seed and fertilizer; some were distributing insecticides and chicken wire. In some places, they would not extend credit even to harvest, and demanded cash. Other posts gave credit until harvest and nearly all posts sold seed on credit.

An encouraging number of farmers were willing to pay cash for small items, especially fertilizer. Small machines, however, are rarely purchased. Machinery prices in the private-sector stores were high. We saw mechanical threshers for $120 and small, motor-driven mills for $1,000. Greater sales volume and competition should lower prices. SATMACI plans to sell small tools.

The Taiwan mission is lending small threshers and rototillers to farmers free of charge and giving out seed and fertilizer during the first year. Taiwanese sickles are sold for 20 cents. This should develop a market for these useful items.

Machine farming operations are available through MOTORAGRI, a branch of the Ministry of Agriculture. These are set up and run with the help of thirty Israeli technicians. MOTORAGRI operates about 250 tractors and other earth moving equipment. It repairs and meticulously services its equipment and trains its drivers and mechanics. It has five major sub-stations throughout the country.

Much of MOTORAGRI's activity is devoted to clearing, sub-soiling, and leveling rice land, and some to plowing and sowing of rice. Between April 1966, when it started operations, and the end of 1967, MOTORAGRI cleared 9,600 hectares and plowed, sowed or harrowed 19,700 hectares, besides building access roads and drying platforms. In 1968, it expects to clear 15,000 hectares and to perform machine agricultural operations on 30,000 hectares. Its activities are carefully programmed. Work is done on request, with the approval of the Ministry, mostly for the government. Although we believe that most of the MOTORAGRI services in rice production could be done more cheaply by hand, demands for its

services far exceed capacity. We believe that its charges accurately reflect the real costs of operations.

When work is done for a non-government entity, the Ministry pays MOTORAGRI and is responsible for collection of the money. The government subsidizes ninety percent of the cost of land-clearing for families farming less than five hectares. This subsidy and government use of MOTORAGRI account for the seemingly insatiable demand for its services. Only a few small farmers are actually able to benefit from this subsidized land-clearing program.

Comparative profitability of rice and other crops

We were unable to analyze the comparative profitability of rice and rival crops. Farm management research permitting such an analysis does not exist. However, many farmers are increasing production of rice for market, new farmers are entering rice farming, and some farmers are working to establish water control on new land to grow irrigated rice. Therefore, these farmers must think that returns to their labor and management from rice growing compare favorably with their alternatives under present market conditions.

Marketing

Prices

The retail price of milled rice is fixed at 55 CFA francs per kilogram (22 cents per kilogram). This applies to imports and local rice. The presence of SATMACI stocks plus government manipulation of imports now keeps the real price close to 22 cents. Most milled rice is sold through large firms which can easily be policed. However, in 1967, milled rice reportedly sold for as much as 81 CFA francs per kilogram (32 cents) in Man before SATMACI's new mill there began to function.

As previously mentioned, the official farm price for paddy is 20 CFA francs per kilogram (8 cents). In 1967, it was 18 CFA francs per kilogram (7.2 cents). SATMACI buys at the official price and has been able to expand its share of the market greatly, though it still commercializes less than half of the paddy.

Before the government first set an official price for paddy in 1966, farmers received prices that varied widely by season and region. According to a Porter International study, paddy prices ranged from 3.2 to 20 cents per kilogram in 1965 and from 6 to 16 cents per kilogram in 1966. Prices in major producing regions averaged 11.2 cents per kilogram in 1965 and 9.6 cents per kilogram in 1966. Thus, the official price is lower than the average the farmer previously received. However, this reduction has been accompanied by an expansion in volume of commercial marketing.

Most private traders will buy paddy for more than the official price, even at the farm. Our investigations indicated that the unofficial price runs from ten percent below the official one to fifty percent above it. Private traders can afford to pay a higher price because they usually buy paddy grown close to markets, thus minimizing transport costs and enabling them to cut out SATMACI. Also, conceivably, as family firms, with negligible overhead, they may be more efficient than SATMACI. In any case, the price in the private paddy trade is now set with the official price in mind. While it may not be as high as it was in days when the trade was smaller, at least it is relatively stable and the seasonal lows have been eliminated.

Imports

The amount of imports is controlled to protect the official price for domestic rice. This operation is in the hands of the Service de Consummation et de Control des Prix, a unit of the Economic and Financial Ministry. Periodically, the government announces its intention to allow a fixed amount of rice to be imported after estimating how much rice will be commercialized by SATMACI and how much more will be needed to fulfill demand at official price levels.

Imports are purchased on the world market by one commercial house, which represents the cartel of rice importers. This cartel is organized by the Chamber of Commerce, which has a monopoly on rice imports through an agreement with the government. The quota is allocated among members by mutual agreement. When the government allows the profitability of importing rice to get high, the companies may squabble for larger quotas; when profitability is less, companies may renounce their shares to force the government to raise their margin. Little imported rice is now stored in the Ivory Coast.

Firms in the cartel tend to be owned by French and Lebanese. An African-owned firm had two percent of the total quota. Allocation of quotas tends to follow each company's share of the retail market.

At present, there is no customs duty or import tax on rice. A duty of ten percent and a tax of four percent have been temporarily suspended. To regulate the profitability of importing rice, the Service de Consummation et de Control des Prix established payments into an equalization fund. At last report, the price structure for imports was approximately:

Price of milled rice delivered Abidjan port	$164-172 per metric ton*
Equalization fund tax	$22-33.00
Price paid by importer	$194-198.00
Handling plus importers' profit	$11.20-15.20
Wholesale price	$209.00
Retailers' margin	$10.80
Retail price	$220.00

*This is the price reported in Abidjan by commercial sources. The world price for 25 percent brokens, which makes up the balance of Ivory Coast imports, was between $190 and $200 per metric ton (FOB). At that rate, there would have been no equalization tax.

The equalization tax varies according to the world price. The proceeds go into a fund which is supposed to insulate the Ivorian market from fluctuations in the world price.

Milled local rice is sold at the same price as imports. Although a small amount of milled "white" rice comes through local private trading channels, most of this local production comes from SATMACI. This is the production which is tending to replace imports. Because of government regulations, milled rice does not have to compete with imports. Competition comes at the other end. To buy paddy, SATMACI must compete with small private traders and with farm families who want to eat their own rice.

The following table, based on government estimates, indicates the growth of SATMACI sales, compared with probably consumption and imports.

Year	Consumption	Consumption from Imports	Consumption from Local Production	SATMACI Commercialization	Other
		(Metric Tons of Milled Rice)			
1964	183,700	62,700	121,000	0	121,000
1965	200,400	68,800	136,500	200	136,300
1966	224,900	86,800	138,100	1,500	136,600
1967	248,000	42,850[2/]	205,150	15,000	190,150
1968				est. 25-30,000	

2/ Imports were 28,100 metric tons, but there was apparently some reduction in the stock of imported rice. This figure is from Porter, International. Local production from 1966 is treated as consumed in 1967.

Milling

SATMACI operates four rice mills with a capacity of four metric tons per hour at Bouake, Gagnoa, Man, and Korhogo. Three identical mills are to be built at Bongouanou, Daloa, and Seguela. The capacity will be justified if rice production expands as planned and if the SATMACI takes over a larger portion of the market. However, at present there is enough overcapacity to constitute a heavy expense for SATMACI. At present, the Man mill is functioning at full capacity; Bouake mill, at two-thirds capacity, Gagnoa and Korhogo mills at one-fourth capacity. There are also small SATMACI mills in Odiénné, Bouna, and Ferkessedougou, each with a capacity of 300 kilograms per hour. SATMACI estimates the growth of its annual milling capacity as follows:

1966-7	4,800 metric tons
1967-8	33,000
1968-9	101,000
1969-70	163,000

Storage

SATMACI also has constructed modern storage facilities at its four major mills with a combined capacity of 16,500 metric tons. Three use bulk storages; the fourth at Gagnoa stores rice in sacks because of climatic conditions. Storage centers with capacities of 1,500 metric tons each have been built in Odiénné, Daoukro, M'Bato, Dimbokro, Sinfra, Vavoa, Touba, and Duékoué.

Marketing local production

SATMACI sells rice to a cartel organized by the Chamber of Commerce. It is composed of large companies with modern retail outlets. SATMACI production had been shared among the same companies which buy imports in the same proportion. This system tends to favor the "modern," usually foreign-owned, companies at the expense of local small operators. However, this system obliges commercial houses to use a constant "mix" of imported and local rice regardless of whether their stores were near SATMACI mills or near the port. They will now be allowed to rearrange their shares of imports and SATMACI purchases. The purchasers pick up their milled rice at the mills for $196 per metric ton (49 CFA francs per kilogram). Their margin and the retailers' margin add to $24 per metric ton (6 CFA francs per kilogram).

SATMACI buys paddy at eight cents per kilogram (20 CFA francs) and sells milled rice at the mill at 19.6 cents per kilogram (49 CFA francs). The average mill out-turn is sixty-two percent, of which forty-nine percent is whole rice plus as much brokens as the market will bear and thirteen percent is additional brokens. The latter are sold at ten cents per kilogram (25 CFA francs). The rest is hulls, bran, and impurities. Some bran is sold at a nominal fee for cattle and poultry feed; some is wasted. Thus, the income from a metric ton of paddy is:

$96	from sale of 490 kilograms of milled rice at 19.6 cents per kilogram
$13	from sale of 130 kilograms of brokens at 10 cents per kilogram
$ 2	from sale of some of bran
$111	
$ 80	price paid per metric ton of paddy at farm
$ 31	margin to pay for milling and transport to mill

SATMACI's commercial operations are now in the red. If the total cost of mill operations is $20 per metric ton of paddy, then $11 per metric ton is left for the operation of collecting the paddy. SATMACI is obliged to pay the same price for paddy at any farm, regardless of where it is. For this reason, it tends to have responsibility for collecting paddy from the most distant farms, while private operators tend to buy paddy from farms close to the market. In spite of this handicap, SATMACI believes that its entire commercial operation will break even

once its mills are operating at capacity. Getting a more uniform paddy would improve the mills' out-turn of whole rice and contribute to the profitability of the operation.

An unknown amount of paddy is purchased and milled by the private sector. There are no reliable estimates of the amount of rice consumed on the farm. A guess concerning the source of rice consumption in 1967 can be made, based on a survey by Porter, International and SATMACI's figures for its own commercialization.

Consumption of Rice ***
(metric tons)

On-farm consumption	89,000
Marketed by Diulas, etc.	27,900
Marketed by SATMACI	15,000
Consumption from local sources	131,900
Consumption from imports*	42,850
Total Consumption	174,750**

*Includes 28,100 metric tons of imports plus carry over of stocks.

**Official estimate is 248,000 metric tons (Chambre d'Industrie..., Bulletin mensuel, #30, January 1968, page 11), a reminder that production statistics are only order of magnitude. Porter seems to have added 1967's crop to the imports consumed in 1967. Actually, for the most part, the 1966 crop was consumed in 1967 and the 1967 crop in 1968. Statistics are usually presented with a year's lag from local production to consumption.

***Milled rice, based on ten percent allowance for seed and losses and milling rate of sixty percent.

The director of SATMACI's rice operations estimates that Diula commercialization for 1967 was about 35,000 metric tons.

Almost all on-farm consumption and rice marketed by Diulas is brown rice. The government's fixed price for brown rice is 14 cents per kilogram (35 CFA francs). The official price is not observed; most observers believe that the actual price of brown rice may be as high as 18 cents per kilogram (45 CFA francs).

Most milled rice -- SATMACI sales and imports -- is consumed in Abidjan. In 1967, seventy-one percent of SATMACI's rice was sold in Abidjan. The same is true of imported rice.

There is a small market for luxury rice. It is estimated at 300-500 metric tons of imports. One luxury rice retails for 55 cents per kilogram (138 CFA francs). The government is now regulating and restricting private purchasing and milling of rice so that only traders who have been issued a buyer's card by the local sousprefet will be allowed to deal in rice. At the time of our visit, the system was not yet functioning.

Transport

Some small private traders are already accredited as buyers by SATMACI. In 1967, SATMACI paid such buyers a commission of 0.8 cents per kilogram (2 CFA francs) for paddy presumably bought at eight cents. Under these conditions, SATMACI management discovered that small private traders would not collect rice at a distance of more than thirty kilometers from a mill. Therefore, the system has been changed to provide bigger commissions for bringing in bigger amounts.

To move rice from the mills to the cities in bulk along major roads, SATMACI pays a contracted truck carrier 11 CFA francs per metric ton per kilometer (4.4 cents per metric ton per kilometer). The distance at which small private traders formerly ceased to bring paddy into SATMACI mills suggests that their cost for hauling small loads from villages along tracks is 67 CFA francs per metric ton per kilometers (27 cents per metric ton per kilometers).

Services

Research

The National Agronomic Research Center at Bouake, near the central part of the country is administered by IRAT. There are substations at Man in the west, Ferkessedougou in the north, and Gagnoa in the south-center. Six Frenchmen and one Ivorian of the engineer level make up the professional staff.

Research at Bouake is restricted to upland rice. At Ferkessedougou, some work has begun on irrigated rice. IRAT considers weeding the main problem of rice producers. The station has been running herbicide trials. Propanyl is the only product which has proven effective, but its cost (10,000 CFA francs or $40 per hectare) is prohibitive.

The station has developed a rotation program for soils in the central region which permits crop production three out of five years without soil depletion, using fertilizer and producing yields as follows:

Rotation Program

Year	Crop	Fertilizer	Amount (kilograms)	Yield (metric tons)
First	yams	Ammonium sulfate	200	10-15
Second	corn	Ammonium sulfate	300	1.5
	and			
	cotton	Ammonium phosphate	60	1.0
Third	rice	Calcium phosphate	60	2.0
	+	Ammonium sulfate	50	
Fourth	Stylo santhes) tropical legume for cover for forage crop.			
Fifth	" ")			

The second problem under study is how to replace corn with rice in the second year of the rotation. No work has been undertaken on improving varieties, or on developing small tools useful to the Ivorian farmer.

IRAT has no soil research program. Such research is handled by ORSTOM (Office de Recherches Scientifiques des Territoires d'Outre Mer.) and consists mainly of soils testing and mapping. ORSTOM also handles research on agouti control. No satisfactory control measures other than fencing have been developed to date. Entomological research is handled by the Service de Protection des Vegetaux (Plant Protection Service) of the Ministry of Agriculture. It runs trials on rice insects and diseases.

Control of predatory birds, chiefly the Quelea quelea, is the province of OCLALAV (Organisation Commune des Luttes Anti-acridiennes et des Luttes Anti-aviares), a regional institution based in Dakar. To date, OCLALAV has worked exclusively in savannah countries, where the Quelea quelea menace is greatest.

Extension and training

In 1968, the Ivory Coast Government spent five percent of its current budget on agriculture and animal production, but agriculture made up thirty-two percent of the investment budget. Investments budgeted to rice were $550,000 in 1965, $3.34 million in 1967, and almost $4 million in 1968. Most of this money went to research or to SATMACI. In 1967, SATMACI's government subsidy was 556 million CFA francs ($2.2 million) of which nearly all was earmarked for the rice program.

If the expenditure were spread over the entire presumed production of paddy in the country, it would amount to just over five percent of the official value of the crop.

Presumably, as SATMACI's commercial operations begin to break even and fewer extension agents are needed, the expense of this program will decline.

The General Agricultural Service, which formerly was responsible for extension work, is limited now to collection of production statistics. Extension is handled by specialized agencies; SATMACI for cocoa and rice, CFDT (Compagnie Francaise pour le Developement Textile) for cotton. Some commodities receive no extension effort.

The government entrusted the development of rice production to SATMACI in 1965. The activity "package" is extension, provision of production inputs, credit, and buying at an established price.

SATMACI has a trained force of 800 rice extension workers. These workers live in villages and set up their own rice demonstration plots. They are equipped with bicycles and are paid $768 per year (16,000 CFA francs per month). They first select and guide pilot farmers, then gradually extend their technical influence to other farmers.

Extension workers were formerly trained at six centers but are now trained at Gagnoa, a center built by French aid. They receive nine months of training in five-week cycles with two weeks in class and three weeks in practical work in villages. Fewer than 100 agents are selected from more than 1,000 applicants on the basis of aptitude at physical farm tasks, literacy, and mathematical ability. All agents have finished at least primary school. The center prefers to recruit young farmers twenty-two to twenty-three years old who have finished military or alternative civil service. The extension workers are directed by about forty supervisors (the number will increase to 100) and about thirty higher-level officers. The supervisors are recruited at a higher level (the Brevet) and trained at Bouake in a center built by the Ford Foundation. Since men with this level of education could become primary school teachers, supervisors' salaries must be similar. The base salary is $364 per year, plus $480 housing allowance and $120 for a motorbike. This adds up to $1,464. After completing an apprenticeship, a supervisor can expect to make $1,728.

Taiwanese mission

SATMACI's extension efforts benefit from the work of 160 Taiwanese rice technicians working at some twenty locations throughout the country. They are providing assistance to farmers cultivating 6,682 hectares of rice.

The Taiwanese program in The Ivory Coast is noteworthy for its large scale. The projects have advanced beyond demonstration phases which show high yields on small plots, to field work with many farmers, in spite of formidable language problems. In many localities, the Taiwanese teams and SATMACI extension agents are working together effectively. SATMACI extension workers locate farmers who want to try irrigated rice and serve as interpreters. The Taiwanese provide the expertise. There apparently are more requests for assistance than the 160 Taiwanese can handle. In the Bouake region, however, we found that SATMACI and the Taiwanese were not working together and that each was misinformed about the activities of the other.

The Taiwanese teams in the Ivory Coast are demonstrating considerable adaptability to local conditions. After introducing intensive, irrigated culture especially appropriate to a land-short economy, the Taiwanese are diversifying their efforts into upland rice. Except for the station at Korhogo where the Taiwanese started, the rice land farmed by Ivorians cooperating with the other Taiwanese stations is five-sixths in upland rice and one-sixth in irrigated rice. The Taiwanese have recently cleared fifty hectares to multiply IR-8 seed at Dabou.

Land tenure

The government has abolished traditional tenure rights for unused land. In principle, anyone not native to a locality can lease unused land upon demand to the local administrator (sous-prefet). However, all land

is "owned" by some family or village, and much that is apparently unused had been cleared and farmed by someone in the past, and may be under bush fallow. In practice, anyone who wants to farm land outside his home area must come to terms with the traditional owner. In areas where land is plentiful, this may be done by a token gift such as a few kola nuts; in other areas, traditional owners allegedly may claim up to one-fourth of the harvest.

The government has no cadastral surveys and little capacity to lease unused land. In Gagnoa, the administrator and SATMACI cooperated to lease bottom-lands near the town principally to non-locals who took up rice culture. However, this was the only such example we saw, and was achieved at the expense of considerable animosity from families who claimed to have once farmed the land.

Suggestions for Improvement

The Ivory Coast is increasing its marketed production of rice at an impressive rate. Local production has been catching up with consumption for the last two years and replacing some rice imports. Three factors are primarily responsible: (1) a relatively high assured producers' price of at least eight cents per kilogram for paddy and a guarantee that lower world prices will not be allowed to upset the local price, (2) good rains, and (3) demonstration and extension efforts by SATMACI and the Taiwanese technicians. The last factor is probably just beginning to be effective.

The government has a program to replace all rice imports with local production. Its operations to reach that goal are well designed. While it is making progress toward that goal, it is difficult to say whether that goal will or even should be achieved. Increasing rice consumption is not and should not be a planning goal. Since foreign exchange is not scarce, achieving self-sufficiency is not a goal to be achieved at any cost. Rather, planners hope that the cost of achieving that goal will be less than the alternative cost of not having foreign exchange at some future date. Furthermore, they hope that the introduction of new techniques will enable the Ivorian farmer to produce rice at a cost at or near the cost of buying rice on the world market. The resource endowment of the country is such that these hopes may be justified.

The country has an abundance of land suitable for rice culture. There is sufficient rainfall to grow at least one rice crop per year anywhere in the country and in some places two crops. The climate is fairly moderate. Four working systems of rice production already exist. There are a few satisfactory varieties available and new varieties could have a major impact. Farmers seem to accept and understand the principle of using fertilizer to increase production and may soon use it on rice in significant quantities.

On the other hand, the environment presents problems. Land clearing is expensive in the south. The tools available are not suited to permit great increases in production output with the labor available. There is a shortage of research information.

Partly because of these deficiencies, production costs are high. Furthermore, certain inefficiencies in the market environment make the government operation to subsidize the rice industry excessively expensive.

The following suggestions for improvement are proposed:

1. Research is needed on varieties, fertilizer techniques, and tillage methods. In such research, the place of rice-growing in the economy of small-family farming needs to be considered, particularly with regard to conflicting labor demands between rice-growing and other tasks. Since labor is the major input factor, costs can be best reduced by improving its efficiency; that is, by finding simple machinery adapted to the needs of the farmer.

   Agronomic research could be coordinated with a West Africa regional program since many problems are common to several countries. The research in the Ivory Coast suffers from lack of continuity and applicability. Researchers do not have enough communication with extension people to know priority problems. Research staff is changed too often. The good physical facilities of IRAT could serve as a framework for a more worthwhile research effort.

2. The extension effort, while getting results at the moment, could be improved. The agents are well-selected and get a sound training in rice production, but this includes little training in extension methods.

   Preparing agents to work solely in rice production is a temporary solution. Eventually, however, they must be competent in other crops, and a training program should be set up soon to broaden their competence. The present training will soon have supplied all the agents necessary for the rice campaign. Plans are being made for using the training facilities for in-service training programs. It would be a good idea to use this program to broaden the training of the agents to include other crops, and increase their teaching effectiveness by including extension methodology. In particular, use of audio-visual methods and techniques of motivating farmers needs to be taught to agents.

3. Taiwanese extension efforts have been most successful where they have been integrated with the SATMACI operation. The pattern of integration followed in the West and Center-West regions should be followed throughout the country.

4. SATMACI and the Taiwanese should be encouraged to identify and popularize appropriate new tools and to stimulate the use of fertilizer.

5. SATMACI should make careful economic analyses before making new investments. The building of milling and storage capacity has been far ahead of demand so that SATMACI is being pushed to buy more paddy and to increase the use of these facilities at all costs, even by using police powers to take over private rice trade.

6. Both SATMACI and the small Ivorian traders have a useful and constructive role to play in rice marketing. The presence of the SATMACI tends to stabilize prices and to guarantee farmers a certain minimum. The presence of the small private traders acts as an incentive to keep SATMACI efficient and should prevent consumer-oriented policy-makers from squeezing the rice farmer. Small private traders should be free to operate, subject to such regulation as is necessary to insure a minimum of fair-dealing. SATMACI should compete with them in the marketplace.

7. The present system of guaranteeing the same price for paddy to all rice farmers anywhere in the country is a principal reason why SATMACI loses money on commercial operations. This system also tends to divert rice production from the most economic locations, close to markets, to less profitable ones. This uneconomic cost may be one the government will want to bear for political objectives; that is, to distribute wealth more evenly geographically. We believe that these objectives could be achieved more efficiently by subsidizing transport to outlying regions or by spending more on roads. Use of these means would make the cost of attaining these equity goals more visible than at present.

8. The government should not fix a price for brown rice. If consumers prefer brown rice, for nutritional or other reasons, and will pay more than 14 cents per kilogram (35 CFA francs) for it, they should be allowed to do so. This would legalize trade that is now technically illegal and create more incentive to market brown rice.

TABLE I

Ivory Coast

Estimates of Land-Clearing Costs per Hectare

Type	Cost		Labor days	Description
	Dollars	CFA francs		
Forest				
Hand	48	(12,000)	60	Western Region; summary clearing, leaving some trees and stumps, felled logs in place; no hoeing.
Machine	300	(75,000)		Dabou; Chinese contract with private firm; windrowing but no sub-soiling
	488-720	(122,000-180,000)		MOTORAGRI; includes de-rooting and sub-soiling.
Cut-over Forest				
Hand	300-400	(75,000-100,000)	300-500	For Chinese-directed farmers near Bouake; clearing bottom land, de-rooting, sub-soiling, leveling, and bunding, including construction of canals; no allowance for Chinese supervision.
	800	(200,000)	1,000	MOTORAGRI's estimate of cost of hand clearing in Center Region; with soil preparation.
Machine	324-520	(82,000-130,000)		MOTORAGRI tariffs for clearing, de-rooting, windrowing and sub-soiling.
Savannah				
Hand	56	(14,000)	70	Western Region; summary clearing of elephant grass with scrub tree growth; no hoeing of roots.
Machine	175-260	(47,000-65,000)		Northern Region; with sub-soiling.

SATMACI estimate for upper limit of cost of preparing rice land consistent with economic profitability:

	400	(100,000)	For irrigated rice
	240	(60,000)	For upland rice

Figures retained for our analysis:

	56	(14,000)	70 Summary clearing for traditional upland culture.

TABLE I (cont.)

Type	Cost		Labor	Description
	Dollars	CFA francs	days	
	200	(50,000)		Machine clearing for improved upland culture.
	120	(30,000)	150	Hand clearing for improved upland culture.
	400	(100,000)		Machine clearing for irrigated culture.
	240	(60,000)	300	Hand clearing for irrigated culture.

TABLE II

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 agoutis and birds (Quelea quelea).
** MOTORAGRI assumption is 100 days.

TABLE III Estimated Costs of Rice Production by Different Techniques (per hectare)

	Traditional Upland		Improved Upland		Mechanized Upland		Irrigated	
		CFA Francs		CFA Francs		CFA Francs		CFA Francs
Recurring material								
Seed	75 kg.	1,500	60 kg.	1,200			50 kg.	1,000
Fertilizer	0		100 kg.	2,200		6,750	150 kg.	3,300
Insecticides	0		1 liter	600			2 liter	1,200
Machines						9,000		
Total		1,500		4,000		15,850		5,500
Recurring labor	40 days	8,000	94 days	18,800	59 days	11,800	195 days	39,000
Total Recurring		9,500		22,800		27,650		44,500
Capital								
Land preparation by hand	70 days x 200 CFA / 2	7,000	150 days x 200 CFA / 10	3,000			300 days x 200 CFA / 10	6,000
Total Cost		16,500		25,800				50,500
Land preparation by machine			50,000 / 10	5,000	50,000 / 10	5,000	100,000 / 10	10,000
Total Cost				27,800		32,650		54,500
Gross Income	1 metric ton	20,000	2 metric tons	40,000	2 tons	40,000	5 metric tons	100,000
Returns to Management								
1 crop: hand		3,500		14,200				49,500
machine				12,200		7,350		45,500
2 crops:		14,000		31,400				105,000
hand machine				29,400		17,700		101,000
3 crops:								160,500
hand machine								156,500

LIBERIA

Because an A.I.D./U.S.D.A. survey[1] of rice production and marketing in Liberia was made early in 1968, the Team spent limited time in this country. Our purpose was primarily to observe the kinds of resources and level of cultural practices being used in comparison with other West African countries as a basis for making recommendations for the region as a whole.

Production

Our limited observations indicated that the resources being used for upland rice were not as well suited to the traditional slash and burn program as is true in Sierra Leone. The slopes were steeper, and the flat saucer type inland swamps were smaller and less numerous. As was noted in the earlier study, upland production, even though improved practices were put into use, would continue at a low level and would contribute little toward meeting the growing rice demand among the non-farm population. It is likely, however, that many small holders are not using lands best suited for upland rice production, and the Liberia Department of Agriculture could help them select better areas.

More suitable resource situations observed were in Grand Cape Mount County near Fandoh and Bo. These comparatively large areas have alluvial soils sparsely covered with trees that are available for development, perhaps between 4,000 and 9,000 hectares. The Department of Agriculture has initiated clearing and trial plot tests on a limited scale. The trials observed at Fandoh looked satisfactory but appreciable quantities of fertilizer would be required to maintain profitable yields. The soils in the Bo area appeared to be more fertile. However, the topography is somewhat irregular and measures to control erosion would be necessary. It was suggested that there are other areas having similar resources that have potential for producing rice under controlled irrigation.

In either of these locations, systems for stabilizing water supplies for irrigation would be necessary. However, the land is sufficiently well suited for rice that capital investment for developing reserve water supplies, or for protecting against floods in periods of heavy rainfall, would appear economical.

1/ Rice Production and Marketing in Liberia, U. S. Department of Agriculture and U. S. Agency for International Development. Washington, D. C. July 1968.

The Department of Agriculture has initiated exploratory investigations to determine the extent of these areas, the yield levels that could be expected, fertilizer needed, and the land clearing and development costs involved. The objective appeared to be to encourage private interests, assisted by any quasi-government funding, to initiate large scale rice production projects. The central government would facilitate such development by extending and improving roads, communication services, and related measures. Local people would be drawn into the project as operators of small holder units and as laborers for the large scale units.

Final judgment as to the practicality of such project could not be made on one visit to the area. However, these locations definitely were the most promising of any observed. The nearness to Monrovia and possibilities for water transport over part of the distance are pertinent factors to be considered.

Our impressions were unfavorable of the ambitious pilot project to determine the feasibility of large scale mechanized rice production on upland carried on by Uni-Royal (LAC). The excessively irregular topography combined with the disruption of the soils in the clearing operations appeared to render the site impractical. It is questionable if land with a slope in excess of three to five percent, in a high rainfall location, can produce rice successfully under mechanization. Furthermore, the capital requirement for highly mechanized rice production makes it practically impossible to obtain yields that will support this type of operation. It was indicated that land with only moderate slope is available within a few miles of LAC headquarters. The possibilities of shifting this part of the experimental work carried on by LAC to such land should be studied. The degree of mechanization that may prove practical is yet to be determined and needs further research.

To the credit of the agronomists in charge, variety testing appeared to be well planned and useful information on comparative merits of a wide selection of varieties is being accumulated. If there is reasonable assurance that considerable lands of modest slopes which could be cleared with minimum disruption of the top soil are available in that vicinity, then the work on variety testing and possibly smaller scale mechanization should be continued.

A brief visit to the Taiwanese Mission at Gbeden convinced us (1) that the Taiwanese technology of growing paddy is well suited to the flat bottom lands near streams which can provide a source for irrigation water, (2) that profitable yields can be obtained with only a nominal level of fertilization and other chemical aids, and (3) the local people can be taught and will respond, in limited numbers initially, to this method of production if a reasonable price incentive is

provided. Even though this was an early Taiwanese project in West Africa, the standard of maintenance for roads, ditches, equipment, and housing was considerably below that found on similar projects in Sierra Leone. This is attributable in large part to the limited support provided by the government of Liberia. It appears that such a project plus the related technical training and extension effort provide an opportunity for many local farmers to receive instructions in improved methods of growing rice. The government should provide adequate support for the program at Gbeden and explore all possibilities of extending it to other suitable areas. An education and direct assistance program should extend the results to small holders in other villages. The Gbeden farmers should have an assured market for their rice. The direct assistance could be in the form of seed, fertilizer at subsidized rates, and limited credit for other production items.

Marketing

Imports

Liberia imported 33,000 metric tons of rice in 1967 and 46,000 metric tons in 1966. Usual import requirements are 36,000 to 42.000 metric tons. Import cost figures are:

	Range Per Metric Ton (dollars)
U. S. No. 5 35 percent broken parboiled milled rice (f.a.s. U. S. Gulf ports)	$176.80 - 189.50
Ocean freight	18.70 - 24.40
Exporter commission	2.00
Consular fees	3.10
Insurance	3.30
Import duty (reportedly to become $11 in October 1968)	5.50 (11.00)
Monrovia harbor charge	3.10
Delivery from port to wholesaler in Monrovia	2.20
Interest	2.20
Total cost to wholesale warehouse - Monrovia	$216.90 - 250.80

The official retail price is $237.00 per metric ton (23.7 cents per kilogram or $10.75 per hundredweight) but retailers sell by the cut rather than by weight so the actual retail price is said to be as much as 13 to 14 cents per pound (28.7 to 30.9 cents per kilogram).

Normally imports are distributed within a period of two months because of the climate and the danger of rice going out of condition from insect infestation or rancidity.

Mill construction

A rice mill is under construction at Monrovia outside the free port. It is expected to be completed by October 1969. The mill, from Scotland, has a milling capacity of four metric tons per hour, or about 30,000 metric tons per year. Also being installed are 18 corrugated steel silos for bulk storage, each with a capacity of about 2,000 metric tons. This mill plans to buy parboiled brown rice from the United States, ship it in bulk to Monrovia, truck it from shipside to the mill, and finish milling it at Monrovia. There is said to be no conference shipping rate established on bulk brown rice to Monrovia, but based on rates from New Orleans to Rotterdam, it is estimated that the rate to Monrovia might be $8.80 to $9.90 per metric ton or about one-half the charter rate for bagged rice. There would also be a savings on the cost of the bags. If parboiled brown rice can be purchased equivalent in quality and broken content to parboiled mill rice at no higher cost, the above savings in ocean freight and bagging may cover the cost of unloading from the ship and of milling. Thus, this firm might have an economic advantage in the value of the final products over importing milled rice in 100-pound bags.

The mill could process locally-produced rice by the installation of hullers and paddy separators. At the present time, it is equipped to process brown rice into milled rice by the use of pearling cones. The lowest quality of brown parboiled rice available from the United States will produce a better quality of parboiled milled rice than that now being imported.

Services

Research

The research conducted at Suakoko was viewed briefly. It is beneficial largely along the lines of variety testing and improvement, measuring response to fertilizer, and studying alternative

ways of controlling diseases. Work at this location should be limited to problems that require studying near a particular production area. Ultimately, work at Suakoko would fill local needs that could not be obtained from possible regional programs for West Africa.

Price policy

The A.I.D. Team which visited Liberia earlier concluded that a guaranteed price of seven cents per pound (15.5 cents per kilogram) to producers for rough rice would be necessary to bring forth enough output to satisfy total country needs. This compares with four cents per pound (8.8 cents per kilogram) being used in the Ivory Coast which also is the approximate level that has been established for stabilizing prices to farmers in Sierra Leone and Ghana.

If seven cents per pound for paddy, plus further subsidization in terms of transportation, storage, and milling is required to gain self-sufficiency, it might be more economical in terms of subsidies from public funds and in prices to consumers if a considerable share of the requirements were imported annually. The fact that a downward trend in world prices for rice during the next few years has been forecast provides justification for considering this alternative.

Alternatively, a consortium of private firms could be authorized to import all rice requirements using charter rates only. Then the government could issue import quotas to interested wholesalers or the latter could buy through the consortium. The consortium would be paid a nominal fee for services (possibly $1.10 per metric ton) and each firm in the consortium would have the same right as any other wholesaler to apply for a quota.

Milling and other processing

Many urban consumers prefer parboiled imported rice to locally produced milled rice. The main reason expressed for their preference was that imported rice did not contain sticks, stones, and sand which are found in local rice. Locally-produced milled rice is sold in the market places at only a small discount, indicating that people recently moved from villages to towns and cities have some preference for it. Therefore, pending increased consumer preference for parboiled rice and until commercial sales of locally produced rice are much greater than at present, there seems to be no need for the installation of parboiling equipment.

Suggestions for Improvement

Economics

Orders for rice imports, other than consumer size packaged rice, should be pooled in minimum quantities (3,000 metric tons or more) to permit chartering conference rate ocean transportation and to prohibit imports at liner rates. This action would save $5.50 per metric ton. If Liberia imports 40,000 metric tons in a year, this would be a saving of $220,000.

The use of small milling machines, as recommended in the April 1968 Liberia report, should be limited to milling rice for producer and village consumption. For such purposes, toll milling could be performed and the producer would not need cash to pay for cost of milling. Japan, Taiwan, and Italy make single-stage hullers that appear suited for this work. These small mills should be installed in localities having sufficient rice for toll milling to pay operating costs and amortize capital costs. Single-stage mills save time and produce more milled rice compared to the mortar and pestle method but are less efficient than larger multi-stage mills. The small mills yield about 10 to 15 percent less milled rice than the multi-stage mills. Therefore, commercial sales of paddy rice, above that needed for producer and village consumption, should be sent to a larger mill for processing, where good quality rice can be processed. There should be no difficulty in selling well-milled rice free from stones and other foreign material.

Buying paddy rice

At present, most sales of paddy rice and producer miller rice are said to be on a barter basis. The buyer reportedly can adjust the asking price of what he barters for rice so that the price paid for rice is low. Under barter, some sources said about the price paid was $3 per hundredweight (6.6 cents per kilogram) for paddy and $5 to $7 per hundredweight (12.1 to 15.4 cents per kilogram) for producer-milled rice, but these prices were not confirmed. Producers are reportedly reluctant to acknowledge sale of rice for fear knowledge of their surpluses will attract relatives and friends, tax collectors or requests for political contributions. Furthermore, a license to sell may be required. Such customs and regulations tend to retard commercial production and sale of rice. Nevertheless, it is believed, many producers desire to break through these barriers to increase their incomes.

NOTE: Opportunities for improving technology, as well as for marketing, are contained in the A.I.D./U.S.D.A. study of Liberia rice issued in July 1968.

NIGER

The Rice Economy

Rice is unimportant in Niger's economy. It accounts for not more than one percent of staple food consumption, of which ninety percent is millet and sorghum. The people of Niger eat about three kilograms of milled rice, equivalent to five kilograms of paddy per person per year on average. Millet and sorghum eat is 370 kilograms per year per person.

Almost all of Niger's rice consumption is concentrated in the capital city of Niamey and a few other towns. Since 1963, rice consumption increased somewhat more rapidly than population, which is growing at a rapid three percent per year or more.

Around nine-tenths of Niger's rice is grown on the narrow flood plain along 250 kilometers of the Niger River Valley from the Mali border to Say. This "swamp" rice culture, generally with little water control, covers about 10,000 hectares. Another 1,000 hectare or so in marshes near Maradi, in south-central Niger, and along the Komadougou River in the southeast account for the remaining production. The climate is too dry for upland rice.

The French have made some efforts to increase water control and improve cultural practices in Niger's small "rice bowl." Taiwanese technicians are now involved in a major program to achieve the same end.

In recent years, Niger has imported small quantities of rice. These volumes have varied with the success of the local harvest, which is dependent upon the regularity of the rains and on the height of the Niger River flood. Imports reached a high of 2,300 metric tons of paddy, worth $330,000 in 1965. Even this relatively small account is a significant foreign exchange cost in a country with a trade deficity as substantial as that of Niger.

A good 1967 harvest gave Niger its first rice surplus. Good rains, a new purchasing policy, and Taiwanese demonstrations were responsible. Unfortunately, high transport costs and the quality of rice from Niger's mills do not permit exports to neighboring countries. Several thousand tons of rice stocks have accumulated. These are being liquidated within Niger at considerable cost to the government.

The Physical Environment

Land

Most of Niger is unsuitable for growing rice due to lack of water. Most production takes place in the main valley of the Niger River.

At present, the government is making little effort to increase rice production, probably because of the current surplus. If it should wish to make an effective effort to increase rice production in the future, the Niger Valley would certainly be the best place to begin.

The Niger River has changed its bed several times. The valley is thus characterized by a series of ridges interspersed with wide alluvial plains. Many of the ridges consist of wind-carried sand heaped on mounds of river gravel. Marshes and small lakes now occupy parts of abandoned river channels.

Thus, the valley offers a wide variety of soils and drainage conditions. However, there are many large (100-200 hectares) areas that are fairly homogenous ecologically.

Vegetation

There are no large trees, or dense underbrush. Hence, expensive land clearing is unnecessary. Various grasses and species of "wild" rice (Oryza barthii, Oryza breviligulata) predominate.

Soils

Disregarding the many dunes in the valley, four types of soils prevail: black silt-loams, gray silt-loams, brown clay-loams, and reddish-brown sandy lateritic clays.

Considerable soil testing and mapping has been done by ORSTOM (Office de Recherche Scientifique des Territoires d' Outre-Mer), which has compiled much information on the soils in the valley. IFAGRARIA, an Italian land development firm, has also completed a soils map of the valley which is not very detailed.

ORSTOM concludes that the four main types of soils shown above are all suitable for rice production, providing cultural techniques are adapted to their needs. The Taiwanese Mission is successfully growing rice on all four soil types.

Ph readings for most soils run from 5 to 6.5.

Research has shown little response to fertilizer other than nitrogen. But most such research was carried out on black silt-loam

soils which are naturally rich in available phosphorous and potassium. Hence, the results would not necessarily be applicable to continuous, high-yield rice culture.

Elevation

Differences in elevation along the length of the valley (160 m - 223 m) have little effect on the climate and may be disregarded.

Availability of land

Of the total land area of 126.7 million hectares in Niger about nine million hectares are part of the Niger Valley. Of these nine million hectares, perhaps no more than ten thousand hectares are in rice production.

From visits to only a part of the region (Kolo to Firgoun), it would seem that this present area of cultivation could be doubled at little capital expense. With a larger capital investment (dikes, pumping stations, drainage and irrigation systems, etc.) several times the actual area could be brought into production. There is, therefore, no shortage of land suitable for rice production. The relative importance of rice is shown below:

	Total Areas in Crops (Hectares)
Millet	1,800,000
Cow Peas	600,000
Sorghum	546,000
Groundnuts	355,000
Bambara Groundnuts	35,000
Cassava	21,000
Cotton	16,000
Rice	11,500
Corn	3,500
Wheat	600

Rainfall

The climate is characterized by a rainy season, from May to September. The date of the onset of the rainy season, duration, and total amount of rainfall all vary considerably as shown below. The three locations for which data are given are Ayourou, in the north of the main rice-producing region; Tillabery, in the center; and Niamey, in the south.

	Date of First Rain (7-year data)	Date of Last Rain (7-year data)
Ayourou	15 April - 17 June	23 Sept. - 21 Oct.
Tillabery	21 April - 29 May	23 Sept. - 16 Nov.
Niamey	9 April - 17 May	5 Oct. - 15 Nov.

Monthly Rainfall (mm.)

	May	June	July	Aug.	Sept.	Oct.
Ayourou	13	51	97	114	35	26
Tillabery	18	55	132	203	86	11
Niamey	46	79	181	206	101	21

	Ave.	Max.	Min.
Ayourou	354	501	318
Tillabery	510	610	420
Niamey	636	652	44

Temperatures

From March to May, high temperatures reportedly interfere with pollen fertilization, causing a high percentage of empty grains. Tillering is also adversely affected if it occurs during this period. The low night temperatures from December to February retard rice growth, prolonging the growing season by as much as much as twenty days. Cold also inhibits tillering. High temperatures during periods of low rainfall cause very high rates of evapotranspiration. Temperature, therefore, is an important factor in rice production.

The temperature ranges are:

Station	Average Daily Max. of Warmest Month	Average Daily Min. of Coldest Month
Niamey	41.2 C	15.8 C
Tillabery	41.7 C	16.5 C

Day length

The valley lies between the 11th and 15th latitutdes. Day length is considered a factor because sunshine during the rainy season may be inadequate for ideal growth. Hoever, there is no evidence to support this commonly-held conclusion.

Rice planted from December to February takes longer to mature than rice planted from June to August. Whether this is caused by variations in day length or temperature is not known.

Flooding

The annual floods of the Niger River are essential to rice culture, since rainfall is insufficient and water control is not extensively developed. The low-water mark at Niamey traditionally occurs in late June and early July. Rains during this period usually cause a river rise in late July, which gains in momentum in August, reaching a first peak in September. As the rainy season ends, the level continues to rise, although at a slower rate, to its maximum height in February. The flood then recedes until June. The average difference between high and low water at Niamey is 3.47 meters.

Production Techniques And Costs

Two main types of rice culture, swamp and irrigated, are used almost exclusively. Depending on the degree and rapidity of flooding, "swamp" rice may be divided into flating and non-floating. Rice growing in water which gets deeper than two meters will be called floating. The importance of the cultures is shown below. The figures are approximate.

Type of Culture		Area	Percent of Total Area
"Swamp":	non-floating	7,270 hectares	73
	floating	2,500 "	25
Irrigated		230 "	2
Total		10,000 hectares	

"Swamp" culture

Usually takes place on cleared bottom lands along the river valley. As soon as the first rains (May-June) have softened the ground, the farmer clears off the old vegetation and digs up the soil to prepare a seedbed. Usually, he broadcasts the seed and covers it lightly by dragging a brush harrow over the surface. He then waits until additional rains cause the rice to germinate and grow.

Weeds germinate with the rice and the farmer will usually try to eliminate them, time permitting. With luck, he can do one weeding before rising flood waters catch up with the growing rice and inundate the paddies. After this, additional weeding is difficult or impossible.

Nothing more is done to the rice until harvest. This is accomplished by the farmer riding in a canoe. He will gather the rice, cut it, and tie it into sheaves which he then dries on the river bank. Harvesting usually takes place from December to February, and coincides with the maximum rice in river level.

Rice is threshed and stored in granaries. Usually it is parboiled and then hand-milled. Much of it is sold for cash.

The rice may suffer from insects, fish, diseases, and hippopotami. Little is done to prevent or control these losses.

The great weakness in this system is that it leaves the farmer almost entirely at the mercy of rain and rising flood waters, both of which may vary considerably from year to year. The late rains must tide the rice over until the river rises to water it. This year, Niger suffered a long dry spell with total rainfall much below normal. Much rice had not sprouted by mid-September. In other years, the river may rise rapidly, covering the rice for more than a week. Usually such flooding kills the rice entirely or reduces yields to insignificant amounts.

Since there is a wide variability in water level in the fields at any given time, due to the absence of leveling, the rice crop matures at different times even in the same field.

Fields may be used year after year. Yields under such a system obviously vary widely, but are reported at between 700 and 900 kilograms per hectare.

French aid and the European Development Fund have financed the construction of several dikes along the river with permit controlled flooding of certain areas. These areas offer the possibility of more-controlled growing conditions and yields have been as high as two to three metric tons per hectare. An area of 810 hectares is protected by dikes.

Irrigated culture

About 230 hectares have been developed by the Taiwanese into rice paddies with complete water control. Of these, 120 hectares are reported to have insufficient drainage, but it appears that this problem could be remedied easily. The Taiwanese are developing another 800 hectares. These should be in production in four years. There is no other fully irrigated land in the country.

Cultural methods employed by the Taiwanese are essentially the same as used in both the Ivory Coast and Upper Volta. Two crops are harvested each year. Fertilizer applications are about the same as in other Taiwanese projects: Nitrogen - 80 kgs. N; Phosphorus - 40 kgs. P_2O_5; and Potassium - 40 kgs. K_2O.

The first major extension effort made by the Taiwanese used Taiwanese varieties. Some japonica rice was distributed. The resulting production aroused antagonism since it was reported difficult to mill and was unacceptable to the local population

who apparently prefer long-rain, "loose" rice. Since then, the Taiwanese have abandoned the japonica varieties in favor of a local variety, D 52/37, which is acceptable from a milling and cooking standpoint. In the future they may switch to IR-8.

Yields under the Taiwanese system of irrigated production have averaged over four metric tons per hectare per crop, for two crops a year.

Disease control

No one recognizes any disease as being serious. The Taiwanese treat their seed with Granosan, a seed fumigant, before planting as a routine prevention against blast disease.

Free-grazing livestock

The Niger Valley is the traditional grazing ground of large herds of cattle and goats. Nomadic groups move their livestock around the country, particularly during the dry season when the valley contains the only green forage in the area. Since none of the valley is fenced, cattle, goats and horses come and go as they please. Even when tended, they frequently wander into irrigated rice paddies; the herdsmen apparently see no harm in their animals' eating a little rice. IRAT, a French research organization, has had many experiments ruined by wandering livestock. Efforts to control this problem have not been successful. The Taiwanese hope the presence of water-filled canals will prevent livestock from crossing their fields. However, one canal in their development zone had been used so much by livestock as a watering place that the banks are virtually ruined.

Tools and machines

The tools used by the Nigerian farmer are similar to those in the Ivory Coast and Upper Volta. A short-handled hoe, an axe, and a short-bladed machete are the basic items.

There are many donkeys (300,000), horses (130,000), camels (355,000) and cattle (3,500,000). We did not see any animals being used for draft purposes, though some donkeys are used for transport. This vast untapped reservoir of animal power could be used to build dikes, level land, plow and prepare seedbeds.

There is equipment (plows and cultivators) designed for animal traction, but little of it is used. This equipment was imported as part of a UNCC (Union National pour le credit at la Cooperation, a government cooperative credit organization) effort to develop animal traction. The effort is considered unsuccessfuly and the Ministry of Agriculture is reorganizing the program.

There is a noticeable absence of small tools which would be useful in rice production. The "houe Hilaire", a cultivator shovel of Senegalese origin on the end of a long handle, is pushed along the ground to remove weeds in millet and cotton fields, but appears unsuitable for weeding rice paddies.

No tool development work is now being carried out. No organization is actively distributing improved hand tools throughout the rice-producing area.

On Taiwanese projects, construction of earthworks, and drainage and irrigation canals to provide water control is done by hired labor and, frequently, heavy equipment. The labor is paid by the Taiwanese project. Bunding is done by the farmer at his own expense, but rototilling and leveling is at the project's expense.

The area at Daikaina (120 hectares near Tillabery) was developed by Taiwanese working in an area already surrounded by a dike built previously by French aid. They had the disadvantage of having to pump water into the paddies during the beginning of the main rice season. The pumps are supplied by Taiwanese aid.

Unlike their effort in the Ivory Coast and Upper Volta, the Taiwanese have taken steps to organize a farmer committee to be responsible for running the area. This includes maintenance of machines, dikes, and canals; and purchase of fertilizer, seed, and gasoline to run rototillers and pumps.

The Taiwanese have partly withdrawn from Daikaina. But the local committee, with the help of three Taiwanese technicians and agents supplied by the Ministry of Agriculture, does a satisfactory job of management. Canals are being maintained, rice is being cultivated using Taiwanese techniques, and rototillers and pumps are still operating. The partial Taiwanese withdrawal, unfortunately, coincides with a government-imposed reduction in rice prices. It remains to be seen whether rice farmers at Daikaina will continue their efforts in the face of falling prices, but they have undoubtedly learned much from the Taiwanese.

IFAGRARIA, an Italian development firm, built a large dike at Koutoukale to protect about 300 hectares of irrigable flood plain so that it could be brought into rice production. It built a pumping station with three turbine pumps powered by large diesel engines, and designed a crude primary-canal system. Then, for reasons which the team was unable to uncover, the Italian firm withdrew. No agents came into the area to teach improved rice culture. No secondary canal system was ever laid out. No efforts have been made to increase rice production and very little if any increase has occurred. The main dike and the unused pumping station are in good condition.

A similar area of about 150 hectares was diked at Firgoun. No pumping station was involved since it was planned to use flood waters. A set of gates was installed to permit partial water control. Levelling is inadequate. This region produces satisfactory rice crops considering the conditions which are too dry to permit unirrigated agriculture. Farmers seemed to have partially developed the area with little direction from anyone. About 100 farmers are working with some guidance from one agricultural agent who seemed to consider water control his main responsibility.

Rice varieties

The Institut de Recherches Agronomiques Tropicales has selected and recommends the following varieties:

1. Dissi 52/37 -- (see Upper Volta) recommended for the main crop on most land sown to rice; will not stand too rapid rise in water level.
2. Sintane Diofor -- (see Upper Volta).
3. Indochine blanc -- recommended for deep water areas.

Dates of maturity appear to vary greatly, depending on whether the rice is planted for the wet or dry season. The same variety may take up to 30 days longer to mature during the dry season.

There is no information concerning the behavior of the above varieties under different cultural conditions.

Selected seed for IRAT is distributed by UNCC at eight cents per kilogram (20 CFA francs), the price of paddy. The higher cost of producing selected seed is born by IRAT.

Fertilizer

Urea is the chief nitrogen form available, but mixed fertilizer is also becoming available. Triple superphosphate is the most frequently used form of phosphorus, and potassium chloride is the most used form of potassium.

The government subsidizes the price of fertilizer; it costs 6.4 cents per kilogram (16 CFA francs). Fertilizer is distributed by the UNCC to local cooperatives on harvest credit bearing 25 percent interest. The collection record appears good.

Fertilizer obviously is greatly needed. However, absence of water control is a more limiting factor than soil fertility. Fertilizer applications are to be recommended only where water can be controlled.

Insecticides

Only the Taiwanese recognize insects as being a serious problem. They

have had trouble with rice borer and now use EPN (an organo-phosphate compound) and Sumithion as a regular part of their rice program. In untreated plots at Daikaina, there was damage from borers, but damage was not widespread.

Irrigated costs

As mentioned above, the only rice grown under complete water control is on Taiwanese projects. Growing techniques are similar to those discussed elsewhere. Irrigation systems must depend on pumping during eight months of the year.

Cost figures are based on the project at Daikaina. Since this up-graded an existing project, the Taiwanese admit the irrigation system has far from optimum efficiency. Cost of pumping, for instance, will surely be lower at the new Saga development.

The Taiwanese estimate current labor input on the Saga development as follows:

Preparing land and seed bed	17+ days per hectare
Transplanting	20
Weeding, water management, et al.	110
Harvest	50
	197+ days per hectare

The labor estimate for Daikaina is 175 man days per hectare. For the Daikaina development, the Taiwanese also count the following inputs per hectare:

		CFA	$
Seed	90 kilograms	1,800	7.20
Fertilizer	350 kilograms	5,600	22.40
Insecticide		600	2.40
Fuel for pumps and rototiller		3,060	12.24
		11,060 CFA	$44.24

Adding $105 (26,250 CFA francs) for 175 days of labor at 150 CFA francs per day (60 cents), the going rate*, current costs amount to $149.24 (37,310 CFA francs) per hectare for each harvest.

If a farmer grows IR-8 and works effectively, he can expect five metric tons per hectare per harvest; if he grows the D-52/37 variety, now encouraged by the government, his average yield will be closer to 3-1/2 metric tons. Last year, paddy sold for 6.8 cents (17 CFA francs) per

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*Farmers may be able to pay 125 CFA francs plus lunch or, in isolated areas, as little as 100 CFA francs.

kilogram early in the season and sold as high as eight cents (20 CFA francs) toward the end. This year, the price will probably be 6.4 cents (16 CFA francs) per kilogram or lower. At 6.4 cents gross income per hectare would be:

for D-52/37	$224	(56,000 CFA francs)
for IR-8	320	(80,000 CFA francs)

In other words, the current cost of growing a ton of irrigated IR-8 is about $30; the cost for a ton of D-52/37 about $42.50. Largely due to lower labor input, the former is somewhat lower than the comparable figure for the Ivory Coast. These figures do not include threshing, drying, and delivery to the collection point. Nevertheless, with paddy selling at $80 per metric ton last year and with the farmer receiving the irrigated land at no cost, rice growing was profitable. Even with the price at $64 or possibly lower this year, farmers with few alternative cash crops should find it sufficiently profitable.

These figures do not include costs of developing irrigated land and maintaining and replacing equipment. These costs are high. Most of them have not been borne by the farmer, but by foreign aid. They are relevant in determining whether such use of aid is the most economical, and in establishing total costs of irrigated rice-growing in order to determine whether the government should undertake such investments.

The pumps, sprayers, and threshers represent a capital as well as current cost per hectare. The Taiwanese estimate the annual cost of amortizing these machines over five years at $28.42 (7,105 CFA francs) per hectare. The pumps, at least, are indispensable.

The cost of development at Daikaina is obscured by the fact that preliminary work was done by French aid, later work by Taiwanese. Projected cost of the Saga development, which will be large-scale and a model of engineering efficiency, is 935,000 CFA francs per hectare ($3,750 per hectare). This figure is all inclusive, even of the salaries of Taiwanese technicians. As should be obvious from the figures above, any attempt to pay off these costs out of the production of the land would be a long-term proposition, certainly not feasible in the ten years we allowed in our Ivory Coast calculations.

"Swamp" costs

As mentioned above, "swamp" rice-growing comes in great variety and produces a wide variety of results.

The farmer sows rice along the riverside without any water control during the rains and harvests from his canoe during high water. His input is small. Let us suppose that it takes him 30 days per hectare to hoe the land, five days per hectare to broadcast seed, and 50 days

per hectare to harvest from his boat*, which he already owns. If he does not do any weeding, uses 100 kilogram of seed per hectare worth 2,000 CFA Francs, and harvests 800 kilogram of paddy per hectare worth 12,800 CFA Francs his return for labor and management is almost 130 CFA Francs per day. If he had to hire his labor at 60 cents per day, he would lose money. If, on the other hand, his harvest was two tons per hectare, his operation would be competitive with irrigated rice growing. In any case, the Niger River bank is lined with a belt of rice just below the anticipated high-water mark. Farmers must feel that it is worth their while.

Partial water control

Economic evaluation is no simpler for simple developments which permit partial water control. These surfaces are not levelled. Yields vary according to land height and drop when there is a time gap between the end of the rains and the rise of the river.

Culture with partial water control appears to be marginal for the farmers. They do not bother to farm a part of the areas for which partial water control has been developed. Furthermore, it is assumed that the social cost of developing land in this way is not justified unless higher yields than the present ones can be achieved.

Disease as a cost

Niger is out of the onchocerciasis belt. The Niger River flows rapidly enough that schistosomiasis does not seem to present a problem. With the spread of irrigated culture, it might become a problem. However, with paddies closely grouped in the valley, control of the disease (and of malaria for that matter) would be relatively cheap.

Marketing

Niger is spread out along the northern border of Nigeria. It is cheaper to move goods to the south than to move them between different portions of Niger. Therefore, Niger is divided vertically into a number of markets. Rice is more likely to be imported into or exported from any one market area than to move between them. The Niger River Valley is

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* Cf. work requirement per hectare given in SEDES study is 86 days. This figure is for shallow water conditions and denotes more time to weeding and less to harvesting: preparatory tillage-33 days, planting - eight days, weeding - 28 days, harvesting - 17 days. Thus, the labor requirement is probably fairly stable whether the culture is "floating" or normal inundation.

the only significant rice market and accounts for 90 percent of rice consumption. The eastern area may have a slight effect on imports, which cross from Nigeria to meet local demands in Maradi and Zinder. However, we will henceforth concentrate exclusively on rice in western Niger.

Imports

Rice imports are now forbidden. UNCC purchases of paddy and hand-milled rice in 1967 were equivalent to almost 8,000 metric tons of paddy or, under normal conditions 5,000 metric tons of milled rice. At the time of this study, 3,000 metric tons of rice were stored in warehouses at the Tillabery mill alone, with last year's harvest still being milled and the 1968 harvest not far off. COPRONIGER, a government marketing cooperative, which has an official monopoly of rice marketing from the mill to the merchant and which does some retailing, had just finished selling its stocks of rice from the 1966 harvest. In 1967, when stocks were building up, Niger was still importing some rice--1,146 metric tons in the first nine months.

In the past decade, Niger's rice imports have ranged from a high of 2276.5 metric tons to a low of 820 metric tons. Mechanics of importing were handled commercially, and rice was bought in the cheapest market. After rail transport from Cotonou to Parakou and road transport from there to Niamey ($60 per ton) the most recently imported rice apparently cost $236 per ton (59 CFA francs per kilogram).

A small amount of luxury rice is still imported. The Economic Affairs Ministry estimates this market at 30 metric tons per year.

Consumption patterns

A SEDES, (a European Economic Development Consulting Firm) study made in 1961 estimated that about 300,000 people in the country's four major towns and the rice-producing regions consumed almost all of the country's rice, eating 21 kilogramsper person per year. The rest of the population consumed about one kilogram per person per year. Thus, most consumption is in the small "rice bowl" and even here rice is not the staple. It is a luxury food. The preferred form is parboiled, long-grained, non-sticky rice. Over half the rice crop is grown for sale instead of home consumption. A large portion of the rice is consumed in Niamey.

Prices

During the 1960s, the price a Niger farmer could get for his paddy has hovered in the neighborhood of 6.8 cents (17 CFA francs per kilogram). A monopoly in paddy purchase from the farmer has been accorded to UNCC. In 1967, UNCC began the season paying 6.8 cents per kilogram for paddy, but ended paying eight cents in a successful effort to win a larger portion of the market from private traders, who continue to operate.

It seems evident that farmers could actually obtain these prices without difficulty. They are concentrated geographically and grouped into 22 cooperatives, usually composed of five or more villages. Since production at last year's prices exceeded local demand and could not be profitably exported, it is almost certain that the price to producers will be lowered. Estimates of next year's paddy price range from 6.4 cents (16 CFA francs) to 4.4 cents (11 CFA francs).

The parboiled, hand-milled market

A large part of local production is parboiled and hand-milled on the farm. Local production consumed on the farm is usually prepared in this way. Most observers believe that this market circuit is larger than that for machine-milled rice.

Marketing hand-milled rice used to be the domain of private traders and the farmers. In 1966, UNCC entered this field. It bought 72 metric tons in 1966, 480 in 1967 and 1,500 in 1968. No real effort has been made to suppress the private trade, so the increasing quantities indicate that UNCC's price must be competitive. It pays $140 per ton (35 CFA francs per kilogram) for parboiled hand-milled rice at its 22 collection points. If we assume that the farmer could have sold his rice as paddy for $68 per metric ton ; then the return to the women's operations of parboiling and pounding is about $27 per metric ton , since the milling rate is about 68 percent, compared with $20 per ton for machine milling without parboiling.

The parboiled, hand-milled product is superior nutritionally and in appearance to Niger's machine-milled rice. From a mixed lot of paddy containing much red rice which a large mill could not easily treat, the process turns out a long-grained, white product with few brokens. At present, UNCC is selling such rice to COPRONIGER, which allegedly retails it for $140 per ton (35 CFA francs per kilogram). Thus both are taking a loss on the operation. Actually, the Niamey population prefers parboiled rice to the lower quality machine product. If parboiled, hand-milled rice reaches COPRONIGER's retail counters, it is immediately bought up for resale in local markets at higher prices. Depending on quality, it was selling as high as $320 per ton (80 CFA francs per kilogram).

Machine-milled rice

Most machine-milled rice sold in Niger now comes from the government mill in Tillabery. Until recently, a part came from imports. Estimated sources are indicated on the following page:

Year	Paddy Commercialized and Milled by UNCC	Theoretical Milled Rice Equivalent	Imports of Milled Rice
	--- Metric Tons ---		
1965	3,000	1,800	882
1966	6,400	3,800	2,276
1967	3,050	1,800	1,200
1968	5,742	3,400	30

Allowing for storage of a part of this production, the yearly consumption of machine-milled rice must be in the neighborhood of 3,000 metric tons.

The system of collecting paddy and getting it to the mill is quite efficient due to the concentration of the production area and its proximity to the mill, and to the village cooperatives in the Niger Valley. Almost all rice destined for the mill is produced in fewer than 200 villages grouped in 22 cooperatives, each with its collection point. The UNCC manages the system and retains ownership of the rice until sale after milling. Transport is contracted to private firms. Costs involved in getting a ton of paddy to the Tillabery mill in 1967 were:

$68.00--80.00	Paid to farmer at collection point
1.00	Paid to local coop for arranging purchase
0.52	Cost of sacking paddy.
4.61	Cost of transport to Tillabery mill (average).
0.63	UNCC's personnel cost for collecting system.
0.66	UNCC's cost of vehicle depreciation in collecting system.
0.01	Other
$75.43--87.43	Per of paddy delivered to mill.

UNCC pays the mill $20 per ton of paddy regardless of out-turn. It costs another $4.30 to sack the out-turn from a ton of paddy and get it into storage, where rates are at eight percent of its value per year, and about $4.50 to get it to Niamey. Thus, the cost of getting the rice produced from a ton of paddy to the store in Niamey, if no storage charges are involved, is the price of paddy plus about $36.23. Whether UNCC recovers these costs or not depends on the sale price and on milling efficiency.

Rice wholesale and retail prices are fixed by the Economic Ministry from month to month. The "usual" prices delivered to Niamey are $180 per ton (45 CFA francs per kilogram) for "mixed" rice, and $80-88 per ton (20-22 CFA rancs per kilogram) for brokens. Bran is sold for $0-20 per ton at the mill, yet a considerable quantity is rotting outside the mill.

The COPRONIGER does not buy all of UNCC's rice. It has 60 stores throughout the country. In 1967, it bought about 1,700 metric tons from UNCC, sold 200 metric tons to other merchants and 1,500 metric tons through its own stores, including 80 percent through its six stores in

Niamey alone. COPRONIGER was reluctant to buy from UNCC because it had already accumulated large stocks of rice from the previous year and wanted to dispose of these first. UNCC, caught in the middle, started selling directly to wholesalers and even retailers. In April 1968, all of UNCC's stocking capacity was full and rice was being stored in the open air, with predictable results. All of COPRONIGER's storage capacity was full, nearly 1,000 metric tons were left from the 1966 harvest, and COPRONIGER was being pressed to buy more rice.

The government realized the gravity of the situation and decided to liquidate stocks of rice at any price. The price of all varieties except brokens was dropped to $140 per ton (35 CFA francs per kilogram). The price of UNCC's delivery to COPRONIGER and the latter's retail price are the same in Niamey; for COPRONIGER's other stores, the firm may add the cost of transport. This is sufficient to reduce the quantities sold in Zinder, for example, to insignificant amounts.

At $140 per metric ton , rice is selling much more rapidly than normal. The usual 45 CFA franc price is at least three times the price of millet, but the current price was only a little more than two times as expensive, and brokens are within the reach of the millet eater. COPRONIGER, instead of selling its usual 130 metric tons per month, was selling about 300 metric tons per month (90 percent in Niamey). It is estimated that stocks will be eliminated by February 1969, although it is not clear whether this includes the 3,000 metric tons stocked in Tillabery. The government plans to postpone the commercialization of this year's crop from December to next February. Then, it is presumed, the price of milled rice will be put back up to the "normal" $180 per metric tons.

The Tillabery mill, constructed with German technical assistance, began operations in 1965. It is the only large rice mill in the country. A smaller one in Niamey has ceased to function and the Taiwanese have a small mill identical to the one described in Upper Volta. The Tillabery mill has a capacity of one metric ton per hour. Parboiling facilities broke down quickly, probably because river water was used without taking out the sediment and without cleaning the tanks. Adjacent storage capacity is over 4,000 metric tons.

Since 1965, the mill has had a number of managements. At present, it is managed by an independent, state company called Riz du Niger and now run by a German technician.

The amount of paddy treated by the mill was mentioned above. This year, UNCC made a substantial effort to treat at least 5,000 metric tons of paddy, the amount considered necessary to amortize the mill. By raising its purchase price for paddy to $80 per metric ton, UNCC succeeded in bringing in almost 6,000 metric tons, which can be milled in about six months operating 24 hours a day.

The mill's out-turn is unsatisfactory. This is largely because the paddy fed into it is not uniform or clean and, apparently, partly because the mill could be run more efficiently. The analysis of a metric ton of paddy which we were given is as follows:

Excess humidity (16 percent instead of maximum 13 percent)	30 kilograms
Empty grains	30
Impurities (straw, sand, etc.)	100
Hulls and bran	240
Rice (containing 10 percent brokens)	320
Brokens	280

The UNCC insists that impurities do not amount to more than 2 percent but it has no way of testing this. When we visited the mill, the "whole" rice being turned out seemed to be closer to 20 percent. The director claims that, when milling uniform lots of long-grain rice (D 52/37, local long-grained, or Bluebonnet varieties), the out-turn is 25 percent brokens and 44 percent rice (10 percent brokens). He said that rice from Taiwanese developments contains about half the impurities of other deliveries.

The mill's chief difficulty is the varigated paddy it receives. Paddy from "swamp" conditions is about half, long-grained and half semi-wild, red rice. At any setting, the mill will either leave some bran on the smaller grains or break the larger ones. The mill operator seems more anxious to avoid leaving some bran on, which the market would probably accept, than to reduce the percentage of brokens. Paying the mill a fixed sum regardless of the percentage of brokens furnishes no incentive to maximize whole rice out-turn.

Last year, UNCC was anxious to increase the amount of paddy it bought; it will be more selective in the coming campaign. UNCC agents will use a core sampler to try to eliminate paddy with too much straw, mud, stones or moisture. They used such procedures several years ago. Possibly, last year, farmers learned that it did not pay to be too careful about impurities. It would probably help if UNCC, instead of rejecting impure paddy as now planned, would establish simple grades and differential prices. Incentive payments for uniform lots would help. The Daikaina project is now planted to a single variety and should yield a uniform lot of 500 metric tons.

A limited effort could probably improve operation of the mill even under present conditions. The equipment could be regulated to leave on a bit more bran and slightly reduce brokens. Replacement of the stone mill with a rubber cone, now being considered, should help improve out-turn. More uniform lots could be put aside and the mill adjusted for them in an effort to save a higher percentage. (The mill operator claimed that this was being done, but we saw no evidence of it.) The existing

sizer could be improved and a mixer added, now planned, to permit mixing whole grains and brokens in whatever proportions are required by markets.

UNCC deficits and exports

At current mill operations and "normal" prices, UNCC realizes $80 from a ton of paddy. This barely covers the cost of paddy at collection points, without counting $20 per metric ton for milling, just over $9 per metric ton of transport costs, and another $7-odd for marketing costs. In 1967, a government subsidy of $196,000 served mainly to balance UNCC's deficit in rice operations; the deficit will probably be larger this year. In the past, these losses have been paid out of the agricultural stabilization fund, built up when world peanut prices were high. Now, the fund is practically exhausted.

Since its present production cannot be sold internally except at a loss, Niger is looking for export possibilities. Unfortunately, the current price structure in Niger precludes this. To break even, UNCC would have to sell the entire out-turn of the mill in whole rice and brokens at $172 per ton (43 CFA francs per kilogram). Even this is approximately the price of extra-African rice with 25 percent brokens c.i.f. West African ports. Furthermore, Nigerian rice faces a normal transport charge of six cents per metric ton per kilometer. This would add $112 to the price of a ton of rice delivered to Abidjan, $88 to Accra and $60 to Cotonou (which is hardly a potential market anyhow). Even if the monopoly price could be reduced by one-third, the transport barrier would be formidable. Rice wholesales in Abidjan for $196 per metric ton; it would have to be available in Niamey for $84 per metric ton.

Aware of Niger's predicament, Ivory Coast recently offered to buy 5,000 tons of Nigerien rice without submitting it to the equalization charge and subsidizing its transport. The transport fee was to have been $40 per metric ton, equivalent to a price of $156 per metric ton in Niamey. Even though this is less than UNCC's break-even price, Niger would have been happy to have made the sale if it could have furnished rice of the required quality -- 25 percent brokens or less. Unfortunately, it could not.

Services

Research

Rice research is carried out at an IRAT branch station at Kolo, about 25 kilometers southeast of Niamey. The staff consists of two French agronomists with previous rice research experience in Madagascar. Trials are carried out at several locations in the valley.

There is a well-organized program of variety and fertilizer trials. Results have shown conclusively the need for nitrogen in continuous rice production. The recommended dose is 80-100 kilograms of nitrogen per hectare, applied as urea, at the onset of tillering or at booting stage. The need for phosphorous and potassium has not been conclusively shown.

Research is being conducted on rice in rotation with other crops. Other work is aimed at determining the best time to plant various varieties, since yields between varieties have varied according to planting. There is no varietal development work, but there is an effort to produce pure lines of selected varieteis. Certain herbicides (2,4-D butylglycol), ester (Negratone 600), and 3,4 dichloropropionalide (Sarcopur and Stam F34) are being tested. Herbicides were compared with hand weeding or no weeding. The importance of weeding is shown in the results of the trial:

Treatment	Yield (kilograms per hectare)
No weeding	937
Hand weeding	4,937
Herbicide	4,708

The facilities at Kolo are simple but, there is ample land (400 hectares enclosed with a protection dike), ample buildings, houses, and equipment to carry out an effective applied research program.

IRAT has no soils laboratory and must send all its samples to Paris for analysis. Most soils have been mapped by ORSTOM. We saw no theoretical research.

IRAT's experiments are frequently invalidated by sloppy execution probably due to insufficient supervision of local personnel. Reports of failure to put on the indicated amount of fertilizer, to weigh properly, or to plant the right variety appear frequently in the literature. Another problem is herds of livestock which often invade research plots.

There was no provision for irrigating rice plots except by opening canal gates when the river got high enough to flood the area behind the dike. But there is no way of bringing in water as needed should the river level fail to rise on time. When we visited the plots, they were obviously suffering from severe drought.

There seems to be some contact between research personnel and officers responsible for extension. But there appears to be no systematic liaison.

There is no research being done on diseases and insects of rice since they are not considered a problem at present. The team saw considerable rice borer evidence. Plant-eating fish (Protyterus and distichoius spp.) are considered a nuisance, though nothing is being done about them.

The Taiwanese team has carried out simple trials on varieties. Future extension phases will be based on the results of the trials.

Extension and training

There is an agricultural school at Kolo, located near the IRAT research station. Boys enter at eighteen to twenty-five years of age, after completing seven years of primary education. They receive a two year course, consisting of both classroom and field work. They are expected to spend one to two months each year in villages working with farmers, but they appear to do so with little supervision.

Agricultural extension service agents are selected from among the graduates of the school. At present, all graduates receive jobs. With the job goes a very handsome house, provided by German aid, and an excellent salary. Agents begin at $864 a year and may move up, after four years in service, to $1,728 a year.

The personnel is as follows, according to grade:

3 Agronomists	- $2,880 per year	- (Ingenieurs agronomes)
10 Agricultural Engineers	- $2,160	- (Ingenieurs des Travaux Agricoles)
26 Supervisors	- $1,728	- (Conducteurs)
136 Agents	- $ 864	- (Moniteurs)

Rice is a minor element in the Kolo training. There are seven agents working in rice extension with mixed effectiveness.

Suggestions for Improvement

Under present conditions, Niger produces more rice than it consumes or can export. Although part of recent increased production is a result of occasional climatic factors, much of it is durable increase. Although 1968 will probably see production fall back from 1967, the new crop will also probably be adequate for local needs. Therefore, the producers' price for paddy should be reduced. This would bring the price closer to a level that would permit exports and also would discourage over-production. Care should be taken, however, not to reduce the price so much that rice producers become discouraged and cut back production to the point where it is again necessary to import rice.

It is difficult to project consumption and production. Unlike some coastal countries, Niger is not experiencing rapid economic growth, and needs not to expect large increases in rice consumption generated by rising incomes. However, population growth plus some urbanization and secular switching from other staples ought to keep rice consumption growing at five percent a year, given constant prices. The experiment of reducing prices to liquidate the national surplus this year shows that there is a very large demand for rice at lower prices. However, rice cannot be produced at this cost, and there is no good reason for

subsidizing consumption of an expensive staple like rice in the long run.

Rice farmers in Niger have shown that they are highly responsive to price changes. The government has the delicate job of managing the producers' price to assure that farmers do not produce more than the country will consume (plus anything that might be profitably exported) at the equivalent, unsubsidized retail price. As the Saga project develops, the decision on prices should consider that more than 1,000 farmers will receive the cost-reducing gift of about 800 hectares of developed land -- possibly equivalent to another 8,000 metric tons of paddy yearly -- ready for irrigated farming.

Niger should be able to meet domestic rice needs by price management alone. The marketing system does not need to be subsidized to do so. With falling world prices, some protection might be necessary, but usually the high cost of getting anything from a port to Niamey is enough.

Despite its economic isolation, Niger might eventually be able to export a bulk commodity such as rice. In the short run (and possibly long-run) this would require preferential treatment in neighboring countries and/or transport subsidies. In the hope of eventually developing exports, Niger ought to work on reducing production costs, not on increasing production at present costs.

Niger's rice industry has several advantages which make the eventual possibility of exporting worth considering. Water is abundant. The production area is concentrated. The marketing system is efficient. Farmers have few lucrative alternatives. Perhaps major cost reductions are possible. These would have to take both of two forms: (1) improve the farmer's efficiency, so that he would supply more paddy at any price, and (2) improve the out-turn of the Tillabery mill. The former would be likely to come from introduction of cheap, labor-saving machinery; more efficient practices; and better varieties. The latter would stem from efficient milling of uniform paddy with a slightly improved mill.

If Niger's farmers were willing to produce enough rice for local consumption plus some for export at $44 per metric ton (a price now being considered), if paddy uniformity and mill efficiency were equal to the United States average, and if brokens still sold at $80 per metric ton, if internal transport and marketing costs were the same as now, then the break-even price of whole rice in Niamey would be around $88.50 per metric ton. At such a price and with slightly lower international transport costs, Niger rice could compete with Ivorian rice in Abidjan if not cost reductions were achieved there and if there were no discrimination.

Specific suggestions

1. The government should (a) phase out subsidies to rice marketing through UNCC as soon as present surpluses are eliminated. This would presumably mean lower producers' prices and/or decontrol of retail prices, but neither rice producers nor consumers are so powerful as to make this policy infeasible; (b) manage producers' price to balance the amount of paddy generated with the amount of rice Niger will consume at related, unsubsidized prices.

2. All paddy is not of equal value to UNCC. Its payments should reflect this by (a) paying a premium for clean, adequately dried paddy, with an elementary grading system necessary to identify it; (b) paying up to 20 percent more for parboiled paddy. For the present, the Tillabery mill is producing entirely for the Niger market where parboiled rice is preferred and whole rice is preferred to brokens; it has to process non-uniform paddy. Experience elsewhere shows that parboiling will raise the milling rate for even non-uniform paddy. The out-turn of all rice including brokens might be raised from 60 percent to 64 percent and that of whole rice from 32 percent to over 50 percent. Additional income from an improvement of this sort would pay for parboiling. Since the mill does not seem to be able to operate the parboiling apparatus and since village parboiling turns out an acceptable product, the latter could be encouraged. (Parboiling improves the nutritional value of rice.) (c) Paying a premium for uniform paddy that will mill well and will be acceptable to consumers. If Niger ever became a rice exporter, higher mill out-turn would have to be achieved in this way and not by parboiling, since potential foreign markets do not esteem parboiled rice.

3. While buying and milling improvements could be important in reducing the cost of rice, the cost of paddy is the biggest cost element. This cost can be reduced by helping the farmer become more efficient through:

   a. Research - The existing IRAT program plus Taiwanese efforts will probably have to suffice for some time, but more research is needed. Here, a regional organization would unquestionably be helpful.

   b. Extension must concentrate on teaching better methods on existing rice lands, not on recruiting more rice farmers and adding land. The Taiwanese government extension workers are already doing this. The scope of their effort seems appropriate to the size of the problem. It would be beneficial if all organizations working on rice could cooperate.

c. Introduction and generalization of appropriate small tools and machines could reduce costs by improving labor efficiency. Tools from Taiwan could be purchased for distribution on credit in Niger by UNCC or/and by the Taiwan project.

4. If it should be thought desirable to increase irrigated rice lands in Niger at some future date, the most effective step would be to encourage the Taiwan project to expand its work to include the Firgoun and Koutoukale Plains. As soon as the current project is completed, the Taiwanese could be asked to survey the valley to identify the areas which could be developed most economically.

NIGERIA

The Rice Economy

Nigeria is a major rice producer among West African countries. Under normal conditions, it accounts for about 20 percent of the acreage and nearly 25 percent of the production of the 11 countries surveyed. Prior to the start of the war in 1967, the area planted annually was about 243,000 hectares and production was about 375,000 metric tons. However, the planting of rice were far exceeded the 53 million hectares in millet and sorghum. Exclusive of the war - disrupted eastern region, rice plantings in 1968 were estimated at 176,000 hectares.

During recent years, Nigeria has been self-sufficient in rice, except for the importation of small quantities of high quality rice for selected markets. During 1961-66, limited quantities of the domestic production were exported, with a peak of 2,900 metric tons in 1964.

No reliable figures on average per capita consumption of rice are available. A range of 2.3 to 3.2 kilograms per capita has been estimated. A marked upward trend, particularly in selected localities, is reported. A 1963 survey of 10 villages in the eastern region showed that rice consumption was expanding rapidly, and in some instances was the preferred staple food for children. In the northern region, millet and sorghum have been the traditional staple cereal grains but rice consumption is growing. The bulk of rice consumption is probably in urban centers due largely to the fact that their food habits are more flexible than is true for rural groups.

Production Techniques and Costs

Nigerian rice production areas have been classified into four typical resource situations. These are: (1) the upland areas, possibly the most extensive in acreage, but relatively less important in production; (2) the naturally inundated land along the rivers (fadamas) of northern Nigeria and the small inland swamp in eastern Nigeria which are the most important production areas; (3) the recently-developed irrigation schemes throughout the country; and (4) the fresh-water tidal mangrove swamps found largely along the southern coastline.

The acreages grown in various regions have been variously estimated. One report based largely on 1962 data indicates approximately 152,000 hectares grown in the northern region, 75,000 hectares in the eastern region, and 12,000 hectares in the western region.

The Federal Research Station at Badeggi indicates that opportunities for expansion in rice acreage are most favorable in the "middle-belt" (area along and to the north of the Niger River from the northwest part of Nigeria to the central eastern region) plus extensions of established areas in the eastern and northern regions. In the northern section, a rotation program which includes rice during the rainy period, followed by wheat during the dry months, has been giving good yields of both crops and may contribute to larger output from this section.

The production techniques used and the yields obtained in rice production in Nigeria are among the best in West Africa. This is attributable in large part to the research on varieties, seed multiplication, and fertilizers carried on at the Federal Research Station at Badeggi. These research programs have been neglected and have suffered for lack of financing due to the civil war.

Considerable data on production techniques, labor and materials used, and levels of output are available. These data indicate that production costs range from about 7.7 to 11.0 cents per kilogram.

Yields are relatively low and doubtless could be increased through improved agronomic practices and more general use of fertilizer. Indications are that commercial production is well established in a number of areas and that small holders are receptive to the use of improved varieties, nominal applications of fertilizer, and other recommended practices. A well planned extension program in concert with seasonal credit should bring about an increase in total production.

Marketing

Processing and marketing are regarded as the major limiting factors to production. Most producers sell paddy rice to processors or traders. Parboiling in small lots is a universal practice, and because of differences in procedures followed, contributes to marked variability in quality of milled rice. The cost of parboiling is 35 to 38 shillings ($4.90 to $5.30) per long ton of paddy. Mechanization of the parboiling and drying process, in large volume lots, would improve the efficiency of this operation.

Approximately 320 small and four large-capacity mills were in operation at the outset of the current civil conflict. About half of the small mills were located in the Abakaliki district of the eastern region, and 102 in the Abeokuts area of the western region. Three of the large mills are located in the eastern region and one at Bida in the middle belt.

The current conflict has disrupted the rice industry, particularly in the eastern region, and one can only speculate concerning the time that may be required to rebuild to the previous level of production. It is reported that most of the small mills throughout the eastern area of Nigeria were dismantled and moved to Biafra at the outbreak of the war. Two large-capacity mills (5,000 long tons per year) have been in operation for a number of years at Uzo and Abakaliki in the eastern region. It is not known whether these mills have been damaged during the war. A mill of 2,000 long ton capacity has been operating at Bida since 1942. It is not capable of processing all the production offered and consideration is being given to construction of a new plant with a capacity of 5,000 long tons.

Owners of small mills generally serve small holders and traders at custom rates equal to 40 to 65 shillings ($5.60 to $9.10) per long ton of paddy. These costs are not excessive compared with costs applicable to large volume commercial mills. However, the low mill turnout commonly received makes it necessary for milled rice to sell for slightly over twice the price for paddy to cover milling costs.

The initial marketing stage occurs near the farm at the local village where traders purchase paddy from small holders. Reports indicate that at most local points the numbers of traders is limited. Consequently, competition is weak. It is apparent that traders do not maintain storage facilities for significant quantities of rice which would allow them to capitalize on the seasonal rise in prices between the normal abundant and hungry periods. Extension agents feel that considerable farm storage is needed. In a number of locations programs for the construction of small silos are being sponsored.

Services

Research

The Federal Rice Research Station was established at Badeggi in northern Nigeria in 1953. Since then, research has been extended to several locations including Ibadan (south central), Berni-Kebbi (northeast), Bendi (eastern), and Warri (midwestern). Limited field testing has been carried on. FAO has conducted fertilizer trials in southern Nigeria.

Research have centered on variety testing, fertilizer trials, and selected cultural practices. Recommended varieties for practically all production areas have been determined, and in some areas small seed multiplication programs have been insituted. Particular attention has been given to the development of long grain varieties adapted to all sections of Nigeria.

Fertilization studies have determined the need for varying amounts of nitrogen, phosphorous, and potassium depending on soil-climate situations. Cultural practices investigated include seed treatment, optimum plant spacing, effectiveness of weed killers, and the practicality of limited mechanization.

Beyond the producer level, limited study of factors affecting milling quality, including equipment and techniques used in the parboiling process, have been conducted. Recommended procedures found best for the different varieties were developed. Some investigations of consumer preference have been carried out.

Extension

Some extension activities have been carried out. Farmer education programs have centered on demonstration plots, instruction in production techniques, use of fertilizer, and distribution of seed and fertilizers.

Limited special government programs to extend rice production in Nigeria have included irrigation schemes along the Niger River and at a few other locations, mostly in the eastern region. Several State governments have sponsored tractor hire units, which generally require considerable financial subsidy. However, this service is in demand in a number of areas. In Kwara State it is reported that the number of tractors available is inadequate to meet the demand.

Suggestions for Improvements

Nigeria has the potential to expand rice production through (1) higher yields and (2) bringing more land into rice production. Improved cultural techniques, including use of pure seed of higher yielding varieties, proper spacing and weeding, fertilizer use, and better water control and the growing of two rice crops per year under irrigation or one rice crop under irrigation and one other cereal on the carryover moisture are two means of boosting production per acre. However, bringing new land into production likely will contribute most to short-run increases in production. Potential rice areas in Nigeria totals about 1.5 million acres with 1.2 million of this suitable for irrigated or wetland cultivation. Doubling of production in less than 10 years is an attainable goal but should be analyzed as to the economic feasibility.

Bottlenecks to expanded production include (1) labor during seasons of peak demands such as the weeding period; (2) processing (low quality, inferior product resulting from improper processing methods and inadequate equipment); and (3) marketing (low price to farmers due to inefficient marketing system inhibits production). Additional information about each problem is needed before an accurate assessment of its magnitude can be made. Nigeria appears to have adequate improved varieties.

The varieties developed by the Federal Department of Agricultural Research contain the potential to increase production of high quality grain.

Rice consumption will probably continue to grow at a rate faster than population due to a slow decline in the preference for root crops, an upward trend in cereal consumption, and rising incomes.

Nigeria has a good research program which, combined with work to be done by the new International Institute for Tropical Agriculture in Ibadan, should be effective in meeting research needs in the immediate future. Research must be continued to expand Nigerian production, and the capabilities required to carry out an adequate program appear to exist.

More extensive government efforts, particularly in quality improvement through variety selection, processing, and milling and expanded use of production inputs should bring increases in production. Even without additional government inputs the growing demand for rice should stabilize prices at a level that will stimulate production.

Estimated Labor Requirements and Costs of Growing Rice at Selected Location in Nigeria 1/

Location and kind of production situation	Per acre requirements 2/				Yield per acre	Cost of Paddy	
	Labor		Other	Total		Kilo	Long Ton
	Days	Dollars 3/	Dollars	Dollars	Lbs.	Cents	Dollars
North central (Bida) 4/							
Irrigated, 1st crop	73	51	30	81	2,231	7.9	81
2nd crop	73	51	19	70	1,786	8.6	88
Season total or av.	--	102	49	151	4,017	8.4	84
Eastern - Farm settlement scheme 5/							
Irrigated, 1st crop	78	54	41	95	2,240	9.3	95
2nd crop	78	54	21	75	1,792	9.3	94
Season total or av.	--	108	62	170	4,032	9.3	94
Eastern - Abakaliki-Abomege-Afikoo area 6/							
Transplanted, terraced but rain fed	82	56	17	73	1,500	10.8	109
Eastern - Norcap 7/							
Inland swamp - transplanted	201	66	13	79	2,000	8.6	88
Eastern - Uzo-Uwani 8/							
Irrigated - transplanted	84	57	16	73	1,500	10.8	109
Western 9/							
Irrigated - transplanted	48 11/	33	45	78	2,240	7.7	78
Midwest - Ilushi flood plain 10/							
Upland - broadcast	187	92	8	100	2,023	11.0	111

1/ Compiled largely from unpublished sources.

2/ Primarily applicable to land preparation, stand establishment, cultivating, harvesting and thrashing. Labor on cost for parboiling and milling was excluded. Also land clearing cost excluded, except for upland rice for which approximately 50 percent of labor for clearing is charged to rice.

3/ Based on daily wage rate of 70¢, except when otherwise noted.

4/ Developed by Team during this study.

5/ Eastern Nigeria Farm Settlement Scheme, Supplement to Agricultural Bull. No. 2, Min. of Ag. Tech. Bull. No. 6 of 1960.

6/ From notes by USAID/Lagos. Possibly from "Rice Farming in Abakaliki Area," Dr. Peter Von Blanckenburg, NISER, Ibadan, Oct. 1962.

7/ From letter dated Nov. 25, 1963 from Olav Aurlien to Mr. Irwin of USAID. Daily wage variable with jobs - 15¢ for bird scaring, 25¢ for weeding, 35¢ for transplanting and 42¢ for all others.

8/ USAID/Lagos estimate.

9/ From Swamp Paddy Study, Nov. 1961, FAO Team, Ministry of Agriculture and Natural Resources, Ibadan.

10/ Calculated from "Investigations in the Ilushi Flood Plain, 1960-63" Waterworth, J. V., Special Report No. 4, Research Branch of MANR, Benin, Aug. 1964.

11/ Land Preparation performed by tractors at custom rates.

SENEGAL

The Rice Economy

Rice consumption in Senegal exceeds local production by at least 180,000 metric tons annually. Local authorities say this is less than the total demand for rice, since the volume of imports is limited by the government. It is calculated that imports would climb to 250,000 metric tons or more were it not for government restrictions.

Senegal has a population of more than 3.7 million people. Approximately one million live in and around Dakar, Senegal's capital. Population increases about 2.3 percent a year. Approximately 74 percent of the labor force is engaged in agriculture.

Per capita rice consumption averages about 80 kilograms per year. The rates of consumption vary by areas within the country.

In urban Dakar and in the delta areas of the Senegal River basin, per capita consumption of rice averages about 160 kilograms a year. The Casamance area averages about 80 kilograms a year. People in the rest of Senegal consume little rice.

Expenditures of foreign exchange for rice imports amount to about $25-35 million annually (about 6-9 billion CFA francs). The cost of imports is held down by importing rice that contains 75 to 100 percent broken kernels, which, however, has about the same food value as the more expensive whole kernel rice.

The Physical Environment

Senegal has an area of over 200,000 square kilometers (76,124 square miles). About 2.4 million hectares are in cultivation. Of this cultivated land, 1.1 million hectares are planted to peanuts and about 1.05 million hectares in cereals.

The topography is low and level to gently rolling, except in the far southwest where the plateau of Bambouk rises 500 meters above sea level. It is drained by several rivers, of which the most important are the Senegal, Gambia, and Saloum. Senegal has two pronounced seasons -- wet and dry.

Rainfall varies greatly from south to north. During the July-October rainy season, rainfall may vary from 1800 millimeters in the south to 255 millimeters in the north. The long dry season, November-June, is accompanied by northeastly winds and low humidity. Land use is determined by the amount of rainfall or the availability of river irrigation water.

Senegal's soils are generally sandy and thus suited to growing peanuts. The river valleys, however, have fertile alluvial soils. Rice production is confined to the alluvial soils along rivers and streams.

Hoes and other simple hand tools are used for most cultivation. In a few areas, farmers have begun using animal power in the production of peanuts. Peanuts are Senegal's main crop. In 1966, Senegal was the world's second largest peanut exporter, and the fifth largest peanut producer. Other principal crops are millet, sorghum, rice, cowpeas, corn, potatoes, and cassava. Production data follows:

Area Cultivated
(1,000 hectares)

	1962	1963	1964	1965
Peanuts	1,013	1,084	1,055	1,114
Millet and Sorghum	865	959	1,011	1,069
Cowpeas	49	51	51	54
Rice (paddy)	66	95	86	82
Corn	31	33	49	54
Cassava	38	34	33	38

Area Harvested
(1,000 Metric Tons)

	1962	1963	1964	1965
Peanuts	894	959	1,019	1,122
Millet and Sorghum	424	478	532	554
Cassava	157	153	156	150
Rice (paddy)	77	106	110	122
Corn	27	27	37	41

Rice is grown in two regions, the Fleuve in the north and the Casamance in the south.

Production Techniques and Costs

Senegal's rice culture varies from the traditional culture in the Casamance, to the mechanized culture at Richard-Toll. Rice is Senegal's traditional food crop. It is produced in the low areas of the mangrove swamps, in the Thalweg area of small streams, and on upland areas. Most local rice is not marketed, but consumed by the producer and his family.

The Region of the Senegal River (Le Fleuve

Rice production and marketing in this region has been under development since 1818. A saltwater condition is the primary inhibitor of yields. The greatest degree of commercialization and mechanization of rice production in Senegal has been developed in this region. Both irrigation and drainage are extensively practiced.

The river area has two growing seasons: the July-October rainy season when plants are grown on the high sandy soils and the November-April season through cultivation of flooded lands as the waters recede.

Rice in the river area is generally planted in August taking advantage of the high water during the flood season. It can also be grown from January onward if irrigation is available.

The delta or pseudo-delta of the Senegal River is subject to fresh water flooding from July to December and to salt water flooding during the other months of the year. Due to investments already made, the river has been diked sufficiently so that major areas of the delta can be protected both from salt water and fresh water flooding.

The Richard-Toll rice station was placed at the confluence of the Senegal and Taouey Rivers. The Taouey River is, in reality, a connecting channel between the Guiers Lake and Senegal River. During flood stage, water flows from the Senegal River into Guiers Lake. During the low water stage, water flows out of the lake into the Senegal River and to the sea. At high tide and in the dry season, however, salt water will flow up the Senegal River (sometimes as far as Podor) and into the Taouey, finally reaching Guiers Lake.

A dam with gates at the confluence of these two rivers was an early attempt at better water utilization. Large pumps capable of lifting huge amounts of water about one meter were installed in the Taouey. These pumps are used to irrigate 6,000 hectares. During the dry season, the reserve in Guiers Lake is available, while inflow from the Senegal River can be used during the flood season.

The Taouey River meanders for 27 kilometers between the Senegal and Guiers Lake. Straight line distance is approximately 15 kilometers. Since there is little slope, flood waters cresting in the Senegal River reach Guiers Lake only a month after starting from the confluence of the two rivers. This means that the total amount stored in the lake is about one meter (in water level) lower than the possible maximum.

Engineers have considered digging a direct channel, bypassing the bends of the Taouey. They have also considered increasing capacity of the lake by diking its borders. Using these two controls, the quantity of water stored could be nearly doubled from 460 million cubic meters to 720 million cubic meters. At present, the Taouey River provides a fish industry equivalent to at least $24,000 a year. Part of this would be

destroyed if a new channel were dug, unless the old channel were preserved.

Preoccupation with water is of major importance to the rice industry in the Senegal River area. With a rainfall of less than 255 millimeters per year, the obvious solution is irrigation. Rice requires at least 18,000 cubic meters of water per hectare for each growing season. In extremely dry years, the need may increase to 26,000 cubic meters per hectare.

Delta soils, although not fertile, are heavy in clay and suitable for rice. The general classifications of soils in the Senegal River basin are Hallalde, Fonde, and Dieri.

Hallalde soils are found in the deepest depressions and are subject to annual flooding and then drying, leaving a dark color. These soils are compact, often undifferentiated within a depth of 1.5 meters. They are low in phosphates, nitrogen, and organic matter. Fonde soils are subject to irregular submersion and are less compacted. They are rich in organic matter. Saltier than the Hallalde soils, they should be leached. The Dieri soils are those above the flood zone.

Rice culture at Richard-Toll has been developed since 1945 with total mechanization in mind. This trend apparently continued until national independence when the Senegalese government assumed responsibility for the work. Since that time, a major part of the work has continued by machine, although an average of 18 men per 100 hectares are employed for rice production. This compares with 28 men per 1000 hectares for mechanized U. S. rice production.

At the present time, Richard-Toll has 6,000 hectares on which water can be controlled. This area is capable of producing 4-5,000 kilograms of rice per hectare, two crops per year, for a total of 8-10,000 kilograms or 60,000 metric tons per year. However, at present the production is only 16,000 metric tons or 2 2/3 metric tons per hectare. The machinery available including 30 mechanical harvesters could be restored to operating condition.

Two rice mills at Richard-Toll, one with 5-ton capacity and one with 2½-ton capacity, are milling the rice produced at Richard-Toll plus the crop from the Fleuve basin. During the 1958-59 season, the old mill produced 9,000 tons of rice.

Six varieties of rice are presently used at Richard-Toll:

- R.T. 2105 - early variety harvested in October
- Mahalioka & D 52/37 - early variety harvested in November
- Bentoubala - early variety from Niger
- Soussanta & R.T. - late variety harvested in December

Society for Development and Cultivation of the Delta (S.A.E.D.)

The S.A.E.D. was created in 1965 to develop the delta which became possible as a result of diking the Senegal River. Some 10,000 hectares are planted to rice there. Of this total, 6,500 hectares have been developed with major dikes; the remaining 3,500 hectares will be diked soon. Annual yields have been approximately 1.5 metric tons per hectare.

Five villages of 200 farm families each have been established at various points accessible to the rice growing areas. An additional 15-17 villages to be established by 1972 are planned.

Each active family member is entitled to own one hectare. The present method of cultivation is designed to maximize use of machinery without prejudicing the individual ownership of property.

Initial land preparation is carried out by S.A.E.D. with six teams of five tractors each. After the seedbed is ready, the farmer sows by hand broadcast and the seed is covered by discing with tractors. After this stage, all labor must be provided by the farmer.

The farmer can obtain fertilizer and seed from S.A.E.D. Credit for these items is extended by the National Development Bank, which collects from the farmer after harvest.

Per hectare costs to the farmer for S.A.E.D. services are:

Dike maintenance	CFA	600	($ 2.40)
Land preparation		6,000	(24.00)
Seed covering		1,000	(4.00)
Fertilizer (150 kg./Ha.)		1,800	(7.20)
Seed		4,200	(16.80)
Total	CFA	13,600	($54.40)

This money is borrowed for the farmer at an amortized interest of six percent. The original plan of S.A.E.D. was to develop 30,000 hectares in the delta. A mission of experts in 1967 considered this objective as still reasonable. The team feels the goal is reasonable, only if yields are significantly increased.

Limiting factors to increased yields are:

1. Date of planting
2. Lack of adequate control of water levels
3. Wild rice
4. Soil toxicity

The date of planting in the delta is dependent on two factors: rainfall and timely arrival of the flood level on the river. Initial germination is generally dependent on rainfall. If flood waters do not arrive on time, the rice will die, necessitating replanting. The effect is a greater caution in the planting date.

In the present system employed in the delta, the water levels within plots of paddy vary from 20-40 centimeters. This variation is much too great for optimum yields. The paddies enclosed in the large dikes, however, are often several thousand hectares in size. The solution to this problem is the design of small dikes on the contour. The per hectare costs of these management factors has been estimated as follows:

	Capital		Recurring (Annually)	
	CFA francs		CFA francs	
Pumps and pumping	38,000	($152)	4,000	($16.00)
Tertiary dike construction	60,000	(240)	2,400	(9.60)
Leveling	12,000	(48)	480	(1.92)
Other	10,000	(40)	400	(1.60)
Total	120,000	($480)	7,280	($29.12)

Wild rice is particularly difficult to eliminate because of its similarity to rice. There are no chemical controls presently available. The only means available for elimination are planting rice in straight lines; early seeding; use of pure seed; and pre-irrigation to germinate wild rice for plowing under.

Aside from the salinity of most delta soils, which can be corrected with proper drainage, there exists a toxicity in some areas, which is not fully understood. This toxicity manifests itself by necrosis of the roots. The effects of fertilizer have been observed to accentuate toxicity in some cases, while attenuating it in other situations.

The middle and upper river valley of the Senegal covers an area of 70,000 square kilometers on the Senegal side. Rainfall in the middle river valley varies from an average of 250 to 450 millimeters per year. The average in the higher valley is closer to 500 millimeters. Although the yield of the river, as measured at Bakel, is 22 million cubic meters per annum on the average, by the time the river passes Podor at the bottom of the valley, the river's yield has been reduced from one-third to half its original volume.

Rice culture in the valley area is insignificant. It is doubtful that enough rice is produced to meet the local needs.

Because several levees have deteriorated, development in the area seems close to a standstill. In considering the future, this area may come under the direction of S.A.E.D.

The Casamance

The Casamance region is in southern Senegal along the Casamance River. The Casamance has long been known as the potential "Granary of Senegal." However, there has been no attempt to realize this potential. The prevailing rice growing techniques, although highly-developed in some aspects, are primitive.

Rice production in the Casamance varies a great deal from one year to the next.

Data follows:

Area Planted to Rice
1958

District	Swamp (Salt) Rice (hectares)	Swamp (Sweet) Rice (hectares)	Upland Rice (hectares)
Oussouye	2,961	216	7,443
Ziguinchor	2,798	671	1,008
Bignona	17,174	2,981	1,375
Sedhiou	4,332	3,005	1,188
Total	27,468	6,873	11,014

Hectares and Yields
(1965)

District	Hectares	Metric Ton per Hectare
Ziguinchor	6,500	1.1
Oussouye	10,000	1.2
Bignona	26,500	1.4
Sedhiou	16,000	1.4
Kolda	6,000	1.0
	65,000	

Total Production 88,250 metric tons

There are presently about 29,000 hectares of rice grown in mangrove swamps and other areas subject to salt invasion. Additional land for this type of culture reportedly is available to the extent of 140,000 hectares.

Rice production in the salt areas is carried out by the Diola people, as well as by refugees from Guinea. At current prices, labor required to produce a unit monetary value of rice is twice the input required to produce peanuts.

To reduce the salt content requires the protection of a paddy from salt water intrusion, as well as a source of fresh water. The Diola build small dikes around their plots during the dry season. At the same time, they make furrows mounding up the soil in long straight lines. While it is still the dry season, the tidal salt waters are allowed to enter the paddy, avoiding a concentration of salt formation due to upward capillary movement. When the rains come and sweet water begins flowing from the hinterlands, the salt water is driven out and the small mounded furrows are washed by the sweet water, reducing the salt content.

Rice production in the mangrove and other salt areas can be increased if economics are disregarded. There are extensive areas still available for development but the cost of reclamation would be high. There are also large numbers of abandoned paddies.

An approach would be the intensification of production by several means: use of varieties highly resistant to salt conditions, improvement of access to paddies, and planting younger more vigorous rice plants. With these improvements, plus the application of fertilizer, it should be possible to obtain average yields of 2.5 metric tons per hectare.

Once average yields have increased to 2.5 metric tons, a second phase of development would be the hydrological development of mangrove swamps, including the use of pumps for deeper and more effective drainage. Yields might reach four tons per hectare but it is questionable if such a venture would be economically sound. A Dutch firm (I.L.A.C.O.) is working on the hydrological development of one mangrove area.

The production of rice in "sweet water" swamp areas holds much greater economic promise.

A large percentage of possible "sweet water" paddies are already utilized. While some virgin areas remain, it must be stressed that traditional property rights restrict use of these virgin soils.

"Sweet water" rice paddies are subject to various problems unique to their culture. Proper water control, a function requiring community action, has rarely been achieved. Aside from adequate water control (drainage as well as irrigation), the intensification of the culture can be achieved by earlier planting, better varieties, and fertilization. There are about 14,000 hectares planted to rice on this type of land.

Upland rice is planted on soil where its growth depends on the amount of rainfall. This rice is usually planted in rows in July when the rainy season begins. In order to grow upland rice, about 900 millimeters of rain are needed over a 90 day period. There are about 22,000 hectares planted to upland rice.

The long intervals of drought frequently experienced necessitates careful choice of soils for upland rice.

Marketing

Senegal is not producing enough rice to meet demand. The government imports about 185,000 metric tons per year. The following table shows rice imports since 1964:

Year	Thousand Metric Tons
1964	184.5
1965	174.2
1966	168.6
1967	183.4

Importation is carried out by the Office de Commercialization Agricole du Senegal (OCAS) at 40.5 CFA francs per kilogram. OCAS establishes a quota for each of 50 rice wholesalers. In Dakar, the legal price of rice is 17.2 cents (43 CFA francs) per kilogram. However, the cheapest rice to be found in the markets was 17.6 cents (45 CFA francs) per kilogram. This rice was 100 percent broken. The prices vary according to the amount of broken rice from 17.6 to 30.0 cents (45-75 CFA francs) per kilogram. The proportion of brokens varies from 50 to 100 percent. Red rice in the lots ranges to 30 percent.

Once the rice leaves Dakar, the retail price increases according to the cost of transportation. The price to the consumer is stabilized by the government. Wholesale prices have changed five times in the last five years. A reserve fund helps stabilize the price. When the cost of imports is below the fixed wholesale price, the difference goes into the reserve fund. When the cost of imported rice is above the fixed wholesale price, the reserve fund is drawn upon to pay the difference. Since recent import prices have been high, in relation to local wholesale prices, the reserve fund is reported almost exhausted. If the reserve fund is not replenished, it may be necessary to raise wholesale and retail prices. The retailer and the wholesaler are each allowed a handling charge and profit of about one cent (2.5 CFA francs per kilogram).

Storage at the Dakar port is adequate for normal imports in bags. It appeared there would be no serious problem in receiving milled rice in bulk at the port.

Ocean freight rates for bulk shipments of imported rice are considerably less than the estimated cost of bagging at Dakar for distribution to wholesale outlets. However, the unloading of wheat and other bulk grain at Dakar is limited to the use of portable screw conveyors. Installation of a moveable marine leg and belt conveyor from the dock to port storage would expedite unloading of bulk grain or bulk rice and shorten ship turn around time.

O.C.A.S. also purchases and distributes domestic rice from the Richard-Toll and the Casamance areas. In 1967 this trade totaled 6,500 metric tons from Richard-Toll and 900 tons from the Casamance. This rice is distributed in the Senegal river valley and in the Casamance. It is illegal to transport locally-produced rice to the Dakar area because of the difficulty of controlling import requirements. The cost of transportation would entail a subsidy to maintain Dakar consumer prices at their current level.

In Dakar, good quality rice sells for 30 cents (75 CFA francs) per kilogram, and poor quality rice (imported) was selling for 22-24 cents (55-60 CFA francs) per kilogram. Local retailers had packaged rice from the United States and Europe priced at 22-24 cents (55-60 CFA francs) for 450-500-gram boxes.

The indigenous rice is usually sold to nearby villagers. The price paid by the villagers was not available.

The official price to farmers for paddy rice in Senegal is 8.4 cents (21 CFA francs) per kilogram. This price is paid by the Office National de Cooperation et d'Assistance au Development (ONCAD), a government monopoly that purchases all farm commodities.

ONCAD purchases paddy rice at the established price after March 1 each year although the harvest usually is done between November and January. Since most farmers must have cash before March 1, the rice purchased in the Senegal river valley is mostly to pay the bank which has a lien for credit extended for mechanized plowing, irrigation and drainage. The 6,500 tons purchased by the government in 1967 represents about 45 percent of the gross production of the producers. The 900 tons purchased in the Casamance came almost entirely from Taiwanese demonstration projects. Thus the goverment purchase program for rice generally is not used by producers other than those participating in governmental or quasi-governmental projects. Prices paid for rice by private traders in the Senegal river valley were reported as low as four cents (10 CFA francs) per kilogram.

There are many village cooperatives for marketing peanuts, but these have not been used in rice marketing.

Most milling is done by hand on the farm. The unhulled rice is pounded with a pestle in a mortar. After each pounding or until the rice is "milled," it is fanned or winnowed to remove the loose hulls or bran. It takes about 100 hours to mill about 46 kilograms of paddy.

Of two mills at Richard-Toll, the older German-made mill consisted of a cleaning machine used to clean the paddy and three stone hullers with a capacity of five tons per hour. The newer Italian-made mill had a capacity of 2½ tons per hour. We observed the finished product of the German mill. The quality was poor, consisting of at least 20 percent red rice, 95 percent brokens and one percent foreign material (hulls). However, the degree of milling could be classified as "reasonably

well milled" by U. S. standards. The process was simple. After being cleaned the paddy entered the first huller, then was elevated to the second, and then went to the third huller. In effect, the first huller was a sheller to remove hulls.

The hulls were found to contain approximately ten percent broken rice. Local women fanned or winnowed the hulls for this rice.

The bran is sold to the villagers for one cent (2.5 CFA francs) per kilogram to be used as livestock feed.

The cost of milling ranges from $17.20 to $20.00 (4,300 to 5,000 CFA francs) per metric ton of paddy.

S.A.E.D. is building a mill at Ross-Behhio. The cost of construction and equipment was estimated at $300,000 (75 million CFA francs). The capacity of the mill will be six tons per hour.

At Sefa, in the Casamance, the government-owned mill was built in 1959 and has a capacity of 1½ tons per hour on long grain and two tons on short grain. The equipment consisted of a paddy separator, two German-made stone hullers, four brushes or polishers, and a carter disc to isolate broken rice. The milling yield or "out-turn" was approximated at 60 percent. The cost of milling is five CFA francs per kilogram ($20 per metric ton).

Services

Senegal has no university-level agricultural college. The principal agricultural research station at Bambe does no agronomic research on rice.

In the Senegal river area, a large station at Richard-Toll has experiments in rice varieties, fertilizer applications, leaf surface ratio studies, and other plant physiological functions. The staff is composed of 13 technicians, of whom 11 are expatriates.

Another rice research station is located near Guede.

The research station at Sefa in the Casamance is operated by Institute de Recherches Agronomiques Tropicals and is devoted mainly to work on peanuts and cereals other than rice.

The government of Senegal has recognized the importance of agricultural extension work. A branch of the Ministry of Plans called Animation Rurale performs this function. Another branch of extension is the Centre d'Expansion Rurale which operates through sub-stations of multi-discipline teams in each region. A third branch of extension is under the Ministry of Information, primarily engaged in audio-visual work.

Services in rice development are provided on a pilot scale by Taiwanese projects which have 14 technicians. The Taiwanese approach is simple. During the first year, they set up demonstration plots. Local labor is employed at Taiwanese expense. Paddies are developed in such a way that complete water control can be maintained. Rice varieties are Taichung Native #1 and IR-8. Where gravity water flow is not sufficient, the Taiwanese have installed pumps to maintain a reliable water supply.

In addition to water control, the Taiwanese have used fertilizer to obtain high yields. Applications are made before planting, 15 days, and 30 days after planting. Intensive weeding is practiced, and the rice is planted in rows to permit early weeding. Yields from irrigated rice planted by the Taiwanese are five metric tons or more per hectare.

At Diende, where the Taiwanese have been working for four years, a dramatic result of their efforts can be observed. Guinea refugees originally employed by the Taiwanese on demonstration plots, are now on their own growing rice using methods learned from the Taiwanese. Undoubtedly, these farmers are capable of obtaining five metric tons per hectare.

The same story is being repeated at Marsassoum where farmers use Taiwanese methods to plant up to 120 hectares of rice in paddies. Water is controlled, and fertilizer is applied.

The Taiwanese also are demonstrating improved practices for upland culture. While success on upland has not been so dramatic as on irrigated rice, the increased interest of farmers in improved practices is largely due to the Taiwan demonstrations.

Suggestions for Improvement

Rice production in Senegal can be increased in the next few years. The initial approach should be intensification of the culture and improvements in processing and marketing. In the Senegal river valley, at the present time, there are 16,000 hectares in rice production. The average yield is about 1,800 kilograms per hectare. If production was raised to 2,500 kilograms per hectare and two crops per year were produced, this would mean an additional 50,000 metric tons.

In the Casamance, rice is raised on a small scale with individual farmers. The land units are farmed by an average of 15 to 20 farmers per hectare. The production is low at 1,200 kilograms per hectare. If the production in the Casamance could be raised to 1,500 to 2,000 kilograms per hectare the region would be self sufficient. The water in most of the marigots is not sufficient to produce two crops per year. Consequently increases in production will have to be brought about by improved techniques.

In those marigots where there is adequate water for a second crop, it will be necessary to work with those farmers on water control.

Specific suggestions

1. Concentrate on hectarage now being cultivated rather than expanding virgin land.

2. Establish a program to produce and distribute pure seed of a high yielding variety, suited to Senegal.

3. Encourage farmers to plant their seeds in rows rather than broadcasting. This will help to control weeds.

4. Organize an activity to destroy the wild red rice which has so highly infested the area.

5. Extend the cooperative system used for peanut production and marketing to rice including provision of credit for tools, implements, and fertilizer.

6. Encourage through demonstrations in major rice producing areas the use of fertilizer.

7. In irrigated areas, provide advice and demonstrations on the construction of inter-lateral levees and other means of water control.

8. Advance the time for buying paddy rice from producers at a fixed minimum price from March to November.

9. In areas where rice is harvested during the rainy season, provide assistance for the construction of inexpensive rice drying and storage facilities.

10. Institute a program to encourage the use of improved tools, implements, and animal traction.

    a. A small plow drawn by a yoke of oxen would aid in land preparation.

    b. A Taiwanese type weeder would keep the rows of rice free from weeds.

    c. A sickle or cradle for harvesting would cut many heads of rice simultaneously.

    d. A foot-operated threshing implement used on Taiwanese projects would speed up harvest and improve yields.

11. In areas where rice is produced on a moderate scale for local usage, single stage rice milling equipment (such as produced in Japan, Taiwan or Italy) should be made available on a toll basis to replace hand milling and to increase the outturn of milled rice.

12. As rice production becomes more commercialized, especially in the Casamance, multi-stage rice milling facilities would permit processing a high quality rice, obtain higher milling yields, and provide a means for shipping out of the area a quality of rice that could compete with foreign rice in urban markets.

13. To reward producers for high quality rice and to take advantage of the demand for high quality milled rice in urban areas, quality standards should be established for both paddy rice and milled rice.

14. Consideration should be given to importing milled rice in bulk and bagging it at the port of Dakar for distribution to retail outlets. This would save on ocean freight costs.

SIERRA LEONE

The Rice Economy

Sierra Leone is a major rice producing country in West Africa and is near self-sufficiency. Domestic production meets about 95 percent of the country's requirement for rice which is the most important food grain for consumers. Yearly per capita consumption averages 100 kilograms for the entire country and slightly over 66 kilograms for Freetown, the capital city.

Sierra Leone's agriculture is highly diversified (some 70 different cultivated crops are reported and one-third of all farmers grow 15 or more crops). The 1965-66 statistical survey shows that rice was grown by 86 percent of all farmers, compared with cassava (62 percent) and okra (53 percent). Rice ranked first and accounted for 42 percent of the total value of all agricultural products.

Rice plays a major role both in subsistence agriculture of the remote areas, and as a cash crop in areas less remote from city markets. More than 86 percent of the farmers grow rice but only 18 percent reported selling a part of their production. Of the total production of approximately 400,000 metric tons, about 21 percent is sold. The 80,000 to 90,000 metric tons sold annually is insufficient to meet demands, so an additional 25,000 to 40,000 metric tons are imported each year.

Although the acreage planted to rice has increased since 1964-65, total production has not increased proportionally. Import requirements are particularly heavy in years of poor harvest and impose heavy drains on the balance of payments. In such years, price distortions, speculation, and hoarding occur.

The decline in average yields has resulted from a smaller total acreage in the higher yielding areas, which has been more than offset by clearings for upland rice in the central and northern sections. The higher yielding areas have been affected adversely to a greater degree than have the upland areas by the migration of labor to the diamond mines and by the shift of younger employables to urban centers.

The Physical Environment

Rice is grown throughout Sierra Leone. Rainfall is sufficient during the summer monsoon season to produce upland rice and also provide water for lowland production grown under swamp conditions.

The monsoon season is from April to October, with the rainfall varying from about 2,000 to 4,500 millimeters. Since controlled irrigation is not used for rice, only one crop a year is produced.

There are five types of culture: (1) upland rice, (2) inland swamp rice, (3) boliland rice, (4) riverain swamp rice, and (5) mangrove swamp rice.

Upland rice

This method consists of cultivation on sloping land cleared from brush or timber growth. Only one crop is grown, usually in conjunction with other crops. The second year cultivation includes cassava and perhaps sorghum and millet. The land is then allowed to go back to native growth for six to ten years before again being cleared for cultivation. Other crops interplanted with rice are corn, cotton, pigeon peas, beans, tomatoes, and okra. About 75 percent of the rice is produced by this method largely for home consumption; however, occasionally a few bags of rice are sold on the market. Yields are low, from 550 to 1,100 kilograms of paddy per hectare. Individual acreages vary from less than one acre (0.4 hectares) to occasionally about five acres (two hectares).

Inland swamp rice

This method of production along stream valleys receives water from stream overflow or run-off from surrounding hills. Such areas contain good soil. If rainfall is sufficient and timely, the areas may remain partially flooded during the major part of the growing season. Land preparation in these swamp areas is good and practically all the rice is transplanted. These rice fields vary in size from less than one-half hectare to over one hundred, which may be cultivated by many individual growers. Cultural practices in these inland swamp areas more nearly equal those used in Asia than any other area observed in Africa. Yields vary from about 1,100 to 3,400 kilograms per hectare. By improving the rice production in these areas, Sierra Leone could become self-sufficient and, perhaps, even export rice. The yields of inland swamp rice could be doubled and possibly a second crop of rice could be produced annually.

Boliland rice

The boliland areas are low, swamp grass lands in the central and northern part of Sierra Leone in the region of Makeni, Pedemu and Kamalu. Most of these large areas do not have natural water outlets and are flooded to various depths during the monsoon season by run-off from surrounding higher country. No means are available to

control water which makes cropping hazardous. These low, swamp areas vary in size from 200 to over 1,000 hectares.

In these bolilands, mechanical cultivation is attempted. Grass growth is such that hand cultivation would be almost impossible on a sizeable acreage. However, with the poor plowing and cultivation by mechanical means, the weed problem (grasses) is still serious. The calendar period during which the bolilands can be mechanically cultivated is short; so, timing of cultivation becomes critical. These lands usually become dry enough for plowing with tractors in January and February.

Until such time as the bolilands can be provided with means of water control by the use of drains and dams, their effect on increasing the country's rice production will be small. For these bolilands to become important rice producing areas, expensive engineering works would be necessary. A great deal of improvement in mechanical cultivation would be required in order to make these areas important in increasing rice production.

Riverain swamp rice

This rice area occurs in the low-lying regions of the western and south-western part of the country. During the monsoon season these areas are flooded with fresh water from river overflow, varying in depth up to as much as three meters. The areas are far enough from the ocean so that tidal action is not a factor. Due to the depth of water, deep water or floating rice varieties are grown. Mechanical cultivation is sometimes practiced on these areas, with plowing and harrowing during the dry season. The variability and intensity of rainfall during the monsoon season leads to wide variation in water depth from season to season, which may materially affect the crop. In the vicinity of Turma Bum on the Sewa River during August 1968, the overflow was far less than normal and concern was expressed due to the lack of flooding.

Sierra Leone has large areas of this type of land which holds promise for increasing the country's rice production. In many respects, rice production in this region is similar to the deep water rice production in Vietnam and Cambodia in the Mekong River Delta. Studies made of the Mekong River Delta rice production should be of great assistance in determining ways to economically farm this area of Sierra Leone. New varieties should be introduced, particularly since the variety of deep water floating rice now being grown in Sierra Leone is of a quality that is not favored by consumers.

Mangrove swamp rice

The area of mangrove swamp lands extends along the coast where tidal action causes an overflow of the water at high tide and draining of the area during low tide. This region comprises a narrow belt along the western coast, yet far enough inland to prevent salt water from flooding the land during the monsoon season. No water control is practiced and flooding depends on the water levels at low and high tide.

Clearing land of the mangrove forest and preparing it for rice production is expensive. The area of mangrove swamp rice under production is about 50,000 hectares. The mangrove swamp areas present other problems, such as:

1. During the dry season the soil becomes acid, due to the sulphides. In order to prevent the formation of an acid condition, the soil must be handled in specific ways to wash out these sulphides.

2. Soil tillage is difficult, due to the constant flooding and draining caused by the tidal action.

3. Transportation to markets is almost entirely by water.

4. Drying and storage of paddy rice is deficient.

5. Damage from fish during periods of high tide was said to be serious in certain locations.

The average yield of rice in the mangrove swamps is the highest of any area of production. This is probably due to the technology developed at the Rokupr Experimental Station, which is located in the mangrove swamp area. Improved varieties have been developed and improved cultural practices promoted. The rice is transplanted and the weed problem appeared to be less serious than in other areas. Regardless of the high yields said to vary from 2,200 to 3,900 kilograms per hectare, this type of production holds the least promise of increasing the country's rice production because of the problems mentioned.

Production Techniques and Costs

The practices used in growing rice are influenced by the soils and topography of the area. Most of the upland rice is broadcast, and random interplanting with other crops is practiced in most locations.

It is not uncommon to observe six to eight different crops growing in the same field. In the swampland cultures, interplanting is not practiced and slightly over half of the fields were transplanted in 1965 rather than broadcast.

Practically no commercial fertilizer is utilized on upland rice, and only a small percentage of the swampland receives even a modest application. A program to provide fertilizer at subsidized rates has been in operation for several years, but the funds available have been limited.

Mechanized plowing was initiated in 1950 in the bolilands of the northern district, and was later extended to the riverain lands of the southern district. The area plowed and harrowed by machinery reached 10,000 hectares by 1955; but, for the past few seasons, has fluctuated around 4,000 to 4,800 hectares. A fee of Le 7.00 per acre ($8.40 or $21.00 per hectare) is charged for plowing, seeding, and disking. When maintenance and overhead cost are included, this charge is about 50 percent of the costs of services rendered. Reportedly, the Ministry of Trade and Industry purchased 300 tractors in 1964 of which only 120 were operative in 1968.

Additional direct assistance to small holders has included supplying improved seed and fertilizer at subsidized prices. Owing to financial problems confronting the government, such programs were inoperative in 1968.

Various schemes for providing incentives to small holders to develop inland swamps for continuous rice production have been proposed. Such swamps, which comprise some 15 to 20 percent of the eastern province (36,000 to 44,000 hectares), could produce 165,000 metric tons of milled rice annually. They are regarded as more productive than the uplands. Once cleared, the small holders keep the land in rice production continuously.

A scheme undertaken in 1967 was financed by a grant of Le 4,000 ($4,800) from the Diamond Corporation of West Africa and administered by the agricultural officers at Kenema. Small holders were issued as a work subsidy a total of Le 14.00 per acre ($42 per hectare) cleared. This was made up of Le 7.00 ($21 per hectare) for brushing, clearing, and bundling; Le 3.15 ($9.50 per hectare) for transplanting; and Le 4.85 ($14.50 per hectare) for fertilizer and seed. The agricultural officer reported that small holders participating in the scheme cleared and planted a total of 236 acres (94 hectares), for which they received payment, plus an additional 118 acres (47 hectares) which various families added to their assigned acres without receiving payments. The estimated cost of clearing for the 236 acres was Le 9.05 ($10.86) per acre or $27.20 per hectare.

Programs for supplying credit through cooperatives were initiated several years ago with the government extending credit at nine percent interest to the cooperatives and the farmers' repayment rate set at 15 percent. Inexperience on the part of management coupled with indifference among farmers toward loan repayment has resulted in heavy indebtedness on the part of many cooperatives. The number of farmers who now receive assistance through cooperatives is limited.

The varieties grown in Sierra Leone are almost as badly mixed as in Ghana. Many types, including a substantial amount of red rice, are grown by farmers in a mixture. Many new varieties have been developed at the Rokupr Station; but, in the absence of a pure seed production program, the rice available for commercial planting is badly mixed. The problem of mixed paddy creates milling problems and produces a milled rice product that is unattractive. Undesirable foreign matter, such as small stones, is also a problem. Milled rice in the public market showed a high percentage of chalky kernels, further evidence of the mixture occurring in the paddy.

Any attempt to determine the cost of growing rice can be little more than an approximation. We were able to glean limited data from previous efforts to derive data for specific production situations. The statistics presented below are based on small holder operations with conventional hand tools.

From 85 to 90 percent of total costs is ascribed to labor, which in these estimates were charged at 50 cents per day. Most of this is by farm members. Also an undetermined portion of the wages of hired labor is paid in kind, some of which may not be considered (by the operator) as a part of the rice enterprise.

These data emphasize the importance of giving primary attention to inland swamps with improved cultural practices and to means of decreasing labor requirements for all production situations.

Estimated Cost of Growing Rice

Production Situation	Yield (kilograms per hectare)	Income 1/ (dollars per hectare)	Costs 2/ (dollars per hectare)	Labor (days per hectare)
Interior swampland-transplanted	2,315	165	110	282
Interior swampland-broadcast	1,820	128	171.50	442
Interior upland-broadcast	1,130	79	169	492

1/ Reflects price of $2.10 (Le. 1.75) per bushel for rough rice, plus some returns ($9.80, $9.80, and $19.60 for each respective situation) from brush wood sold as by product of clearing land.

2/ Includes direct cash costs of $19.95, $16.58, and $12.97, respectively, for each situation, plus the total hours of labor charged at 50 cents per 10-hour day. Labor for bird scaring which totaled 1450 hours for the two broadcast situations is performed largely by small boys and was charged at only two-thirds of the 50 cent daily rate.

Marketing

Local farmers generally sell rice either as paddy or rough milled to traders near the farm who assemble reasonably large quantities, and transport it to larger trade centers for sale to wholesalers or distributors. The first stage of processing, parboiling, may take place on the farm or in the nearest village to the producing areas. However, some rice moves through the wholesaler to the final distributor who performs the complete process of parboiling and milling before it is channeled into the retail trade.

Retail Market Prices - Freetown

	Leones	(Dollar Equivalent)
Local Parboiled	0.10	(0.12)
Imported	0.15	(0.18)

Each year the Sierra Leone Rice Corporation invites applications from Sierra Leoneans for appointments as buying agents. These

buying agents are authorized to buy rice from farmer producers and to pay prices set by the Corporation. During the 1968-69 season or until further notice, the buying agents are authorized to pay the following prices:

Dried Paddy	$2.40 per bushel (60 lbs. net)	8.8¢ per kilogram
Dried Milled (Upland)	$7.80 per bag (168 lbs. net)	10.2¢ per kilogram
Dried Milled (Swamp)	$10.56 per bag (168 lbs. net)	13.9¢ per kilogram

For the above services, the buying agents are authorized a buying allowance of $4.00 per ton plus a transport allowance of $1.80 to $3.00 per ton depending on the location of the buying agents' purchases. Payment of the buying allowance is authorized only for deliveries of over 70 bags and when transportation is not provided by Corporation vehicles.

The buying season for upland hand-milled rice and upland paddy rice will begin on December 1, 1968, and close May 31, 1969. For swamp hand-milled and swamp paddy, the season will extend from January 15 to June 30, 1969, inclusive. For cooperative societies, the buying season for swamp hand-milled and paddy rice begins on January 1, 1969 and ends on June 30, 1969.

The Rice Corporation, created in 1965, carries out these activities:

1. Appoints buying agents to procure locally produced rice for the Corporation and to act as distributors when required.

2. Publicly announces in the Sierra Leone Gazette prices to be paid for rice during the buying season (January 1 through May 31) to producers and authorized agents at rice mills and depots; also fixes the allowances for buying, transport, and the landing of water consignments by launches.

3. Purchases rice on a delivered weight basis at its three mills and seven depots.

4. Designates the condition of quality which will be acceptable in the purchase of rice.

5. Operates parboiling, drying, and milling equipment at Kissy in the Western Area, Mambolo in Kambia district, and Torma Bum in Bonthe district.

6. Controls the importation and distribution of foreign rice, including the prescribing of prices at which this rice might be purchased and sold; wholesalers are allocated quotas which control the quantity of imported rice they can purchase.

7. In addition to storage of rice in stores adjacent to its mills, it maintains depots for the storage of rice at the government wharf in Freetown and at nine up-country points.

8. Maintains and operates mechanical equipment for rice cultivation as a service to cooperative marketing societies and other farmers on a custom charge basis.

9. Arranges for transport of rice.

The Rice Corporation supported the price of paddy rice to growers at Le 1.80 per bushel (7.9¢ per kilogram) for the 1967 crop, and has announced a price of Le 2.00 per bushel (8.8¢ per kilogram) for the 1968 crop.

About half of the rice sold is paddy (may or may not have been parboiled) and half is lightly milled and parboiled. Rice is also assembled by 54 (in 1966) Farmer Cooperative Marketing Societies which receive rice and act as the selling agent for their members. The cooperatives represented only 3 percent of all farmers who sold rice. Approximately half of the cooperative societies owned mills and processed rice for their members. The societies sell rice either to the Rice Corporation or to private traders, depending on the relationship of prices on the open market to the government support prices to farmers.

The cooperatives have been reasonably successful in their operations. A study of 29 societies showed that 20 had an average capital of $3,600 in their operation in 1964 compared with $1,600 in 1961, whereas the average capital of the remaining nine had declined. The marketing societies expanded into a number of related activities under the Rice Corporation Act of 1965 which limited the trading in rice either at wholesale or retail to citizens of Sierra Leone. Six of the societies have formed a cooperative union which operates a large store supplying other cooperatives, several have initiated milling activities, and five are supplying mechanized equipment at custom rates.

Transportation

The first movement of rice is from the fields to the farmers' storage for family use, or to a connecting point for trucks which move it to various trading centers. This stage of transport

generally is by head load and carried by a farmer and his family or workers in his employ. A survey indicated that of the produce sold from farms 26 percent was carried for distances that could be covered in less than an hour; 49 percent over distances that required one to three hours; 15 percent, four to six hours; and 10 percent, more than six hours.

At the point of contact with truck services, traders frequently purchase paddy or native milled rice and transfer it to the town where their operations are headquartered. Some producers may pay the transportation and sell direct to distributors in town.

A considerable number of bulkers operate only within their trading center, and thus move the rice for a relatively short distance. However, 38 percent of such operators in towns and villages moved the greater part of their rice for distances of 20 to 60 miles (30 to 100 kilometers), and 25 percent moved it more than 60 miles. Wholesalers who purchased from bulkers or direct from farmers moved a greater part of their rice 20 to 60 miles.

The national road system has 1,700 miles (2,750 kilometers) of primary, of which 400 miles (650 kilometers) are bituminous surfaced, and secondary roads and 2,300 miles (3,700 kilometers) of feeder roads. Although the road system is relatively adequate in mileage, their conditions, especially during the rainy season, are undesirable. The costs of repairs, maintenance, and replacement for vehicles are high. A major deterrent to flow of traffic is the necessity of using ferries for crossing.

Storage

Information on storage facilities indicates that a large share of annual production is held at or near the producing area until marketed and that the cost of storage is very nominal. Conditions or quality of storage are highly variable, and waste and deterioration may be great.

It appears that a great number of farmers are equipped to hold a significant part of their storable produce on the farm. This and the fact of small volume per transaction suggests that an appreciable number of farmers are financially able to hold rice beyond the surplus period at harvest, and that rice is used as a source of cash for living expenses during several months of the year.

Some variation in the kinds of storage facilities was noted, but barns or special structures located on their farm plots are the principal facilities. About 70 percent of the farmers have storage

space on their production sites. In addition, some storage space is in or adjacent to living quarters. About 60 percent of the farmers maintain stores or cribs located at the home, and others use boxes or similar facilities for such purposes.

In the upland areas where the volume produced per farm is less, special storage facilities at the production site are less frequent. In the southern and eastern sections most farmers have special storage facilities of their own, or through cooperatives having access to central warehouses.

Most traders (bulkers) located near the production areas own adequate storage to accommodate small volumes of rice. Generally rice is sold to wholesalers soon after purchase, and the amount of space required is not great. Practically all wholesalers own storage facilities and a relatively high proportion own special facilities, having moderately large capacity (ranging from 32.5 to 65 metric tons).

The largest storage facilities are owned by the Rice Corporation and used for domestically produced as well as imported rice. This includes space for 8,000 short tons (7,200 metric tons) at Kissy (serving Freetown), 4,000 short tons (3,600 metric tons) at Mambolo, 3,000 short tons (2,700 metric tons) at Torma Bum, about 4,500 short (4,050 metric tons) at Pujehun, and 3,000 short tons (2,700 metric tons) at Bonthe. In addition, considerable capacity is available at some 10 to 12 receiving stations in the principal producing areas.

For the foreseeable future storage space appears to be adequate.

Price determining

The Rice Corporation functions as a stabilizing force for rice prices throughout the economy. For imported rice it fixes prices for wholesale and retail. These prices reflect transportation costs to inland points, based on Freetown.

For domestic rice, the Corporation announces prices it will pay for milled and rough rice. These tend to serve as a minimum floor for prices to producers. With these prices as guides, and the relative demand as observed in the trade, dealers tend to judge the reality of prices by the reaction of buyers and sellers with whom they are in contact.

Imports

The small amount of milled rice that is imported usually is procured from sources offering the most favorable prices. Egypt was supplying rice at the time of our visit. Burma, Thailand, Guyana, and Surinam are potential suppliers. Some U. S. rice of high quality is imported, but only in small quantities. The Egyptian rice observed was a short grain variety of poor quality. Most imported rice is not of the better grades.

Services

Research to improve rice culture in Sierra Leone currently is at a very minimal level. At the Rokupr Station, where in earlier years a strong research program on varieties was carried on, work is limited mainly to variety trials and fertilizer response measurements. Only two senior research officers are on the staff. Some work on fertilizer response is conducted at Njala University. There is practically no established procedure for channeling information from these centers to extension officers or trainees.

Extension

The Ministry of Agriculture maintains extension officers in each of the major regions. Each extension officer has approximately six instructors who generally serve two political areas or chiefdoms. These individuals usually have a certificate from a two-year agricultural school and carry on educational programs largely through group meeting. Approximately 1,000 to 1,200 rural families are served by each instructor. Travel to each neighborhood or village center is by foot or public transport if available.

In recent years about eight to nine graduates from Njala University were added to the extension staff each year; but, in 1968, none were employed.

The Peace Corps conducts limited assistance and demonstration programs in selected areas in Sierra Leone. Some have developed paddy demonstration plots in their neighborhoods, assisted by local farmers who usually receive a share of the produce but may be employed at a daily wage. Other Peace Corps Volunteers have given attention to programs for distribution of improved seed and fertilizer.

Two Taiwanese rice production demonstration areas are at Hastings and Mange. These demonstration plots were outstanding in

illustrating what can be done to improve rice production by using the techniques and technology from Asia. Both locations contained production on upland and irrigated plots. The improved practices were transplanting in rows and drilling upland rice in rows on well prepared seed beds, cultivation to control weeds, use of fertilizer, and the use of pure seed. These demonstrations provide excellent training centers for farmers and extension workers.

Suggestions for Improvement

1. There should be established pure seed production stations and a program to supply growers with seed of the improved varieties. Initially, one variety of rice should be sufficient for the whole of Sierra Leone, with the exception of the floating rice grown in the riverain swamp areas. The best yielding inland swamp rice would probably also be the best yielding upland rice. A one-variety country would greatly simplify problems of milling and seed production and would yield a uniform product with consumer appeal.

The Ministry of Agriculture should decide on one good yielding variety that most nearly fulfills the consumer preferences, then proceed to purify this variety and start pure seed production. When a sufficient quantity of pure seed is produced, a campaign should be organized to encourage its wide distribution and use. The several varieties released by the Rokupr Station should be examined to identify the single variety that meets the requirements of the country.

2. The seed beds of inland swamp rice should be fertilized in order to produce healthier seedling plants with greater vigor and more growth. If limited amounts of fertilizer are available, it should be applied first on the seedbeds. Four liters of 12-12-12 fertilizer to 100 square meters of seedbed should produce excellent plants for transplanting. This fertilizer should be incorporated in the top three inches (7.5 centimeters) of the soil prior to seeding. If no fertilizer is available, the seedbeds could be treated with compost, legume cover crops, manure, or other refuse.

3. The use of young plants for transplanting is another way to materially increase yields. For seedbeds, we observed that some plants being transplanted were nearly two months old. Such plants have passed the stage of growth where tillering can be expected. Plants of this age have already developed to the point where the size of the panicle may be determined and they will not give

maximum yields. It appears that the size of plants, rather than age of plants, is the criterion now being used to determine when to transplant. The age of plants should be the determining factor. If seedbeds are fertilized, seedlings of sufficient size and vigor can be produced in three weeks for transplanting. If transplanting to the field extends over a period of weeks, then the seeding of the seedbeds should also be scheduled at intervals over the same length of time.

4. Yields on the inland swamps can be increased by transplanting seedlings in rows. This facilitates weeding, gives plants adequate distance for maximum tillering, and leads to uniform growth and maturity. Transplanting in rows in two directions is preferable. Hill distance should be six to eight inches (15 to 20 centimeters) apart in rows running in two directions and three to four healthy plants should be placed in each hill.

5. Another practice that would increase yields in the inland swamp areas would be the construction of bunds around small paddies and diversion of the stream water around the field, from one paddy to another. This would permit controlled irrigation. For many inland swamp areas this could be done with little extra work and no expense for materials.

6. A research and field testing program should be started to introduce small power units for land preparation, weed control, and selected operations at harvest.

7. Associated with the effort to reduce labor requirements should be a program to improve the quality of rough rice. Maintaining pure seed would be a key factor. The Rice Corporation should establish grades for paddy rice with differentials in support prices to encourage growers to deliver quality rice. Better quality domestic rice is needed if imports are to be replaced.

8. As the aggregate output approaches the normal requirements of Sierra Leone it will become increasingly difficult to avoid surpluses or deficits during some seasons. With a large part of the production area dependent on the vagaries of rainfall, considerable fluctuations in output are certain to occur. Thus, a dependable price stabilization program, including adequate storage and milling facilities, will be needed. Unless a stabilization device is offered, farmers cannot be expected to assume the risk of surpluses and deficits to maintain aggregate output at the level of self-sufficiency for the country.

TOGO

The Rice Economy

The Togolese are not dependent on rice as a major food staple. They prefer yams, cassava, millet, corn, and rice in that order. In 1966, the production of yams (408,000 metric tons) and cassave (395,000 metric tons) each exceeded the production of all cereals combined. Production of millet and sorghum was 86,000 metric tons; corn, 76,000 metric tons; and rice, 20,000 metric tons.

Rice production has been increasing. The output of paddy increased from 16,000 metric tons in 1966, to 18,000 metric tons in 1967 and an estimated 20,000 metric tons in 1968. During this same period, imports of polished rice ranged from 2,900 to 3,700 metric tons with an average of 3,000 metric tons a year. Thus, Togo produces approximately 70 percent of its rice requirements and this percentage is increasing as new land is being brought into production. Without too much effort, the country could become self-sufficient in rice.

Present per capita consumption of rice is between eight and nine kilograms a year. This figure has been increasing and is likely to continue in line with increasing incomes and urbanization. Rice consumption is greatest in urban areas and the highest rate is in the capital city of Lome. Producers prefer to eat corn for which their market return is 12 CFA francs per kilogram and market their rice which brings 23 to 24 CFA francs per kilogram.

The Physical Environment

Togo covers 56,000 square kilometers, (22,000 square miles). It measures 400 miles from north to south and 31 miles from east to west along the Atlantic coast.

Togo is mostly flat, except for the Atakora and Fago mountain ranges which form the watershed for the Upper Volta river basin in the west and the Mono river to the east. These mountains begin approximately at Palime in southwest Togo and extend north and northeast to Bassari, Bafila. The highest peak, Mount Agou, is near Palime, rising to 1,020 meters (3,315 feet).

The country is divided naturally into four regions, the Maritime or Coastal region in the south, the Plateau region, the Central

region, and the Savanes region. Most of the rains fall from June to September, but along the coast the rainfall is mostly in April. The following table shows rainfall for 1964 - 1965 at four stations:

	LOME -millimeters-		MANGO -millimeters-	
	1964	1965	1964	1965
January	0.0	52.2	0.0	29.1
February	0.0	5.2	0.0	9.6
March	22.7	30.5	115.9	82.6
April	83.4	176.5	50.0	189.1
May	161.3	63.0	60.9	43.5
June	197.7	198.4	115.0	187.6
July	21.6	113.5	177.9	148.3
August	0.0	20.9	345.5	96.6
September	5.4	27.3	260.1	99.8
October	44.3	15.2	24.3	72.9
November	0.0	0.0	6.0	91.1
December	17.2	2.7	41.9	26.2
Total	553.6	705.4	1,647.5	1,076.4

The principal rivers in Togo are the Mono, Zio, Haho, and Oti. The valleys of the lower Mono, the Upper Oti and the Zio have rich soil and abundant water suitable for rice cultivation.

Production

There is no shortage of cultivable land in Togo. Soil quality varies. The most naturally fertile land is densely inhabited. According to Togolese data, the following land area was available for cultivation in 1963 and 1964:

	1963	1964
Region maritime	204,400 hectares	216,759 hectares
Region Des plateaux	240,020	280,430
Region Central	257,044	298,703
Region des Savanes	147,930	147,945
Total	849,394 hectares	943,837 hectares

Statistics on rice production are:

Year	1959	1960	1961	1962	1963	1964	1965	1966	1967
Hectares (1,000's)	17	15	15	16	25	27	20	22	22
Metric Tons (1,000's)	14	11	17	18	16	17	20	23	25
Yields Kilograms per Hectare	857	736	720	787	720	625	1,000	1,045	1,137

The farmers in Togo cultivate rice by traditional methods. Rice is planted in the lower areas of a river basin before rains cause the river to flood into the basin. Most of the rice raised by the farmer is used for home consumption on holidays or other special occasions, or is for sale.

The most concentrated rice production is at Mission Tove located on the Zio river approximately 35 kilometers from Lome. Under the direction of a Taiwanese team, this area has 50 hectares under cultivation by Togolese farmers.

Marketing

Rice is imported into Togo by the import-export firms doing business in the country. The government does not control the volume that may be imported but does control the profit margins of the importers. The margin of profit for the wholesaler is nine percent and for the retailer, 15 percent. According to one importer, rice imported from Cambodia cost 52.67 CFA francs (21 cents) per kilogram delivered to the warehouse. Of this price, 5.7 CFA francs per kilogram was insurance, tax, and customs and one CFA franc for transportation from dock to warehouse. Local rice delivered to the warehouse in Lome costs 45 CFA francs (18 cents) per kilogram.

The following table shows imports and exports since 1961:

	IMPORTS (Metric Tons)	EXPORTS (Metric Tons)
1961	3,089	283.0
1962	3,159	72.0
1963	2,965	229.0
1964	3,106	1.0
1965	2,888	0.1
1966	3,667	18.0
1967	2,687	46.0

In 1966, most of the rice imports was from Taiwan (2,078 metric tons). In 1967, the largest importation was from Cambodia (1,626 metric tons).

Importers sell to small merchants who, in turn, sell to consumers at 60 - 70 CFA francs per kilogram, depending on the grade. Local brown rice was selling for 50 CFA francs per kilogram during our visit. There are only sixty-two rice venders in the ten Lome markets compared to over 300 venders of rice and sorghum.

Services

Two organizations assist the Togo government in programs for increasing rice production with the goal of making the country self-sufficient. These are the Bureau for the Development of Agricultural Production and a Taiwanese rice team. The bureau works with SORAD, an organization responsible for agricultural development, on the development and improvement of upland rice in the coastal or maritime region and in the savannah region in the north. Trials and demonstrations involving 10 hectares of rice were initiated this year in the coastal region. Varieties tested included R-66, R-71, Gambia 4, Taichung Native #1, and Non Han. Results show that Taichung Native #1 yielded highest, 4.5 tons per hectare. However, it is a glutinous rice and the taste is not readily accepted by consumers. R-66, although lower yielding (3 tons per hectare), has consumer acceptance.

The goal of this program is to select a non-glutinous variety that has a short growing season (110 days), and produces well under dryland conditions, and to expand production to 1,000 hectares by 1972. The program in the northern region around Dapango is further advanced with 500 tons of milled rice produced last year.

The Taiwan rice team has established demonstrations at Mission Tove, Amou Oblo, Lama Kara, Mango, and Anie. To date, 140 hectares within a target of 240 hectares have been developed and put into production. Most of this work is devoted to irrigated rice, although several sites include upland demonstrations.

The Mission Tove site is the most highly developed. Fifty hectares of irrigated rice are being cultivated by Togolese farmers. Each farmer is alloted a hectare of land on which he produces two crops of irrigated rice per year, each averaging five tons. The rice is threshed and polished in small huller and polishing machines provided by the Taiwanese. No charge is made for this service other than the cost of the fuel. The polished rice is purchased from the farmers at prices which range from 32 to 40 CFA francs per kilogram. Since there is no transportation cost to the farmers, this seems to be a reasonable price when compared to the price of 45 CFA francs per kilogram for local rice in the warehouse at Lome

The Taiwanese leader estimated that water is available to expand the area under cultivation to 300 hectares on a two-crop basis. IR-8 is the highest yielding variety and produced more than eight metric tons to the hectare on the demonstration plots and an average of five metric tons under field conditions. Seed of this variety is now being multiplied.

Suggestions for Improvement

Although Togo is not a major rice consuming country, imports account for 30 percent of the total rice consumption which represents a considerable outlay in foreign exchange. Without too much effort, the country could become self-sufficient. Specific suggestions are:

1. Additional hectarage should be developed for irrigated rice along the Zio river. For example, the Mission Tove project could be expanded to approximately 300 hectares.

2. Farmers trained in improved production technology by the Taiwanese technicians should be assigned plots in these newly developed lands.

3. Processing and marketing systems would have to be developed in these new production areas in order to assure the farmers of a ready market.

4. Inputs such as seed and fertilizers need to be readily available for purchase by farmers who have been trained in the new prcduction methods.

5. Credit for the purchase of the previously mentioned inputs will have to be supplied.

UPPER VOLTA

The Rice Economy

Whatever estimates of Upper Voltan rice production one believes, the place of rice in the diet and in the economy is quite marginal. Rice takes on a certain economic importance only in the context of the country's severe trade deficit. At present, rice imports use up precious foreign exchange. Planners hope Voltan farmers will be able to produce at least enough rice for the country's needs, and perhaps even eventually a few exports.

Voltan rice imports have been gradually rising both in amounts and in cost. For the last four years, they were:

	Quantity of Rice Imports (metric tons)	Value (dollars)
1964	3,500	370,000.00
1965	3,257	470,000.00
1966	4,114	630,000.00
1967	3,816	650,000.00

These amounts may seem insignificant. They must, however, be seen in the context of the small total value of Upper Volta's exports (between $12 million and $16 million in 1965 and 1966) and of its trade deficit ($24 million and $21 million for the same years). Thus, rice imports may cost as much as five percent of the country's foreign exchange earnings.

From 1948 to the present, estimates of rice production have been based on the reports of local administrators. Though probably erroneous, the reports form a consistent series. However, estimates of the error differ. The Planning Service estimates 1966 production at 24,000 metric tons. However, the chief technical counselor of the Statistical Service in the same ministry feels that, as a result of increasing urban consumption, production in 1966 must have been 52,000 metric tons. The USDA estimate, 34,000 metric tons, falls between the two.

Rice constitutes between two and one-half to five percent of the starchy-food consumption, about eighty percent of which is sorghum and millet. Furthermore, it is a luxury item, more than three times as expensive as sorghum which has comparable nutritive value. During our stay, staple prices in the Ouagadougou central market were:

	CFA francs per kilogram	Cents per kilogram
Sorghum and millet, all varieties	15	6
Yellow corn (imported Ghana)	19	7.6
White corn	22	8.8
Red or brown rice	35	14
Wheat flour (imported)	45	18
White rice	50	20
White rice (imported)	65-70	26-28

Annual consumption of rice per head is very low, between six and thirteen kilograms per year. It is unevenly distributed, however. Probably most consumption is in the administrative towns, the home of 290,000 Voltans or about six percent of the population. It may be presumed that virtually all imports and rice which is marketed are consumed in the towns, and mostly by the upper-income groups.

In the countryside, the growing of red rice (Oryza glaberrima) has been known for centuries, but this was a very minor activity. White rice probably entered with the French conquest. Culture takes place principally in flood plains covered with water during the wet season, with little or no water control. Over two-thirds of local production comes from the Bobo-Dioulasso region in the southwest and almost half from the circles of Banfora and Gaoua, the wettest part of the country. Not surprisingly, most rural consumption of rice is in areas west of the Black Volta.

As one prominent Voltan told us, "Rice is considered a very noble food, but millet demands less care." There is some tendency for rural people to switch over to rice, and urban people generally eat rice when they can afford to. However, factors which explain rapidly expanding rice production in coastal African countries are not so marked in Upper Volta; income per head is not growing and urbanization is much slower. The number of Voltans who can afford the "noble" food is not expanding rapidly.

The Physical Environment

Land

The Voltan countryside is gently rolling with vast areas almost devoid of relief. Valleys are generally wide and often slope gently to a narrow stream, but without possessing broad bands of fertile flood plain suitable for rice culture. The land does not lend itself to irrigation dams, since the valleys are so wide and flat that very long dams must be constructed to retain water. Reservoirs are thus quite shallow, giving rise to very high evaporation losses.

Repeated burnings of vegetative cover during the annual dry season have denuded the soil. Sorghum and millet culture is carried out on a slash, burn, and plant basis. As a result, much of the land is covered with a surface hardpan which will not support any sort of crop.

Lands in the southwest and western part of the country seem the best for rice production, since there are a number of valleys where the soil is relatively fertile and the shape of the valleys is such that they might be brought into irrigated-rice production. Unfortunately, the cost of developing these valleys is likely to be prohibitively expensive. This is discussed at greater length below.

Vegetation

Almost all of the country may be considered sub-Saharan or Sahelian savannah. Very large areas support practically no vegetation. There is almost no real forest. The Forestry Service has begun a modest program of reforestation.

Grass grows abundantly over most of the country during the rainy season, but is traditionally burned during the dry season.

Soils

Most of the soils are not suited to rice production. Two-thirds of the land is covered with red, lateritic soils containing high percentages of sand and gravel. They are low in organic matter and available nutrients.

There are, however, some valley soils well suited to rice production. These soils have good texture, a satisfactory balance of clay and loam particles, sufficient organic-matter, and a high pH. An analysis of a southwestern valley soil, with a pH of six, is shown below.

	Depth (centimeters)		
	0-15	15-30	30-40
Large sand	3.1 percent	3.4 percent	2.8 percent
Fine sand	19.4	23.3	24.6
Loam	12.5	15.0	11.9
Clay	63.0	57.0	60.1
Organic matter	2.0	1.3	0.6

Though there has been no widespread soil testing, the above analysis is probably representative of valley soils in much of the southwest due to the similarities of the parent rock, climate, and relief.

These soils, usually poorly drained, do not stand up well as dikes due to high sand content.

Not enough experience has been accumulated with irrigated rice to be able to tell whether these soils would deteriorate under continuous rice production. There is every reason to think that they would not deteriorate as long as fertilizer applications kept pace with nutrient removal by crops.

Availability of land

Total land area is 106,000 square miles. About eighteen percent of this is arable. Approximate areas in major crop production are:

Grain	Area (000 hectares)
Sorghum	1,237
Millet	540
Cowpeas	267
Peanuts	241
Corn	211
Bambara groundnuts	86
Rice	43

Most of the area planted in rice is in bottom land which is flooded during the rainy season. Very large quantities of this sort of land are available, mostly in the south and the southwest. Though no figures are available, perhaps as much as 100,000 hectares could be brought into irrigated rice production. But much of this land is off limits due to the presence of onchocerciasis (river blindness). Whole populations have moved out of affected valleys leaving thousands of hectares uncultivated.

Two valleys in the southwest region are of particular importance. They are the Loumana and the Dionkélé. The former has a dam, a primary canal, and about 1,600 hectares of irrigable land. It is, unfortunately, connected to consumption areas by about eighty-five kilometers of very poor dirt road. The latter involves about 10,000 hectares of irrigable land and is about thirty kilometers from the new Bobo Dioulasso-Faramana road. The Dionkélé area has a dam at the exit of the river which permits flooding of the plain during the rice season and a main drainage canal. Both of these valleys would require extensive survey work to determine the feasibility of developing them.

Rainfall

About 1,400 millimeters of rain per year is the average for the extreme southwestern part of the country. This declines regularly as one moves toward the northeast, where the annual average is 500 millimeters.

Throughout most of the country, there is a rainy period beginning in April-May, rising to a peak in August, and ending in October. The remainder of the year is extremely dry.

An important factor is the variability of rainfall from year to year.

	Annual Rainfall (millimeters)			
Location	Average	Maximum	Minimum	Max./ Min.
Gaoua	1,162	1,564	823	1.9
Boromo	1,010	1,879	539	3.5
Ouagadougou	860	1,123	499	2.2
Dori	540	783	402	1.9

Temperature

Like rainfall, temperatures decline from southwest to northeast. There is a period of high temperatures from March to May. This coincides with the onset of the rainy season. Temperatures do not appear to be a limiting factor in rice production in the areas where sufficient water is available. The range may be shown as follows:

Area	Average Daily Maximum of Warmest Month (°C)	Average Daily Minimum of Coldest Month (°C)
Southwest	37.4	18.8
Central	39.0	16.6
Northeast	41.0	13.8

Day length

All of the areas suitable for rice culture lie between the 10th and 13th parallels where variations in day length are relatively unimportant.

Production Techniques and Costs

Upland, swamp, and irrigated rice-growing techniques occur in Upper Volta. Only swamp rice is now important, but irrigated culture may be in the future.

Upland

There are very few parts of Upper Volta where upland rice-growing is possible; a little is grown in the Banfora and Gaoua areas. The rainy season is sufficiently short and sufficiently likely to be interrupted that upland rice growing is a risky business.

The technology of upland rice growing is similar to that described for the Ivory Coast except that clearing of the savannah demands very little time, and farmers harvest with a sickle instead of a knife.

The Upper Voltan upland rice farmer has a much higher chance of failing than his Ivorian counterpart, but, if he does not depend on his crop for livelihood, his stakes are lower. Upland rice-growing may well be worth the gamble in the limited regions where it is possible. However, this is hardly a policy issue, since no one proposes to expand this sort of rice culture anyhow. Risks of crop failure being what they are, it would probably not be wise to invest more labor or capital (e.g. fertilizer) in upland rice production.

Swamp culture

The great bulk of rice culture may be classed as "swamp." This category describes a gamut of cultural practices on cleared bottom lands ranging from upland to irrigated. During most of the growing season, the rice is standing in water. The farmer has little or no control over the water level and all too often it will get either too deep or too dry for optimum yields. Before the approach of the rains, the farmer digs up his field with a daba, a short-handled hoe. He may bury the surface vegetative matter, but he is much more likely to burn it. With the advent of the first rains (April-May), some farmers plant rice grains in holes made with a narrow-bladed daba. Others, possibly twenty percent, prepare seedling nurseries, then transplant the seedlings. The transplanting technique is used in widely separated regions, but principally west of the Black Volta. There, it is a traditional practice; the agricultural extension service has only just begun to teach rice culture involving transplanting to farmers in other regions.

The farmer then may weed the rice, depending on time available and the need. Weeding is by hand or with the daba. Nothing more is done until harvest, usually in October or November, when the rice is cut with a sickle one handful at a time.

In some cases, rice is cut as needed. In others, it is harvested and stored, either on the stalk or after threshing, which is traditionally done with flails. When used by the farmer for his own food, it is first hand-pounded and then winnowed.

The chief limiting factor to Voltan rice production under this system is poor water control. Water may completely flood the field following high rains, or it may not rain at all for several weeks, causing severe drought damage. We saw fields near streams where the rice was growing in about a meter of water, and others less than 200 yards away where there was no water at all. Yields are subject to wide variation.

Insects, disease, and, to a lesser extent, bird and rodent damage are ignored. Some effort is made to store the grain off the ground in a dry, well-ventilated place. The traditional Voltan granary does meet these needs, but it is seldom insect proof.

The same field may be used year after year. Since no other crop is grown on the bottom lands, there is no chance of rotation.

Average yields are estimated at 870 kilograms per hectare, but they may vary from about 2.5 metric tons per hectare with traditional techniques under ideal conditions to a few hundred kilograms per hectare if the water level is too high or too low. We do not have information on the likelihood that water level will be unsatisfactory in any given year. We have little information on the variations from mean expected water level which inundated rice will stand, and with what effects.

We are unable to calculate the cost of producing swamp rice. In addition to the gaps just mentioned, labor requirements have not been studied. Moreover, there simply is not a "typical" case.

The very fact that it is widely practiced indicates that many farmers feel that swamp rice culture, though replete with risks, is a worthwhile use of their time and floodplains. However, it is also noteworthy that farmers regard rice growing as a supplementary activity to be undertaken when there is time left after subsistence activities and the growing of other cash crops.

Not all farmers who live near appropriate floodplains cultivate rice and not all floodplains appropriate for swamp rice are cultivated, even when free from river blindness and near settlements. Probably, unless risks can be reduced, Voltan farmers will be unlikely to increase their inputs of labor per hectare or undertake capital investments in swamp rice-growing.

Irrigated culture

Growing rice with water control is a recent development in Upper Volta. Some traditional farmers achieved rudimentary and incomplete water control, as did some French development projects begun in the 1950s. But, the first true irrigated rice was introduced by Taiwanese technicians in 1965.

At present, 160 hectares of irrigated rice are being cultivated in Taiwan projects. Extensions now in progress would raise that figure to 1,440 hectares in 1972. SATEC (Societe d'Aide Technique et de Cooperation, a French societe d'intervention) is also working to expand irrigated rice-growing. It is helping to bring sixty hectares into production at Mogtedo, downstream from a dam built by the European Development Fund, and is planning more such projects. If only these projects are realized and if two crops are grown where feasible, irrigated methods will be producing over 12,000 metric tons of rice five years from now.

That would be a sizeable portion of national production.

The method used by the Taiwanese and cooperating Upper Voltans is essentially the same as outlined in the report on the Ivory Coast.

The Taiwan group in Upper Volta is recommending a slightly different application of fertilizer per hectare per crop than in the Ivory Coast, as follows:

60-80 kgs. of N in the form of 130-174 kgs. of urea.
30-40 kgs. of P_2O_5 in the form of 166-222 kgs. of 18% bicalcium phosphate.
40-50 kgs. of K_2O in the form of 80-100 kgs. of potassium sulfate.

IR-8 is used in most of the extension phase of Taiwanese program, and they hope to be able to get two crops of rice per year regularly. Where there is enough water, yields have averaged four tons per hectare for the first crop and three and one half tons for the second.

The SATEC method is somewhat different from that of the Taiwanese. Variations include different varieties (SATEC uses mostly varieties which are indigenous or those selected by IRAT that are longer-season than IR-8), less seed for the seedling nursery, (20 kgs. vs. 60 kgs. per hectare of rice to be transplanted), and much lower rates of fertilizer. SATEC's fertilizer application consists essentially of 100 kilograms of urea (45 kgs. of N) applied in split doses at planting and tillering.

SATEC's recommendations in printed form are different from those actually practiced in the field. The former include, in addition to the above, 500 kilograms of phosphate per hectare and 100 kilograms of potassium per hectare. However, due to the high price of fertilizer and the difficulties of supply, phosphorous and potassium are not now part of the SATEC program.

SATEC is still working out an improved, practical system of harvesting and threshing. These are now performed as described in the section on inundated rice.

SATEC is a newcomer to rice extension, having put most of its effort into cotton production until now. It is difficult to evaluate results, but SATEC's rice extension specialist claims yields of one and one-half to three metric tons per hectare with an average of two.

Preparing irrigated rice land

The Taiwanese, in their projects, do all the engineering and supervision. The only local participation is in the form of hired labor, paid by the Taiwan aid program.

Once the land is prepared for planting, a peasant is allotted the paddy and he begins to farm it under the supervision of the Taiwan technician who works very closely with his Voltan counterpart during the crop season. This is a highly disciplined effort which permits no mistakes. To make sure the farmer plants the right varieties, seed for the first crop is provided at no cost. So are insecticides and fertilizer. Rototillering is done free. Water is controlled by the Taiwanese technicians. Harvesting and hulling equipment is loaned free of charge. Every precaution is taken to see to it that the farmer follows the Taiwanese method explicitly.

The Taiwanese claim this method permits the land to be brought into production quickly, efficiently, and correctly. They also maintain that the farmers learn quickly and are able to continue on their own initiative once the Taiwanese technicians have handed over the project to their local counterparts.

There is considerable evidence that the Taiwanese are right. However, they still control the water level, and repair and operate the rototillers, rice hullers, and other equipment. There seems to be no provision in the Taiwanese program for passing on these tasks to Voltan farmers, nor for creating a local organization which can assume these responsibilities.

SATEC uses a different approach. It has one French technician and five Voltan agents at work developing the plain of Mogtedo. The dam and main canals already exist and they are busy tracing tertiary canals and laying out paddies. All of this work is being done by hand by the farmers who receive no pay.

The agents supply the "know-how."

The farmer buys his own seed and fertilizer from SATEC. No insecticides are used. The farmer digs up his paddy with his own tools, harvests with whatever tools he has at hand, and receives no help in the form of loaned equipment for threshing or hulling.

SATEC claims that though this method is slower than the Taiwanese approach, it is likely to be more meaningful to the farmer because he will have acquired the ability to clear land and produce rice entirely on his own. He can do this best, of course, only where there is a dam and an irrigation system.

SATEC's method also seems to be working. Farmers at Mogtedo are carrying on cheerfully, almost entirely on their own, and doing an acceptable job. There is excellent rapport between agents and farmers.

Costs in irrigated culture

The method of growing irrigated rice in Upper Volta hardly differs from that practiced in the Ivory Coast. However, soil and climatic conditions are different, the costs of factors of production are different, and Taiwanese technicians estimate that the amounts of time required to perform certain farming operations are different. They estimate the labor input per hectare as follows:

	Labor Input (man-days per hectare)
preparatory tillage	80
seed-bed preparation	15
transplanting	30
weeding & fertilizer application	56
pest control	30
irrigation	24
harvest	40
	275 days

Fertilizer is expensive in Upper Volta. When available, it costs from 35 to 60 CFA francs per kilogram ($140-240 per ton). Improved seed costs 40 CFA francs per kilogram ($160 per ton). When labor has to be hired, the farmer must pay about 150 CFA francs per day (60¢) to get a decent day's work. Taiwanese technicians estimate the costs of production as follows, assuming that all labor is worth 150 CFA francs per day: *

	Costs of Production (CFA francs)	
seed (60 kilograms at 40 CFA francs per kilogram)	2,400	
fertilizer	12,350	
insecticide and fungicide	3,000	
labor	41,250	
	59,000	($236)

*In an effort to make this calculation comparable to those for Ivory Coast, we have omitted depreciation of tools (2,000 CFA francs), taxes (2,500), and post-harvest labor (25 days or 3,750).

All of these factors conspire to raise costs. If the farmer succeeds in raising four metric tons per hectare, the return to the irrigation investment and to his management will be $68 (17,000 CFA francs) if his paddy sells for the official price of $76 per ton (19 CFA francs per kilogram).

However, even government corporations buy paddy for as much as $100 per ton (25 CFA francs per kilogram) and Taiwanese technicians estimate that paddy will bring up to $140 (35 CFA francs per kilogram). At these rates, the returns would be 41,000 or 81,000 CFA francs per hectare ($164 or $324).

In most cases, the reservoirs on Taiwanese projects contain enough water to irrigate two crops. Assuming that one hectare of land yielded four metric tons of paddy in the first crop and three in the second, and that it sold for 25 CFA francs per kilogram ($100 per ton), the return on one hectare would be 57,000 CFA francs ($228).

In other words, the current costs of producing irrigated rice are about $59 per ton for the first crop, $67½ per ton for the second, or an average of $63 per ton for the two. This does not include drying and threshing, nor does it include any investment costs. At the official government price for paddy ($76 per ton), this is barely economic. At the $100 per ton the farmer can probably get for paddy, it is more profitable for him, provided he receives the developed land free. The cost of developing irrigated land is extremely high. Valleys are shallow, dams large per unit of water retained, evaporation high, and soils are porous so that most canals have to be lined with cement (which is quite expensive).

The Taiwanese projects at Boulbi (80 hectares) and Louda (300 hectares) take advantage of existing dams which were previously unutilized. Nevertheless, the irrigated project of Boulbi cost the Taiwanese 462.000 CFA francs per hectare ($1,154). In the Kou Valley project (1,200 hectares), where the Taiwan Mission is starting from scratch but where constant flow makes a retaining dam unnecessary, the estimated development cost is 1.080.000 CFA francs per hectare ($2,700). Of this figure $327 per hectare is for cement alone (5.84 tons per hectare at 14.000 CFA francs per ton ($56 per ton) and $720 per hectare for labor. Almost all work is to be done by hand; there is little clearing involved. These figures include all land development costs except a projected $1,200,000 worth of World Food Program food to be given to the workers over four years and, of course, the settlement costs. If, for accounting purposes, these costs were to be paid back over ten years--our assumption for cost of preparing irrigated land in the Ivory Coast--no return at all would be left to management.

As far as the individual farmer on a Taiwanese project is concerned, land-preparation cost need not be considered. It is paid by Taiwan technical assistance.

Land is distributed by the government. A fair number of the farmers appear to be civil servants or town dwellers who hire their labor. Their returns per hectare would be as indicated above.

For those farmers, however, who would do the work themselves, the calculus would be different. Using the same assumptions as before (including a paddy sale price of $100 per metric ton), we can subtract their cash outlay from total income and divide by the number of their days of work. This gives us return to labor, management, and the investment in land preparation per day of work. For a first crop of four metric tons, this figure would be $1.20; for a second crop of three and one-half metric tons, it would be 83 cents. If the state gives the farmer his rice paddies, then his labor and management are getting him more than he would have made by taking an unskilled job, even after making allowance for additional labor in drying and threshing. However, this advantage is strictly marginal for the second crop. Moreover, if the farmer has to participate in the development of the irrigated land, as he does under the SATEC method, his returns are still lower; he may be tempted to take an unskilled job in a coastal city.

Are the development costs of irrigated land in the Taiwanese projects typical for UpperVolta? It is difficult to say since there is little irrigation, but they probably are. The construction of a dam and the major irrigation and drainage canals, (but without secondary canals and land leveling or clearing) at Mogtedo cost 150.000.000 CFA francs or $9,200 for each of the sixty-five hectares that can be irrigated. The Deputy Head of the Rural Hydraulic and Construction Service estimates the cost of developing one hectare of irrigated land at $1,000 to $2,000.

Nevertheless, there may be opportunities for economic expansion of irrigated agriculture. In the last two decades, French and European Economic Community aid have constructed over seventy dams around the country. The water retained in these dams is not now used and the flood plains are not irrigated. Yet, they might be used.

However, the Taiwanese experience indicated that building canals, bunding, and draining are expensive in themselves.

At Loumana, west of Banfora, the dam and major canals and drains are already built for an irrigable plain of 1,600 hectares. At the Niéna-Dionkélé plain on the Malian border, described above, it might be much cheaper to achieve water control. At outlet dam and drainage canal have been constructed for $300,000. It has been estimated that construction of four dams to control inflow plus construction of major canals would cost 800,000,000 CFA francs or $240 per hectare.

Moreover, if some way could be found for increasing returns from swamp rice and improving the odds of getting a decent crop without complete

water control, a great many floodplains might be brought into production quite economically.

Disease and production costs

The working efficiency of the population is obviously cut down by disease. Malaria is endemic and schistosomiasis common. The effects of these diseases were discussed in the Ivory Coast section.

The most serious disease affecting rice production in Upper Volta is onchocerciasis or river blindness. People simply do not produce rice in areas where it is common; they move out. A large and potentially fertile area suitable for rice-growing, particularly the river valleys of the southwest, is uninhabited because of this disease. Re-establishment of habitation, hence of rice culture, in these areas depends on control of onchocerciasis. Just before our visit to Upper Volta, a group of experts and representatives of countries with onchocerciasis problems met to discuss this control. It was impossible to estimate the costs of control. Program expenditures would have to go on indefinitely to prevent re-infestation. Experts agreed that active cooperation of all the governments in the region is required before a program can succeed. Even if control of the disease turns out to be economic (and the value of potential rice production in the effected area would enter into the calculation), lack of intergovernmental cooperation seems to preclude any successful effort in the short-run.

Production services

Government revenues do not cover current expenditures in Upper Volta. Any investments in agriculture and any services to rice farmers inevitably result from foreign assistance in one way or another. Since rice is a minor crop, it has attracted little interest, except for the Taiwanese program. IRAT provides small quantities of improved seed for sale at $80 per ton. The agricultural parts of the country have been divided into twelve ORDs (Organization for Rural Development). The government has found donors willing to provide the encadrement for nine of these. The ORD of Banfora distributes improved rice seed and a disinfestant for treating seed; it also performs a role in rice marketing (see below).

ORDs have not yet been organized for Bobo-Dioulasso and Gaoua/Diébougou, two of the country's most important rice zones; government agricultural services are rudimentary in these areas. The government has been unable to coordinate the efforts of a variety of foreign donors.

There are no government programs to provide rice farmers with fertilizers, insecticides, or small tools. A Western-style sickle is widely employed in Upper Volta.

A great many farmers have donkeys (178,000 reported) and quite a few of them are used for draft purposes. Approximately 8,000 pull-type cultivators (houe manga) are in service in the central part of the

country; these were distributed by SATEC as part of its campaign to increase cotton production. The cultivator has a small wheel in front, three or more shovels, and is equipped with two handles for the operator who walks behind and guides it. It can be pulled by one donkey. It is sold at $42 (10,500 CFA francs) by SATEC on a five-year credit scheme. Unfortunately, SATEC has been able to collect on only fifty percent of the loans. The rig includes harness and interchangeable shovels. It may be equipped with a simple six inch mold board plow or with a seeder for planting small grains (corn, sorghum, millet, cotton, peanuts). We did not see animal traction being used in rice culture.

Marketing

Foreign trade

Exports of rice are now forbidden in view of the expected national food shortage resulting from the 1967 drought.

Some rice imports come from Ghana and also Mali in small lots. Aware that it is unable to control this commerce, the government has exempted all such imports in amounts of 20,000 CFA francs ($80) or less.

Large-scale imports are subject to government authorization. At present world prices, transport costs and import duties keep the price of imported rice above that of the local product, except perhaps in times of shortage. During our stay, imported rice cost at least thirty percent more than the local product, though it was also whiter. Presumably, should world prices fall, the government would limit issuance of import authorizations to keep imports from replacing local rice.

Importing operations then follow normal commercial channels. This is also the case for SOVOLCOM (the government marketing company) imports, which are carried out by one of the large, foreign commercial firms.

Imported rice contains about 25 percent brokens. The most recent price of rice to SOVOLCOM delivered by rail to Ouagadougou 52.27 CFA francs per kilogram ($205 per metric ton). This includes a freight charge of about 17,100 CFA francs per kilogram ($69 per metric ton) for rail transport of 1,140 kilometers from the port of Abidjan. When the duty of ten percent, the import tax of four percent and the statistical tax of one percent are added, this becomes 60 CFA francs per kilogram. In principle, paddy imports are subject to additional tazes: ten percent development, one and one-half percent subsistence tax. However, paddy imports come exclusively in small lots which are duty exempt. The retail price is 65 CFA francs per kilometer ($260 per metric ton).

In 1967, Upper Volta imported 3,626 metric tons of rice worth 154,855,800 CFA francs ($620,000). Nearly one-third of this, 1,100 metric tons, was handled by SOVOLCOM. Almost all of imports were twenty-five percent brokens; the luxury rice market is very small indeed.

Marketing local production

There are no reliable national estimates of the amount of locally produced rice marketed. It is certainly higher in areas where rice growing has been introduced recently than in areas of traditional production. A study of the Ouagadougou area by SEDES, a French development firm, in 1964 estimated that seventeen percent of the rice produced in the region went to seed and losses, twelve percent was marketed outside the circle of production, thirty-three percent was commercialized within the same circle, and thirty-eight percent consumed on the farm. The national figure for on-farm consumption must be higher.

Prices

The market for the farmer's rice in Upper Volta is very uncertain. The government has established a producers' price of $76 per metric ton (19 CFA francs per kilogram) of paddy, but cannot enforce it. SOVOLCOM reports that it must pay from $84 to $100 per metric ton (21-25 CFA francs per kilogram) if it wants to buy any paddy at all, although the paddy must be delivered to one of its twenty collection points.

While all buying of agricultural products from the farmers is now supposed to be handled by the ORDs, these do not exist yet in several regions and are functioning only partially in others. Moreover, rice is not a major crop and, hence, not the primary concern of the ORDs. In many villages, the situation is probably similar to the one found by the 1964 SEDES study of the Ouagadougou region. Then, paddy prices after harvest averaged 22 CFA francs per kilogram on rural markets, ranging from 17 to 32 CFA francs. During the pre-harvest famine, they averaged 30 CFA francs per kilogram ranging from 21 to 40 CFA francs.

Because of the imperfections in the government buying system, most farmers are simply not able to sell to government organizations. Since private commerce tends to avoid the worst tracks, many villages allegedly cannot sell their produce at all unless they are prepared to transport it themselves. Some we met on main roads preferred to bicycle their excess paddy to the nearest market town to sell it themselves.

The government price is not announced until after the harvest.

Milling

Most of the rice marketed in Upper Volta is probably hand-milled or rough-milled by small machines. These machines are found in many villages and serve principally to mill sorghum. There is no way of knowing how much paddy is treated in these ways and marketed. Since the country's one large mill is operating at a fraction of capacity, the hand-millers and small mills must be competing effectively.

The mill at Sisalia, just south of Bobo-Dioulasso, is operated by SOVOLCOM. It has a capacity of about 4,000 metric tons per year, but

processed only about 1,000 metric tons in 1967. The mill has parboiling facilities, but they have been broken for some time. The government received an attractive offer from an Italian firm to build and finance a new rice mill in the capital, but wisely refused the offer until existing facilities can operate at capacity.

Because of the heterogeneous character of paddy received, the Sisalia mill turns out a high percentage of brokens, which can be sold only with difficulty at the official price and only in the Bobo-Dioulasso area. Head rice is of low quality and contains quite a few stones. Out-turn from a ton of paddy breaks down as follows:

hulls, etc.	200 kg.			
bran	120	@ 5 CFA francs per kg.	600 CFA francs	
milled rice with 25% brokens	500 kg.*	@ 50	25,000	
other brokens	180	@ 35	6,300	
			31,900	($128)
less price paid per ton of paddy delivered to mill			25,000	($100)
less cost of operating mill.			5,000	($ 20)
Margin			1,900	($7.66)

* People at the mill thought out-turn of head rice was 62-69 percent.

But this "margin" must cover the cost of transporting the milled rice and retailing it. 50 CFA francs for rice ($200 per metric ton) and 35 CFA francs for brokens ($140 per metric ton) are the prices in SOVOLCOM's retail twenty outlets, not at the mill door. When we also take into account the fact that SOVOLCOM buys some of its paddy outside the region and transports it to Sisalia, getting it there at a net cost of more than $100 per metric ton, it is not hard to see why the operation loses money.

Sisalia's only competitors for the white rice market are imports and the product of the small Taiwanese-made rice mills located at Taiwanese projects. The out-turn of the latter is much higher than Sisalia's, partly because they receive uniform paddy from the projects' fields, part because they are inherently better machines. One machine can process 700 kilograms of paddy per hour into brown rice and can polish a part of that into 120 kilograms of white rice per hour.

Parboiling

To our knowledge, parboiling is not practiced in Upper Volta.

Transport

Getting rice to market is a major problem for all Voltan rice growers except those around the major towns. Since the country is so poor, there is less to transport. The commercial trucking system is much less articulated than in the Ivory Coast. A very high percentage of roads must be classed as simple tracks. There are no paved roads. Consequently, the cost of transport, when available, is very high.

Until the ORD's agricultural-product collection system really begins to function, there will be no cheap way for the isolated farmer to get his rice to market. If and when the system begins to function, it will still constitute a government subsidy to isolated farmers, thus a social change. Unlike the Ivorian government, which is easily able to bear this change by subsidizing SATMACI, the Voltan government cannot easily support this expense.

The official price of Transafricaine, the country's largest road transporter, is six cents (15 CFA francs per metric ton per kilometer) along the major roads. The cost by train, decisive for foreign trade, is also fixed at 15 CFA francs per metric ton per kilometer by collusion with Transafricaine and other major transporters. Where the client can assure that the truck will return full, apparently the price can be reduced to 4.4-4.8 cents (11-12 CFA francs per metric ton per kilometer), which is also the average price charged by African truck owners. There are probably too many of the latter for the amount of business, and this rate may be below their real operating costs. Many are being forced out of business. SOVOLCOM has a contract with a private trucker to move its produce over all roads linking its twenty stores (thus the major roads) at 15 CFA francs per ton per kilometer whenever it can assure a full fifteen-ton load; for smaller loads the price rises to about ten cents (25 CFA francs) per ton per kilometer for five tons.

Some of the major roads are little better than tracks. However, the price of transport over back roads is higher. This is reflected in the amounts that the ORDs must pay to contract with private truckers for the collection of agricultural products. The Koudougou ORD was criticized for estimating that the metric ton per kilometer cost of such transport was ten cents (25 CFA francs). However, that figure may be too low. The Banfora ORD pays a private trucker 20 cents (50 CFA francs per ton per kilometer) to visit each village and collect agricultural products. It is convinced that the operation would be more costly with its own trucks.

In an effort to improve the transport network and lower costs, the government is now studying the creation of a national transport company (TRANSVOLTA), which would be a mixed enterprise with participation of the government, the Transafricaine, and smaller truckers. If

properly organized and managed, such a company might reduce road transport costs. An improved program of road maintenance would also reduce costs.

Storage

A recent government survey of every silo, hangar, and warehouse in the country indicated a total capacity of 11,700 metric tons. Not all of these facilities are in good repair; the study also estimated that it would cost about $4,000 to fix up all but a few.

This capacity, of course, is for many things besides rice. The SOVOLCOM stores a few hundred tons of rice in the Sisalia factory in bags and rents bulk storage in Ouagadougou. It feels that efficient, modern storage facilities would help reduce its costs.

The Entente Fund is studying a project to stabilize staple food prices in the area by increasing storage capacity and stocks. It is not apparent that storage capacity is now a major bottleneck in rice production. A definitive judgement on the matter would require expert study. We do not know what the extent of losses during storage might be, but some insect damage could be seen at Sisalia. Some farmers fairly near markets store rice, usually as paddy, in mudbrick granaries or in their houses, selling it as they need cash.

Services

Research

Several stations are maintained by IRAT. One is at Kamoinse, near Ouagadougou, where pure seed stocks were formerly maintained. The same work is now done at Saria, also near Ouagadougou. A station also exists at Farako-Ba, near Bobo-Dioulasso, and another at Mogtedo, east of Ouagadougou, where work is being carried out on irrigated rice.

Most of the work is of a theoretical nature. There is not varietal development work. There are no crop rotation trials involving rice. A number of varieties have been studied in the past and their relative productivity is well known, but only under station conditions.

There are two French agronomists, one Swiss hydraulic engineer, and several local staff of the "conducteur" level. Staff varies from year to year. There is a noticeable lack of coordination between research and extension, even when the two are working in proximity.

IRAT has selected and recommends the following varieties:

1. Dissi 52/37: 140 days, originally from British Guiana, tillers well, tall (1.3-1.5 meters), resists variations in water level, shatters easily, productive (station trials of

up to six metric tons per hectare, with an average of about four metric tons per hectare).

2. Sintane Diofor: 120 days, Senegalese variety, valuable for regions with a short rainy season, short-strawed (rarely more than one meter), responds well to fertilizer, is relatively productive. Station yields have reached 3.5 metric tons per hectare with an average of about 2.6 metric tons per hectare.

3. Gamb'aka: 150 days, originally from Gambia, the most widely planted variety in Upper Volta, tall (1.2-1.3 meters), shatters easily, average station yields are 4.1 metric tons per hectare.

4. Fossa: 130 days, a rather special variety in that it will not tolerate flooding or dry soils. The water level must be just below the surface. It is very easy to hull by pounding in a mortar, and this characteristic is one of its chief advantages. It does not tolerate transplanting, it tillers poorly, it does not shatter, and it requires good soil.

The Taiwanese mission is apparently putting all its effort into propagating IR-8, since it performs better than the Formosan varieties. It has shown characteristics in Upper Volta similar to those reported for the Ivory Coast.

IRAT uses only nitrogen in its plots, and maintains that, though soils show analytically low levels of potassium, there is little yield response to applications of potassium. Phosphorous is regarded as being necessary, but IRAT has not yet formulated recommendations. It carries out no fertilizer trials.

Urea is the chief form of nitrogen available. Calcium bi-phosphate and potassium sulfate seem the only available forms of phosphorous and potassium.

Fertilizer is greatly needed. We saw deficiency symptoms, particularly of nitrogen, in all of the fields visited except those of the Taiwanese.

Herbicides for weed control are not being used or recommended. No trials on herbicides are being carried out.

Insects are recognized as being a serious problem, particularly in irrigated culture and with the newer, more productive varieties. Only the Taiwanese have a well-developed insecticide program. Even they are not sure which insects they are treating but, with broad-range insecticides, they seem to be preventing insect damage.

No research is being undertaken on insect control.

IRAT has no soil research program, nor indeed any laboratory facilities for one. This work is carried out by ORSTOM, but time did not allow a

visit to their facilities nor a discussion with their staff. There is a dearth of literature on the soils of Upper Volta.

There appears to be no work underway at present on the diseases and insects affecting rice. The Plant Protection Service is largely an administrative entity. There seems to be little or no coordination between this service and other agencies. The Director of IRAT, for example, did not know which insects were decimating his rice plots, nor did he know to whom to go for help.

Insects do seem a serious problem, particularly in the cultivation of improved varieties. There is no evidence of any research being carried out on these problems.

Extension

The density of coverage by extension workers varies widely between Upper Volta's regions, largely depending on whether the region's ORD is functioning yet or not. In agricultural areas, there seems to be one extension agent for from 3,000 to 6,000 of rural population. In many areas, rice is a very minor crop. Extension workers knew little about it and were concentrating on other things. In the Banfora ORD, however, where rice is more important, an energetic young Voltan had worked out a simple rice extension program for his agents. All of these agents were agricultural generalists.

About 300 farmers are receiving help from Taiwanese technicians, on whose projects they grow their rice. As previously mentioned, one SATEC technician and five agents help a lesser number of rice farmers at Mogtedo. The SATEC rice specialists would like to have the ORDs of Ouagadougou and Koudougou (those staffed by SATEC) designate a small number of extension agents for special training in rice. So far, he has not succeeded.

Extension efforts dealing with swamp culture, such as those in the Banfora ORD, are handicapped by the fact that research has not yet figured out a very reliable way of improving swamp culture.

At present, all government training of extension workers and supervisors is conducted at Matourkou, just south of Bobo-Dioulassa and adjacent to the rice mill and IRAT station. This school was started in 1963 and is supported by the Food and Agriculture Organization of the United Nations. Extension agents are recruited from primary school leavers (CEP) and given a nine-month course. The school is turning out sixty-six this year; its capacity is ninety. Supervisors are recruited from pupils who have had eight years of schooling (brevet) and given a four-year course, one year of which is spent working in a village. At present, the school is turning out about twenty supervisors per year. The training seems to be good and well organized, though possibly insufficiently practical.

SATEC and CFDT train most of their extension workers themselves. There are differences of opinion on the relative merits of their training and that of the Matourkou school. SATEC had given more thought to training in extension methods than anyone else we met in the region. SATEC trainees were learning about audio-visual techniques and about how to relate to villagers.

Extension agents get starting salaries of about 6,500 CFA francs per month ($312 per year) while in training, including an allowance for housing and a bicycle. Afterward, their average salary is 10,000 CFA francs per month ($480 per year) including allowances, and can go as high as 14,000 CFA francs per month ($672 per year). Supervisors, who become civil servants, start at about 15,000 CFA francs per month ($720 per year), including allowances for housing and a motorbike, and can work up to about 20,000 CFA francs per month ($960 per year). These salaries are high in rural Upper Volta.

Only a small portion of the training of agricultural agents is devoted to rice.

Upper Volta has a severely limited education budget and is far from able to accommodate its primary-school-aged population. Schools of rural education have been created with assistance from the European Development Fund to accommodate some of the many children who have had no chance to attend primary school. These train teenagers for four years in literacy and farm techniques. The course includes a lot of practical work. At least one such school is sending its pupils to learn rice growing from the Taiwanese at Louda.

The Director of Agriculture in the western region has recuperated facilities from an abandoned agricultural school at Dionkele to establish a two-year school for graduates of the rural-education schools. With an annual budget of $4,000, this school is providing training in rice-growing and animal traction. It is hoped that the graduates will take up rice farming on the Dionkele-Niena plain.

Suggestions for Improvement

Local needs

Because of its severe foreign trade deficit, Upper Volta ought to attach considerable priority to achieving at least self-sufficiency in rice.

Although no more than informed guesses are possible, it is probably that Voltan rice consumption is increasing at only about four percent per year, about double the rate of population increase. Since no economic growth is now taking place, the additional two percent is due to a limited amount of urbanization and secular switching from other staples to rice, but is not a response to rising incomes per head.

The completion of the Taiwanese project at Louda will bring eighty more hectares of irrigated rice into production next year; that of the Kou Valley project, 1,200 hectares by 1972. If one crop yielding four metric tons per hectare were grown on these lands, which seem likely, the output would nearly equal Upper Volta's present rice imports. A second crop of three and one-half metric tons per hectare harvested on these lands alone would about equal the increase in Upper Volta's demand between now and 1972, assuming a four percent annual growth in consumption and an increase in other local production parallel to the increase in population (two percent). Therefore, assuming that the Taiwanese projects are carried forward successfully, only a modest extension effort should be required to achieve self-sufficiency in rice by 1972. Imports between now and 1972 might be reduced if improved road maintenance, organization of transport, or support of higher farm prices for paddy produced a corresponding increase in traditional production. An increased extension effort ought to be able to produce the same results. After 1971, barring the initiation of additional, large irrigation projects for rice, increases in consumption would have to be met in this way.

1972 and after

Barring unforeseen developments, such as the acceleration of economic growth or a drop in the retail price of rice, Upper Volta's rice consumption needs should take care of themselves by 1972. But, what will happen after that, and ought Upper Volta to be thinking about rice exports?

In the southwest, Upper Volta has an abundance of land suitable for rice culture. Clearing represents no great expense. Though soils are poorly drained, they are otherwise excellent for rice production. A number of dams which are already built may have irrigation possibilities. Some local varieties are quite good, though IR-8 looks more promising if there are no problems of consumer acceptance.

On the other hand, rainfall is erratic enough to make swamp culture risky. Little research has been done on swamp culture, though yields may be doubled by weeding, timely and correct planting, and improved water control. Irrigation is expensive because cement is expensive, the evaporation rate is high, and valleys are flat. Finally, the rice farmer lives in an environment where production inputs are expensive and the market for paddy is uncertain. Rice production for market is less lucrative than in the Ivory Coast, for example. But, then, the Voltan farmer is poorer and does not have the profitable alternatives which his southern neighbors have.

After 1972, Upper Volta will probably have the same need for foreign exchange, and therefore, for rice self-sufficiency. How should production be expanded by four percent per year to keep up with internal demand or possibly by more to generate exports?

It is impossible to say, at this point, whether the country should concentrate on increasing production of swamp rice or of irrigated rice four years hence. Under present economic constraints, investment in irrigated rice land is not justified by the return (but, of course, foreign gifts should be welcome if it is that or nothing). However, it is possible that rice paddies might be developed more cheaply near existing dams or existing works such as Dionkele and Loumana.

Additional swamp land similar to that now used to grow swamp rice is available and accessible. Either better market incentives or better extension might generate a major increase in swamp production. Hopefully, by 1972, Upper Volta should begin to benefit from regional research efforts. We may know more about how to grow rice cheaply without complete water control.

Exports

Upper Volta's geographical situation precludes exports unless costs of production can be lowered. The nearest major export market to the Sisalia mill is Abidjan. At present, it costs six cents (15 CFA francs) per metric ton per kilometer to ship in bulk by rail from Bobo-Dioulasso to Abidjan. At this high rate, with the price of imported rice after paying the equalization tax at Abidjan at $194-8 per metric ton and transport costing $56 per metric ton, milled rice (twenty-five percent brokens) would have to leave Bobo at $138-42 per metric ton. At present milling rates and present prices at which the SOVOLCOM can sell the extra brokens and bran, the mill would have to be able to buy paddy at from $76.60 to $78.60. (See Appendix.) This is more than the present "official" price at the farm, but less than the $100 per metric tons which SOVOLCOM now pays for paddy delivered to Sisalia -- a price which creates so little interest among farmers that they deliver less than one-quarter of the mill's capacity. The mill would be exporting its milled rice at the price SOVOLCOM now gets for brokens. This also assumes that Ivory Coast would waive the equalization payments for Voltan rice, which it probably would no do if it attained self sufficiency.

The transport cost of getting Voltan rice to other West African markets is higher. Transport from Bobo to Monrovia would probably cost at least $70 per metric ton; to Dakar (whether via Abidjan and ship or Bamako and rail) from $80 to $90. To make such exports possible, local costs would have to be reduced accordingly. First, Voltan farmers have to supply local needs at existing cost possibilities. Then, relatively modest cost reductions might make Voltan rice competitive in neighboring markets, provided the latter would grant it the same protection they accord local rice, and that Volta rice would be of good enough quality to compete there. Such cost reductions might come 1) from lower rail-transport rates, 2) from delivery of more uniform paddy to the mill, hence higher out-turn of head rice, 3) from better operation of the mill, or 4) from willingness by the farmers to deliver more paddy at a lower price because of technical improvement.

Specific suggestions

1. A survey should be made as soon as possible of existing dams and water control works and their possibilities for irrigated rice production, with an eye to cost. Perhaps, the Taiwanese teams could undertake this task; their competence in the matter is undeniable. The Dionkele-Niena plain is already being investigated by Porter, International under contract with the Agency for International Development. No new and substantial effort should be undertaken to increase irrigated rice production prior to completion of such a survey.

2. The present agronomic research organization is inadequate to the country's needs, but it is the best the country can afford. Like the Ivory Coast, Upper Volta would benefit from the regionalization of research.

3. SATEC's efforts to expand rice production involve little cost. Most of them are now being expended in a region where little rice is grown. They should be extended to the rice area of the southwest. SATEC's experience and ingenuity in extension techniques might be incorporated into a regional rice extension, training program.

4. Upper Volta has no development interest in increasing consumption while there are rice imports. Therefore, the SOVOLCOM and the ORDs should charge enough to have their rice operations break even. If necessary, the tax on imports could be adjusted to prevent competition with the local product.

5. The town of Bobo-Dioulasso is in the middle of the rice-producing region. It has an agricultural training school, a small research station, a farmer-teacher training school, a disease research center, international air service, and will soon have a huge Taiwanese irrigated-rice project nearby. Upper Volta's needs do not justify development of the potentialities of this cluster for rice research and training; its budget will not permit it. However, within a regional context, the Bobo cluster could have possibilities.