Analysis of Rice Production in the Ivory Coast

Charles P. Humphreys
Food Research Institute
Stanford University

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INTRODUCTION

The Ivory Coast stands as an enviable example of successful agricultural development in Africa. In the decade between 1965 and 1975, production of industrial crops increased by 5 percent per year. Food output grew by 3-4 percent per year during the same period. The growth of food production was nearly double the growth of the rural population, and despite higher incomes and rapid urbanization, domestic food production reduced food imports for urban consumers by nearly one-half (20, p. 44). With an annual increase of more than 5 percent during this decade, the rice sector was one of the leaders in the growth of food output (6, p. 20). By 1975-76, the country had even achieved self-sufficiency in rice, due in significant measure to increased production.

Government policies have not only promoted this impressive growth but also changed the structure of Ivorian rice production, increasing the share of output supplied by improved seeds, fertilizers, irrigation, and mechanized techniques. These increased tonnages and the adoption of modern methods are often considered as testimony to the success of Ivorian rice policies (17, pp. 144-45). An evaluation of Ivorian rice policy, however, depends more on an analysis of the costs of production than on measuring growth rates. Unless rice output can be expanded at costs that are competitive with the imports it replaces and unless the new techniques lower costs of traditional production, policies to bring about these changes cause an inefficient allocation of national resources.

The purpose of this paper is to examine the efficiency of Ivorian rice production in order to evaluate rice policies of the government. The analysis relies on costs and returns that are fully disaggregated to the micro-level and estimated in both social and private prices.

A comparison of private and social profits reveals the impact of government policies on the incentives provided to farmers, merchants, and millers to grow, process, and distribute rice. By using social prices it is also possible to evaluate the relative efficiency of various methods of producing rice domestically. Finally, the gain or loss to the nation from various government programs can be estimated by aggregating social profits of different techniques. These welfare effects and transfers can be used to measure quantitatively the effects of government policies on its objectives. With these results it is possible to draw conclusions that can guide future government programs for the rice sector.

The rest of this paper is divided into seven sections. The next part describes the techniques of rice production, assembly, milling, and marketing. The subsequent section reviews the structure of government incentives affecting rice production. It is followed by a review of the methodology and important empirical assumptions used in the analysis. The empirical results are presented in the succeeding three sections. These results comprise a comparison of private and social costs, an examination of the sensitivity of the results to changes in assumptions, and an evaluation of the effectiveness of rice policies in advancing government objectives. The paper ends with conclusions drawn from the analysis.

DESCRIPTION OF TECHNIQUES

The techniques described in this section form the basis of the micro-economic analysis of the costs of rice production.[1] In the first part that follows, the production of paddy in the Ivory Coast is divided into several farm techniques, each having different technical coefficients. The subsequent three subsections present information that describes the major methods used to market paddy, mill rice, and distribute rice to consuming centers. The

various techniques of these four activities--production, marketing, milling, and distribution--can be combined to describe all the national production of rice in the Ivory Coast. Some of these combinations are discussed in the final subsection.

Production

In 1976, paddy production attained 425,500 metric tons (mt), down about 10 percent from the record harvest of the preceding year. On a national basis, yields averaged 1.2 mt/hectare (ha), although they varied from 0.9 to 4.0 mt/ha, depending on the method of farm production. Table 1 gives 1976 output estimates and other descriptive information for 20 farm production techniques. This broad range of techniques reflects the wide diversity of production possibilities in the Ivory Coast. To a large extent, this diversity results from the interplay of four major factors --climate, water control, mechanization, and the use of modern inputs. Table 1 shows how these four characteristics vary for the different techniques of farm production.

The Ivory Coast covers two major ecological zones (for details, see 7). The forest zone, extending over the southern half of the country, is favored by high rainfall (1,500-1,600 millimeters [mm] in the major rice areas) distributed over two seasons, the second season having lower and more erratic rainfall. About 65 percent of Ivorian paddy is produced in this region. The other half of the country is covered by savannah, which is characterized by lower and more variable rainfall (1,100-1,500 mm) occurring in only one rainy season. Traditionally, both yields and costs of farm production are lower in the northern, savannah region, as a result of poorer pluviosity, lower wages, and easier land clearing.

In the Ivory Coast, there are no indigenous water control systems and

Table 1.--Key Characteristics of Rice Production Techniques, 1976*

Production technique[a]		Harvested area 1976 (000ha)[b]	Paddy yield (mt/ha)[c]	Paddy production 1976 (000mt)	Type of water control	Rice crops per year	Land preparation	Harvest	Improved seeds	Fertilizer	Pesticides
Total		364.		425.5							
FOREST											
F1	Upland	221.7	1.12	248.95	rainfed	1	manual	manual	no	no	no
F2	Upland	4.615	2.0	9.23	rainfed	1	manual	manual	yes	yes	no
F3	Lowland	2.787	3.5	9.75	div. irr.[d]	1.3	manual	manual	yes	yes	yes
F4	Lowland	4.809	2.5	12.02	div. irr.	1.3	manual	manual	no	no	no
F5	Lowland	.603	3.5	2.11	div. irr.	1.3	power tiller	manual	yes	yes	yes
F9	Irrigated	1.469	2.75	4.04	d/p irr.[e]	1.85	tractor	combine	yes	yes	yes
SAVANNAH											
F10	Upland	107.3	.89	94.98	rainfed	1	manual	manual	no	no	no
F11	Upland	1.331	1.5	2.00	rainfed	1	manual	manual	yes	yes	no
F12	Upland	2.303	1.75	4.03	rainfed	1	ox	manual	yes	yes	no
F13	Upland	.162	1.0	.16	rainfed	1	ox	manual	no	no	no
F14	Upland	4.161	1.75	7.28	rainfed	1	tractor	combine	yes	yes	no
F15	Lowland	1.189	4.0	4.76	div. irr.	1.1	manual	manual	yes	yes	yes
F16	Lowland	3.873	2.4	9.30	div. irr.	1.1	manual	manual	no	no	no
F5A	Lowland	.293	4.0	1.17	div. irr.	1.1	tiller	manual	yes	yes	yes
F17	Irrigated	1.328	3.5	4.65	dam irr.	1.85	manual	manual	yes	yes	yes
F18	Irrigated	.779	2.5	1.95	dam irr.	1.85	manual	manual	no	no	no
F19	Irrigated	.160	2.75	0.44	pump irr.	1.85	tractor	combine	yes	yes	yes
F10A	Flooded	1.824	1.7	3.10	unimp. fl.[f]	1	manual	manual	no	no	no
F11A	Flooded	2.298	2.0	4.60	imp. fl.[g]	1	manual	manual	yes	yes	no
F14A	Flooded	.983	1.0	.98	imp. fl.	1	tractor	manual	yes	yes	no

*Total production figures are taken from Ivory Coast, government of, Ministère de l'Agriculture, Direction des Statistiques Rurales, Statistiques Agricoles, Abidjan, 1976. Breakdowns of areas and yields are estimated mainly from information in Ivory Coast, government of, Ministère de l'Agriculture, Compagnie Ivoirienne pour le Développement des Textiles (CIDT), Rapport Annuel 1975-1976; Rapport Général de Synthèse 1972-1976, Riz-Coton, Bouaké, May 1976, and Société pour le Développement de la Riziculture (SODERIZ), Rapport Annuel 1976, Abidjan, 1976. See also Charles P. Humphreys and Patricia L. Rader, "Background Data on the Ivorian Rice Economy," Stanford/WARDA Study of the Political Economy of Rice in West Africa, Food Research Institute, Stanford University, Stanford, June 1978.

Table 1. Footnotes

[a]The F designations refer to the numbering system used to identify production techniques in the analytical calculation. Estimates have not been calculated for the techniques whose F designation is followed by the letter A, but the technique indicated by the corresponding number, can serve as approximations.

[b]This is total cropped area, and therefore includes areas on which second crops are grown.

[c]The yields are estimates for 1976. Slightly different yields, considered more representative, are used in the analysis.

[d]"Div. irr." refers to improved lowland cultivation using diversion irrigation systems.

[e]"D/p irr." refers to irrigation using either dams or large pumps or a combination of the two.

[f]"Unimp. fl." refers to cultivation relying on natural flooding, mainly in the northwest.

[g]"Imp. fl." refers to cultivation relying on natural flooding, probably without land improvements, but using modern inputs. One-third may be plowed by oxen.

paddy production is primarily rainfed, mostly upland.[2] In 1976, upland production covered about 95 percent of the area in rice and contributed about 85 percent of national production. About two-thirds of the upland area is in the forest zone, which provides 70 percent of upland production Irrigated production has been emphasized since the mid-1960s, and investments depend on the government for initiative and financing. By 1976, over 17,000 ha of rice were harvested in irrigation schemes, adding almost 50,000 mt paddy to the national supply.

Three main types of irrigation have been tried in the Ivory Coast. The first and most prevalent is the lowland irrigation system which diverts water from small streams onto nearby bottom lands. These developments are small (10-15 ha), relatively inexpensive to build, rely heavily on farmer participation, and are widely dispersed. The two major disadvantages are that they do not provide complete water control, making double cropping rare, and they demand regular maintenance which farmers seldom provide. By 1976, nearly 19,000 ha had been developed under this system of irrigation, some of which has been converted to dam irrigation. About three-fifths is located in the savannah zone (6). Despite some possibilities for double cropping, only about 90 percent of the available area is actually harvested because of the large number of swamps that have been abandoned.

The second type of irrigation system relies on dams and storage reservoirs. The system is designed for large flood plains, generally exceeding 100 ha. The networks are constructed and managed by government agencies, financed primarily with foreign funds. Farmers contribute to the investment only by participating in the clearing, leveling and bunding, as they do in the smaller lowland irrigation systems. Although quite expensive to build (1.7 million CFA francs/ha),[3] the systems theoretically assure double

cropping, which is important in the savannah areas where they are mainly located (6). But because of insufficient water storage and porous soils, they often fail to provide year-round water security (21). By 1976, dam irrigation systems covered about 3,500 physical ha,[4] although data in Table 1 indicate that not all was in cultivation.

The third irrigation system uses water pumped from nearby rivers, sometimes in conjunction with dams. Large, diesel-powered pumps (650-700 cubic meters per hour (m^3/hr)) are employed to supplement rainfall. To date only three schemes exist, each fairly experimental and small. Together, they amounted to about 1,000 physical ha in 1976. In addition to being expensive to build and operate (the investment is 1.2 million CFA francs/ha), these systems have been plagued by highly variable river flows, porous soils, and extremely inefficient water delivery and use. Though a few farmers have experimented with small portable pumps (15-20 m^3/hr), there have been no government efforts to develop a small-scale technology.

The third distinguishing characteristic of rice production techniques is the source of power used for cultivation. Most rice, both rainfed and irrigated, is manually cultivated using short handled hoes (dabas). Of the several alternatives to annual cultivation, it appears that the most widely used are medium sized tractors (65 hp), sometimes with combine-harvesters. Nearly 7,000 ha are cultivated in this manner, almost exclusively on upland rice in the savannah zone. Tractor cultivation in this region dates from before independence, although it has been greatly expanded in recent years by mechanized land-clearing and tractor-hire services provided at subsidized rates by government agencies. The use of tractors on irrigated lands is limited to a few experimental projects and government seed farms.

The next most widely used alternative to manual cultivation is animal traction. Since the late 1960s in the savannah, the Compagnie Ivoirienne pour le Developpement des Textiles (CIDT), the state agency in charge of cotton production, has promoted oxen cultivation, which appears to be spreading rapidly for both cotton and cereal production. By 1976, oxen may have been used to cultivate as much as 2,500 ha of rice, both upland and lowland. This technique is largely precluded from the forest zone owing to infestations of trypanosomiasis.

The government has recently taken steps to introduce small-scale motorized equipment, primarily power tillers, on irrigated rice fields--mostly in the forest zone. Small, motorized drum-type threshers are also occasionally used. Efforts to introduce manually-operated machines, such as pedal threshers and crank winnowers, have met with little enthusiasm from farmers, largely because they offer no savings of labor time.

The last key characteristic of rice production techniques is the use of modern inputs, such as improved and treated seeds,[5] compound fertilizer, and urea. An insecticide (Furadan) is also used on improved irrigated rice against stem borers. Government programs that deliver these inputs provide an extension service to help assure that recommended practices are followed. The application rates for these inputs are tabulated below:

	Upland	Irrigated
Selected seeds (kg/ha)	60[6]	40
Compound fertilizer (10-18-18) (kg/ha)	150	150
Urea (46-0-0) (kg/ha)	75	75
Insecticide (kg/ha)	--	28
Extension (ha/agent)[7]	100	50

The only differences are between upland and irrigated rice. Recommended fertilizer applications, however, are constant, regardless of climate, water control, or type of mechanization. These modern inputs, provided mainly through government distribution programs, were used on nearly 25,000 ha in 1976, which produced over 50,000 mt paddy.

Of the several farm production techniques that make up Ivorian paddy production, only 9 will be examined in detail in this paper. These are the techniques that produce the bulk of paddy or that represent major alternatives to traditional production methods. They are summarized below:

F1 - Traditional upland, manual, forest

F10 - Traditional upland, manual, savannah

F2 - Upland, modern inputs, manual, forest

F11 - Upland, modern inputs, manual, savannah

F3 - Improved lowlands, modern inputs, manual, forest

F17 - Dam irrigation, modern inputs, manual, savannah

F12 - Upland, modern inputs, oxen, savannah

F14 - Upland, modern inputs, tractor, savannah

F5 - Improved lowlands, modern inputs, power tiller, forest.

Together these techniques account for over 90 percent of paddy production and over 70 percent of the modern inputs used. The important technical and economic coefficients for them are given in Table 2.

Traditional production (F1 and F10) is currently the predominant technique in the Ivory Coast. Normal yields in the forest zone are about 1.3 mt/ha reflecting higher and longer rainfall and the fact that rice comes at the beginning of rotations. In the savannah, they are 30 percent less or 0.9 mt/ha. Upland rice is usually planted only on freshly cleared forest or bush fallow in the forest zone, often in conjunction with the establishment

Table 2.--Technical and Economic Coefficients for Farm Production*[a]

(data are given per ha)

Production technique	Yields[b] (mt paddy)	Farm labor[c] (days)	Land development cost[b] (000 CFA francs)	Intermediate inputs[e] (000 CFA francs)	Extension service (000 CFA francs)	Mechanization cost (000 CFA francs)
F1 Traditional upland, manual, forest	1.3	126	13.5	3.9	0	0
F2 Upland, modern inputs, manual, forest	2.2	121	18	24.7	7.8	0
F3 Improved lowland, modern inputs, manual, forest	3.5	240	365	32.7	15.7	0
F4 Improved lowland, without modern inputs, manual, forest	2.4	209	365	3.3	0	0
F5 Improved lowland, modern inputs, power-tiller, forest	4.0	202	420	32.3	15.7	23.6
F9 Pump irrigation, modern inputs, tractor, forest	2.75	34	1,243	46.9	15.7	72.0[f]
F10 Traditional upland, manual, savannah	0.89	85	7	4.1	0	0
F11 Upland, modern inputs, manual, savannah	1.5	97	7	25.2	7.8	0
F12 Upland, modern inputs, oxen, savannah	1.8	90	12.7	25.2	7.8	7.7[g]
F13 Upland, modern inputs, tractor, savannah	2.0	30	130	25.2	7.8	43.1[f]
F15 Improved lowland, modern inputs, manual, savannah	3.5	237	365	33.3	15.7	0
F16 Improved lowland, without modern inputs, manual, savannah	2.4	206	365	3.3	0	0
F17 Dam irrigation, modern inputs, Manual, savannah	4.0	247	1,703	33.3	15.7	0
F18 Dam irrigation, without modern inputs, manual, savannah	2.7	211	1,703	3.3	0	0

Footnotes for Table 2.

*Data for these techniques appear in Charles P. Hymphreys, "Data on Costs of Ivorian Rice Production," Stanford/WARDA Study of the Political Economy of Rice in West Africa, Food Research Institute, Stanford University, Stanford, January 1979.

[a]All costs are in 1975 CFA francs and represent market delivery costs. Therefore, these costs include indirect taxes and subsidies incurred in the delivery of these inputs but exclude farm level subsidies or charges.

[b]Yields used to convert per hectare subsidies to paddy equivalents are different from those of 1976 shown in Table 1, but are considered more representative because 1976 was a drought year.

[c]Male and female labor days are considered equal in physical terms but each is valued at a different wage rate.

[d]This cost is equal to the initial investment.

[e]Intermediate inputs include seeds, fertilizers, insecticides, and herbicides. Working capital is not included.

[f]This figure includes the cost of mechanized harvesting.

[g]This cost represents the capital, repairs, and maintenance on oxen and equipment.

of tree crop plantations. In the savannah, crop rotations average four years of which rice may be two or more. Threshing times are somewhat higher in the forest as a result of the higher yields. In both regions, cultivation is usually the responsibility solely of women. Because of its land-extensive nature, continued expansion of traditional upland rice depends critically on the availability of forest or fallow land.

Improved upland rice production, while still wholly manual, benefits from modern inputs. The use of fertilizers and improved seeds results in increases in yields of 0.9 mt/ha in the forest and 0.6 mt/ha in the savannah. Cultivation techniques are similar to those used in traditional rice, except that land clearing, seeding, and weeding are more because of the use of improved production systems. Despite more intensive cultivation and higher yields, total labor times are only slightly higher than for traditional production, a result made possible by the use of sickles or harvesting. Probably owing to the use of commercial inputs, men are responsible for the bulk of the labor. Because this type of production is more prevalent and profitable in the forest zone than in the savannah, consideration is focused mainly on its use in the former (F2).

Two techniques are used to illustrate the two primary methods of water control--lowland swamps and dams. Production in both techniques is assumed to be entirely manual and to use modern inputs. Yields, averaging 3.5-4.0 mt/ha, are higher for dams because of better water control. The labor input--about three-fourths male--is 100-150 percent higher than on upland rice. These high labor times are the consequence of yearly land preparation, transplanting, careful weeding, irrigation control, and longer harvesting times needed for the higher yields. Although swamps have been developed in both the forest and the savannah, recent government investments have favored the forest zone, where this type of irrigation (F3) is most effective. The

use of dams (F17) is analyzed only for the savannah, where most have been constructed. Production in irrigation systems also occurs without fertilizers and other modern inputs, but these techniques are not viable in the long run.

Three techniques are used to illustrate the three primary mechanized alternatives to manual cultivation--power tillers, oxen, and tractors. All use modern inputs, but the type of water control and location vary. Power tillers (F5) are studied only in conjunction with lowland irrigation in the forest zone, where they are mainly used. Yields are estimated at 4.0 mt/ha, higher than under manual cultivation largely because better farmers are assumed to use power tillers. Compared to similar manual cultivation, the net labor savings amount to 38 days, all for land preparation. Oxen and tractors are analyzed only for upland rice in the savannah, since their use in the forest zone is negligible. Experience with oxen (F12) indicates that yields are 0.3 mt/ha higher than under manual cultivation, and labor savings--both for land preparation and transport--are estimated at only 7 days. Tractors (F14), along with combine harvesters, save two-thirds of the labor (67 days) required for manual cultivation. Every technique except weed control is mechanized, and deeper plowing facilitates that task. In addition, experience shows that yields are even higher than with oxen.

Paddy assembly

The post-harvest activities include the assembly of paddy, milling, and distribution to consumers, but only about 40 percent of paddy is marketed. Most production is hand-pounded or hulled locally and consumed by the producers. For this share of output, no assembly is necessary.

For the production that is sold, two marketing systems coexist--a

government network and a private channel. The state rice agency established some decentralized buying stations to which farmers themselves can deliver their paddy, and these are now maintained by the newly created Office de la Commercialisation des Produits Agricoles (OCPA). The government then assumes the responsibility for delivering the paddy to mills owned and operated by the state.

The private marketing system, however, furnishes the bulk of paddy delivered to government mills and all the marketed paddy that is processed in small-scale hullers. Hence, collection techniques in this analysis are based solely on the private channel, which operates through buying agents and a large private transport network. By most accounts, it is highly competitive and efficient (see 20, p. 44). In contrast to the government system that accepts paddy only at buying stations, private merchants purchase directly on the farms and assume responsibility for all aspects of paddy marketing.

The most important feature differentiating the different private collection techniques are distances between the farm and the merchant's entrepot and between entrepot and mill. For paddy delivered to government mills the distance between farms and entrepots is estimated at 15 km, and shipment from the warehouses to mills averages about 100 km. Despite the shorter distance between farm and warehouse, transport costs appear to be 50 percent greater for this stage of collection. For paddy delivered to small-scale hullers, only the initial bulking distance is included because these small mills are widely dispersed. In both marketing techniques, losses are assumed to be 3 percent of the paddy, and average storage periods are estimated at 1 month. Additional details are given in (3).

Milling

Paddy is converted into rice by three different processes in the Ivory Coast--hand-pounding, motorized steel cylinder hullers, and integrated industrial mills. Table 3 gives basic information about each milling technique, including potential capacity, utilization rates, milling outturns, and costs.

Rice consumed by producers and sold in village markets is usually hand-pounded by women in wooden mortars and pestles. Probably over half the rice produced is milled in this manner. The method has a high labor input and is competitive with mechanical milling only because there are no assembly and distribution costs and lower losses. Such rice may sometimes be parboiled, although the practice is not common.

Hand-pounding is being replaced by small-scale milling, especially near towns. The mills--manufactured in the Ivory Coast since 1968--employ steel cylinders and screens to separate the hulled rice from husks and bran. The mills are powered by either electric or diesel motors (11 hp), but the latter appear to be preferred. These mills are usually operated on a custom basis, with charges calculated per unit of output. Thus, there are no charges for bags, losses, or working capital. A few mills are, however, vertically integrated with assembly and distribution.

Mills are widely dispersed in rice-growing regions, reducing the distance over which paddy must be transported. As shown in Table 3, the private milling sector has an enormous capacity, in part because coffee hullers can be easily adapted to mill paddy. But because of high, subsidized prices paid at government mills since the price increases in 1974, as of 1976-77, these private mills have been relegated to milling for local own-consumption and to supplying local markets when government mills are unable to purchase

Table 3.--Key Characteristics of Rice Milling Techniques*

Milling technique	Projected full capacity (mt paddy/year)	Quality of output	Milling ratio	Rice milled (mt milled rice)	Unit cost (CFA francs/mt milled rice)[a]	Use of by-products
M1 Hand pounding, forest	158,000[b]	sometimes par-boiled; some-times red; often stones.	0.69	109,000	32,910	chicken feed
M2 Hand pounding, savannah	63,000[b]	sometimes par-boiled; some-times red; often stones.	0.65	41,000[c]	33,400	chicken feed
M3 Small scale steel hullers	650,000[d]	sometimes par-boiled; some-times red; often fresh.[e]	0.63	47,000[f]	5,000	usually none; sometimes for cooking fuel.
M3 Government in-dustrial mills.	157,000[g]	25-35% brokens; white only; not always fresh.	0.66	78,803[h]	13,961	brokens sold to breweries; flour sometimes sold for small animal feed; husks and bran are burned.

*This information is based on data from: Charles P. Humphreys and Patricia L. Rader, "Background Data on the Ivorian Rice Economy," Stanford/WARDA Study of the Political Economy of Rice in West Africa, Food Research Institute, Stanford University, Stanford, June 1978, and "Rice Economy of the Ivory Coast," Stanford/WARDA Study of the Political Economy of Rice in West Africa, Food Research Institute, Stanford University, Stanford, June 1978; and Ivory Coast, Government of, Ministère de l'Agriculture, Direction Générale du Développement Agricole, Direction des Statistiques Rurales, Recensement Agricole, Abidjan, September 1976, Société d'Assistance Technique pour la Modernisation de l'Agriculture en Cote d'Ivoire (SATMACI), Opération-Riz, "Budget Prévisionnel Rizeries," Gagnoa, n.d., and Société pour le Développement de la Riziculture (SODERIZ), "Compte d'Exploitation Prévisionnel 75-76-77," Abidjan, n.d., "Détail des Charges d'Exploitation Générale par Rizerie et par Kilo de Paddy Usiné sur la Période du 26-09-76 au 25-03-77," Gagnoa, 4 August 1977, "Etablissement d'un Bareme d'Usinage," Abidjan, 10 January 1977, Projet de Développement de la

Table 3 (Footnotes)

Riziculture des Bas-fonds en Zone Forestère - Addendum à l'Etude de Factibilité SODERIZ, Abidjan, n.d., and Personal Communication (Direction de l'Industrialisation), Abidjan and Gagnoa, 1977. See also Charles P. Humphreys, "Data on Costs of Ivorian Rice Production," Stanford/WARDA Study of the Political Economy of Rice in West Africa, Food Research Institute, Stanford University, Stanford, January 1979.

[a]Because the milling operations do not have identical cost categories, these unit costs are not strictly comparable. For example, working capital charges for paddy and rice stored between harvest and the time of consumption (an average of 6 months) are included in hand pounding because there are no assembly and distribution activities associated with this milling technique. For small-scale hullers, which are assumed to do custom milling only, no working capital on paddy and rice is charged, because merchants bear these costs. For the industrial mills, an average period of only 3 months is used for the calculation.

[b]Projected full capacity is assumed to equal rice milled in 1976. Real capacity is probably sufficient to mill most of the national production.

[c]This figure is calculated as the residual of total production in 1975 (465,000 mt paddy) minus seeds (about 24,000 mt paddy), the quantity assumed to have been milled by small-scale hullers (75,000 mt), and the amount of paddy purchased by government mills (148,000 mt). This residual is allocated to the forest and savannah according to the yields in Table 2 and land area in Table 1.

[d]Based on estimates of 1,500 operating units with a capacity of 0.2 mt of rice per hour, 10-hour days, 135 days of operation per year, and a milling out-turn of 63 percent. This capacity is never fully utilized.

[e]Rice hulled by small-scale mills is usually marketed soon after harvest. Compared to government rice, which may have had longer storage, this rice smells and tastes fresher.

[f]Based on estimates of 50,000 mt of paddy marketed and 25,000 mt of paddy custom milled for producers.

[g]This estimate is based on 11 months of operation at 500 hours/month, assuming 75 percent utilisation of installed theoretical capacity.

[h]This quantity was milled during SODERIZ's fiscal year--25 September 1975 to 25 September 1976 and includes 565 mt paddy milled at San Pedro. Less than 85% of the paddy purchased that year was milled.

paddy. As a result, capacity utilization may be less than 15 percent. Milling outturns are relatively low because of mixed varieties and the inadequacy of the adjustment mechanism. But the quality of the rice often exceeds that produced in government mills because the processing and marketing network associated with the private milling is shorter and faster, which enables fresher rice to reach consumers.

The large industrial mills are owned and operated by the government, although the state system still relies primarily on the private marketing and transport sector to deliver paddy and distribute milled rice. Presently, there are 10 installations, the largest having an average annual throughput of 15,000-20,000 mt paddy.[9] The mills--usually manufactured by Olmia--consist of dryers, cleaners, hullers, whitening cones, and sorters, all arranged in integrated units and powered by electric motors. Milled rice is packaged in 60 kg plastic fiber bags which are not reused. Losses are estimated at 3 percent, and average storage of paddy and rice may be as long as 3 months. Only fine and medium brokens are sold as by-products, mostly to breweries.

Construction of these mills was begun in the mid-1960s, but they have been utilized to a significant degree only after high government subsidies enabled them to compete successfully with the private milling sector. These mills acquired an estimated three-fourths of the paddy marketed in 1976. With the improvements installed in the 1970s, milling outturns steadily rose from the low levels of the 1960s and now exceed the milling ratio for steel cylinder hullers. As shown in Table 3, however, unit costs remain higher.

Rice distribution

The major difference among the techniques to distribute rice is the distance between the mill and the consuming center. No distribution is necessary for home consumption. Transportation charges are assumed to be negligible for consumption in villages within the producing areas, and the distribution consists only of handling and storage. For rice consumed in the major urban centers--Abidjan and Bouaké--the distances depend on whether rice is produced in the forest or the savannah zone, as indicated below:

Producing region	Consuming center	Estimated average distance (km)
Forest zone[a]	Abidjan	400
Savannah zone[b]	Abidjan	650
Forest zone[a]	Bouaké	250
Savannah zone[b]	Bouaké	300

[a]Distances are calculated from Daloa.

[b]Distances are calculated from Korhogo.

To both Abidjan and Bouaké, the distance from the forest zone is less than from the savannah zone. Bouaké, however, is closer to the producing regions than is Abidjan.

The distribution of rice from mills to wholesalers relies both on the government and on private merchants and transporters. The government does not own distribution facilities but arranges for rice to be shipped from state mills by private carriers and delivered to private wholesalers. In this way, the government rations shipments from state mills to assure an adequate supply of rice to Abidjan, reimburses private carriers who actually transport the rice for it, and assumes responsibility for storing rice in Abidjan, usually in private warehouses that it rents. The government

also bears the costs of storage, working capital, and losses; the latter are estimated at 2 percent.

Because the government subsidizes the shipment from its own mills, distribution by the private sector is largely limited to the rice--from both government mills and small hullers--that is consumed locally. The private sector techniques differ little from those supported by the government, although losses are assumed to be only 1 percent.

Combination of techniques

These four activities--production, assembly, milling, and distribution--are integrated in different ways to produce Ivorian rice. Traditional paddy production milled by the government and shipped to Abidjan is the most important combination, accounting for over a third of the rice marketed. Traditional production consumed locally accounts for a larger share of marketings than that shipped to Abidjan. For these local markets, small-scale millers and government mills are equally important. Improved production techniques are estimated to furnish less than one-fourth of paddy marketed, and most is probably milled by the government. Except for improved upland manual production and production from irrigated lowlands in the forest zone, however, no improved technique coupled with government milling provides more than 1 percent of rice marketed.[10]

GOVERNMENT POLICIES

Although the private returns from rice production are strongly dependent on the underlying technical coefficients summarized in the last section, economic policies of the government intervene to increase or decrease returns from the various techniques. The purpose of this section is to describe the Ivorian policies that are used to promote, or discourage, national rice production.

Government incentives can be classified into four policies -- trade control, domestic price support, subsidies (or taxes) on recurrent inputs, and investments financed from public funds. Trade control, by keeping domestic rice prices above import prices, increases returns to farmers and encourages production. Between 1960 and 1973, the nominal protection coefficient (NPC)--which is a measure of the incentive to domestic producers relative to imports--averaged 1.3, although at current domestic prices and expected long-run import prices, the NPC is only 1.13.[11] Trade policy has been maintained by restricting rice imports. Although official import duties on rice are usually suspended, import quotas have been set and allocated since 1955 by the Caisse Géneral de Péréquation des Prix des Produits et Marchandises de Grande Consommation (Caisse de Péréquation) and a cartel of the major private import-export firms. The premium generated by the import quota is now largely received by the government (see 7).

Since 1975, domestic price support for rice output has been much more important than trade control. By heavily subsidizing both milling and distribution costs, the government has been able to raise producer prices for the paddy it purchases without equivalent increases in consumer prices. Producer prices are officially established for the farm level, but

they are usually supported at the government mills and sometimes at government buying stations. In 1974, the following official buying prices were established (in CFA francs per kg paddy):

Farm level	65
Government buying station	70
Government mill	75

The price actually received by the farmers, however, depends on their location. For those who are isolated, actual prices received will be less than the official farm level price. Data presented in (3) suggest that at distances of only 35 km between the farm and government buying station (or merchant's entrepot), the farm price for paddy may be as low as 60 CFA francs/kg. Actual farm prices also depend on the ability of the government to purchase all the paddy delivered to state mills. Owing initially to inadequate storage and milling capacity and subsequently to the failure of the government to provide funds, state mills have been unable to purchase all paddy offered for sale, allowing a parallel market in paddy to operate.[12] Since the private channel for assembly, milling, and marketing does not benefit from government subsidies on milling and distribution, unofficial paddy prices are determined by the consumer price. Since 1975, this price has been effectively maintained by trade policy at the official level of 100 CFA francs per kg rice.[13] Hence, paddy prices in the parallel private market are no more than 50-55 CFA francs per kg, delivered to small rural markets in 1976-77 (9).

By subsidizing state milling and the distribution of rice through government channels, the government has artificially compressed the usual margin between the purchase price of paddy and the selling price of rice, creating a deficit as shown below (in CFA francs per kg rice):

Official cost of paddy[a]	114
Estimated cost of rice, delivered Abidjan[b]	136-138
Official selling price of rice to wholesalers	87
Approximate deficit	49-51

[a]This estimate is based on a purchase price of paddy at state mills of 75 CFA francs and a milling outturn of 0.66.

[b]This estimate is based on state milling costs of 14.5 CFA francs/kg rice and shipping costs of 7.4 and 9.4 from the forest and savannah zones, respectively (see 3).

In order to cover this deficit, the government treasury is obligated to pay to mills operated by state agencies a subsidy of 52 CFA francs per kg rice produced. In addition, it reimburses transport and other charges on rice shipped from these mills to Abidjan and Bouaké. This price policy was originally financed from taxes on rice imports, but more recently funds have come from taxes on exports of coffee and cocoa through the Caisse de Stabilisation et de Soutien des Prix des Productions Agricoles (CSSPPA). By 1976, most of the subsidies had not, in fact, been paid, and the state mills--already deeply in debt to the Banque Nationale du Dévéloppement Agricole (BNDA)--were unable to continue to finance their deficit buying operations.

The third type of government policy consists of subsidies on recurrent farm inputs. Since the early 1970s, the government has greatly increased its supply of modern inputs and services to farmers. Inputs like selected seeds, fertilizers, and insecticides--along with extension services and the maintenance of water delivery systems--are delivered as a package. Mechanization, except for animal traction, is delivered as a service. For oxen and implements, the government subsidizes the investment. In

return, the farmer is assessed a fixed fee for the input package or service, which is denominated in paddy and varies according to whether production is upland or irrigated:

	Kg paddy per ha	CFA francs[a] per ha
Modern inputs for upland rice	350	22,750
Modern inputs for irrigated rice	650	42,250
Power tiller-irrigated rice	262	17,000
Tractor and combine-harvester		
Upland rice	550	35,750
Irrigated rice	785	51,000
Pump irrigation	240	15,600

[a]These values are based on 65 CFA francs/kg paddy.

These fees cover only a portion of total costs, and every type of improved paddy production is subsidized to some extent through government programs to aid farmers.[14]

In Table 4, these input subsidies are presented in terms of various packages delivered by the government. Subsidies are calculated both per ha and per mt of output, and the subsidy rate is also given. Several conclusions can be drawn from this table. First, there is no significant difference in subsidy rates for modern inputs between the forest and savannah, but the level of subsidies per mt of output for upland rice is higher in the savannah. Second, both the level and rate of subsidies on modern inputs for upland rice are higher than for irrigated rice, reflecting the similarity of input packages for the two types of water control but lower yields on upland rice. With respect to tractor services, irrigated rice receives both higher levels and rates of subsidies than does upland rice. Finally, absolute subsidies per mt of paddy are much higher for large-scale than for small-scale mechanization.

Table 4.--Farm-level Subsidies on Inputs, 1975-76*

(in CFA francs unless otherwise indicated)

Input package	Total market cost of input package[a] (per ha)	Net farm level subsidy (per ha)	Net farm level subsidy (per mt paddy)	Net farm level subsidy (per mt rice)[e]	Subsidy rate (percent of total market cost)
Modern inputs, upland rice, forest[b,c]	37,129	14,379	6,536	9,903	39
Modern inputs, upland rice, savannah[b,c]	37,695	14,945	9,963	15,095	40
Modern inputs, irrigated rice, forest[b,d]	63,034	20,784	5,938	8,997	33
Modern inputs, irrigated rice, savannah[b,d]	63,119	20,870	5,938	8,997	33
Power tiller services, irrigated rice	24,170	6,580	1,645	2,492	28
Animal traction investment and maintenance, upland rice	9,165	1,885	1,047	1,586	21
Tractor and combine-harvester services, upland rice	43,600	7,950	3,975	6,023	18
Tractor and combine-harvester services, irrigated rice	72,929	21,929	7,974	12,082	30

*These figures are based on data in Charles P. Humphreys, "Data on Costs of Ivorian Rice Production," Stanford/WARDA Study of the Political Economy of Rice in West Africa, Food Research Institute, Stanford University, Stanford, January 1979.

[a]The market cost includes indirect taxes and subsidies incurred on the manufacture and distribution of these inputs.

[b]The values for modern inputs include a charge for working capital over 9 months, plus a 5-10 percent increase to account for exoneration from repayment in case of crop failures except where pump or dam irrigation provides full security. Mechanical services and pump irrigation charges carry an average working capital charge over 3 months, except for power tillers, where the charge is over 6 months.

[c]These modern inputs include seeds, fertilizer, and extension.

[d]These modern inputs include seeds, fertilizer, insecticides, extension, and maintenance of the irrigation canals.

[e]Conversion from paddy to rice is based on a 0.66 milling outturn.

The fourth type of government policy to provide incentives for paddy production is publicly-financed land development, usually made available to rice farmers free of charge. Through this investment policy the government has promoted irrigated production to a level where it accounts for about 10 percent of national production. This program has been extremely costly, and subsidy rates on investment costs have been much higher than those on recurrent inputs and services, as shown in Table 5. In all cases, subsidy rates exceed 50 percent. The most heavily subsidized land developments are the largest and most capital intensive production systems, both irrigated and upland. Absolute subsidies per mt paddy and subsidy rates are highest for systems with full water control.

In addition to these four instruments directed specifically at rice, several other policies affect private incentives to produce rice. These policies consist primarily of tariffs on imported inputs, domestic value-added taxes, and special credit programs. Agricultural equipment and modern inputs receive favored taxation treatment, with very low or zero tariffs and the lowest tax rate on value added. On the other hand, indirect inputs, such as fuel and transportation, are relatively heavily taxed. These indirect taxes reduce direct government subsidies at the farm level by 10-15 percent for improved production.

Low interest credit is provided through the BNDA for farmer working capital and investments and for the purchase of paddy and the distribution of rice by government agencies. Access is largely

restricted to approximately 15-20 percent of Ivorian farmers who also receive modern inputs from state agricultural agencies.[15] The majority of

Table 5.--Farm-level Subsidies on Land Development*

(in CFA francs unless otherwise indicated)

Land investment	Initial cost (per ha)	Total market cost per crop[a] (per ha)	Subsidy per crop (per ha)	Subsidy per crop (per mt paddy)	Subsidy rate (percent of total market cost)
Lowland irrigation, forest	365,000	35,800	22,645	6,470	63
Lowland irrigation, forest, suitable for power tillers	420,000	43,839	22,645	5,661	52
Lowland irrigation, savannah	365,000	42,309	26,762	7,646	63
Pump installation and irrigation network	1,243,000	79,627	79,627	28,955	100
Dams and irrigation network	1,703,000	85,633	77,313	19,328	90
Winch clearing, upland, savannah	12,744	3,785	2,804	1,558	74
Mechanized clearing, upland, savannah	130,000	28,398	23,398	11,699	82

*These figures are based on data presented in Charles P. Humphreys, "Data on Costs of Ivorian Rice Production," Stanford/WARDA Study of the Political Economy of Rice in West Africa, Food Research Institute, Stanford University, Stanford, January 1979.

[a]The market cost includes indirect taxes and subsidies incurred on the inputs used in these land developments.

[b]Subsidies are converted to a mt basis by using the yields in Table 2.

farmers finance their investments at traditional interest rates which are considerably higher than those offered by the BNDA.

The impact of the trade policy and direct subsidies on inputs and investments, as well as the effect of indirect taxes on inputs, is measured by the effective protection coefficient (EPC).[16] For paddy produced by improved techniques, milled by the government, and shipped to Abidjan for consumption, the EPC ranges from 1.17 to 1.29 (3, Table M4). Since the NPC is equal to only 1.13 under the same assumptions, these results show the importance of direct government subsidies on recurrent inputs and on investments to the rice sector.[17] These direct subsidies offset other indirect taxes and augment the incentive provided by trade protection. Moreover, domestic price support policies provide even stronger additional incentives.

METHODOLOGY AND MAJOR ASSUMPTIONS

The methodology is designed to measure the economic efficiency and comparative advantage of rice production. Production expenses are divided into categories--the taxes and subsidies stemming from government policies, and the real resource costs--

which allow results to be calculated in both social and private prices (15).[18] This measure of social efficiency, labeled net social profitability (NSP), equals the difference between the import value of a kg of rice and the cost of producing it domestically. Resource costs are divided into imported inputs valued at c.i.f. prices and primary factors--labor, capital, and land--valued at social opportunity costs Because the NSP equals the difference between value-added in world prices and opportunity costs to the economy of obtaining this value added, a negative NSP implies a lack of comparative advantage, or a loss of economic efficiency.

If efficient economic growth is an objective, activities with a larger NSP should be preferred. Since the magnitude of the NSP depends on the unit used, comparisons with activities other than rice production require a measure which is free of units. One such measure is the resource cost ratio (RCR), which equals the social opportunity cost of domestic primary factors divided by value added in world prices.

The impact of government policies can be assessed by estimating net private profitability (NPP) and comparing it with the NSP. In this methodology, private profitability is defined as the difference between the market value of output and the private cost of all inputs--including capital, where private prices include taxes and subsidies.

This method of analysis requires the critical assumption of fixed input-output coefficients, implying constant costs for each alternative. As a result, average and marginal costs are equal for each technique. Results are interpreted in a partial equilibrium framework. The measures of efficiency refer to marginal changes, and results may differ if changes in output are sufficiently large to alter the aggregate demand for domestic factors. In carrying out the calculations, technical coefficients have been used that are in accordance with normal, long-run conditions (see 3).

In addition to technical production coefficients, prices are needed to estimate social and private profitabilities. The remainder of this section discusses shadow prices for labor, capital, and land, the world price of rice, and private rice prices.

Shadow prices of domestic factors

Estimates of shadow prices--or social opportunity costs--depend on two

conditions (19). First, if there is no alternative use for the factor brought into rice production--that is, if it is not fully employed--its shadow price can be assumed equal to zero. This condition applies for land in the Ivory Coast. Second, if the factor markets function well and distortions caused by government intervention are minor, market prices offer good approximations to shadow prices. Shadow wage and interest rates in the Ivory Coast rely partly on this assumption.

Shadow wage rates for unskilled agricultural labor are based largely on market wage information for irrigated rice production in the forest zone (19). They are assumed to differ by ecological zone and by sex, as shown below (in CFA francs per day) (3):

	Forest zone	Savannah zone
Men	450	350
Women	350	275

In addition to actual cash wage payments, they include adjustments for meals, search costs, and supervision. Although wages vary by sex and region, there is virtually no evidence of seasonality.[19] These wages are consistent with returns to traditional food crop production for on-farm consumption, which establish a minimum value for wage rates in a land-abundant, agricultural economy. Wages for skilled labor vary according to skill level, and specific rates have not been estimated. However, it is assumed that for skilled labor, shadow wages also equal market wages.

In order to estimate comparative advantage for the future, it is important to evaluate whether these wages are likely to remain constant in years to come. The past growth of rural agricultural wages is difficult to evaluate, owing both to the lack of a reliable time series for wages and an appropriate income deflator. However, daily agricultural wages appear

to have increased faster than the consumer price index (13, 12, 11, 5, 6):

Year	African consumer price index, Abidjan	Daily agricultural wage		Growth of real GNP per capita
		CFA francs[a]	Index	
1960	100	100	100	100
1963	110	125-135	130	122
1976/77	236[b]	300-350[c]	325[c]	172[b]

[a]This value is only the cash portion of the wage.

[b]This is the index for 1976.

[c]These values refer mainly to 1977 and apply primarily to the Center West region in the forest zone.

The real growth in wages between 1963 and 1976 amounts to slightly less than half of the growth in real GNP per capita in the same period. If the past growth of the Ivorian economy continues in the future, it is probable that real wages will increase at an average rate exceeding 1 percent per year.

Shadow interest rates are more difficult to estimate because the capital markets are highly segmented into public funds, commercial bank loans, and traditional credit. In addition, selling and buying prices for traditional credit are widely divergent. This segmentation represents market imperfections--rationing of funds by foreign aid donors, limited absorptive capacity, externalities that reduce the cost of lending to farmers in public projects and to borrowers in the commercial sector, and the lack of information and high transaction costs in the traditional sector (19). Because these imperfections are likely to persist in the future, it is preferable to estimate the social value of capital in each segmented market, rather than to estimate an average interest rate for the economy, weighted by the share of capital from the different sources. It is assumed that the market interest rates that currently prevail in each market represent the shadow

interest rates when adjusted for expectations of inflation. In the traditional market, lower rates are assumed for self-financed, long-term investments by traditional farmers than for short-term borrowing from moneylenders. The difference reflects the high transactions costs in the traditional market, which are not relevant when capital is self-financed. This segmentation tends to increase the social price of capital in traditional rice production relative to improved production where cheaper government financing is available. These interest rates are the same for both forest and savannah zones and are summarized below in real annual percentage rates (3):

Government funds (loans to SODERIZ)	5
Agricultural development bank funds - (BNDA loans to farmers)	8
Investments by farmers using own funds (savings)	15
Short-term financing by farmers using borrowed funds (traditional credit)	25

Although unused land remains available in the Ivory Coast, a private market does exist--especially near urban areas and for developed agricultural land. As data from the Center West in the forest zone show, both land prices and rents can be significant (16):

Type of land and transaction	Private land cost (000 CFA francs/ha)
Sale of forest upland	15-25
Sale of forest improved lowlands	120-280
Rental of forest upland fields for food crops	5
Rental of improved lowlands	25-30

These costs have been used to estimate the following private land rents in rice production (in CFA francs/ha) (3):

Upland, modern inputs, forest	5,000
Improved lowlands, manual	11,845
Improved lowlands, power tillers	28,806
Dam irrigation	16,680

For irrigated land, the share of the investment contributed by the owner is excluded from the rent, since it is a capital charge .

Despite these positive private prices, the shadow price of land has been assumed to be zero because these rents probably reflect site value--the favorable location of the field relative to roads, villages and markets--rather than a scarcity of resources (19). Even including fallow land, probably no more than two-thirds of total arable was in farm production in 1975 (7, p. 5). The rate at which upland forest areas are being brought into production has been increasing, and projections indicate that all land may be in a production cycle by 1990 (7, note 63). Although undeveloped irrigable land is extensive, as much as 60,000 ha (7, p. 7), land for upland rice production may become scarce in the future. At such time, a positive shadow price would be warranted.

World price of rice

The world price of rice used in this analysis is assumed to be $300 per mt, c.i.f. Abidjan, or 75 CFA francs per kg rice. The figure is based on the following factors: an estimated long-run price of $350/mt for Thai 5 percent brokens, f.o.b. Bangkok in 1975 dollars (2); Ivorian imports of 25-35 percent brokens, priced about 30 percent below the Thai 5 percent brokens;[20] and an estimated transport cost of about $50/mt.[21] In order to compare imported with domestically produced rice, internal prices have been calculated from the $300 base figure. To obtain internal prices, costs are added to the c.i.f. Abidjan price to reflect the tradable inputs used to unload and transport imports to consumption

centers (or to consumers for on-farm consumption). These world price equivalents are summarized below in CFA francs/kg rice (3):

Consumption center	Price
Abidjan, c.i.f.	75.0
Abidjan, unloaded	75.1
Bouaké	77.7
Daloa (forest)	77.8
Korhogo (savannah)	78.3
Forest farms	79.8
Savannah farms	80.3

In order to simplify the analysis, four basing points for consumption have been chosen. The major consumption center is the port city of Abidjan. Consumption in the producing region of the forest is assumed to be centered around Daloa (400 km from Abidjan) and that in the savannah is assumed to be centered around Korhogo (650 km from Abidjan). The secondary, internal consumption center is Bouaké, lying roughly mid-way between Daloa and Korhogo and 375 km from Abidjan.

Private rice prices

Net private profitability depends on the private prices of both inputs and outputs. Since input prices are discussed above, this subsection focuses on rice prices in the domestic market. Several factors determine the choice of private rice prices selected for use in this analysis. First, private margins are assumed to reflect real operating costs because the private commercial sector can be considered competitive, in view of the extensive transport network, the considerably underutilized capacity in small hullers, and the large number of marketing agents. Second, the government usually defends the wholesale rice prices effectively, through its use of trade control and

the rationing and subsidization of domestic rice milled by state agencies. Third, the inability of the government to purchase all paddy offered for sale, except perhaps in 1975-76, has permitted merchants in the private market to collect and sell paddy to both government mills and private hullers. The price of paddy milled by the private sector will depend, of course, on the retail price of rice, while the government price of paddy will reflect its domestic price policy. These private prices are summarized in Table 6.

PRIVATE AND SOCIAL COSTS

In this section, results--in both private and social prices--are compared for several techniques of producing and processing rice in different regions. Private costs and profitabilities are discussed first, with particular focus on farm-level production. That subsection is followed by an examination of social costs and profits. The final part compares the two sets of results.

Results in private prices

Farm costs.--At the farm level, paddy production is uniformly cheaper in the savannah, as shown in Table 7. For similar production techniques, private costs are 4-9 CFA francs/kg paddy cheaper in the savannah, or 10-20 percent of total costs. The largest divergence, between improved lowlands in the forest (F3) and upland oxen cultivation in the savannah (F12), amounts to 16 CFA francs. These differences occur despite higher yields in the forest zone because significantly lower wages assumed for the northern area make total costs per kg paddy less than in the forest zone. Labor-saving techniques used on irrigated paddy production in the forest zone do not lower private costs sufficiently to make it competitive with production in the savannah.

Table 6.--Private Prices, 1976*

Marketing stage	On-farm, hand-pounding	Small-scale hullers	Far from government mills	Close to government mills
Farm price (CFA francs/kg paddy)[a]	52	50	60	65
Mill purchase price (CFA francs/kg paddy)	52[b]	59	75	75
Mill selling price (CFA francs/kg rice)	103	99	87[c]	87[c]
Equivalent wholesale buying price (CFA francs/kg rice)	103	100/104[d]	87[e]	87[e]

*Available price data are taken from Charles P. Humphreys and Patricia L. Rader, "Background Data on the Ivorian Rice Economy," Stanford/WARDA Study of the Political Economy of Rice in West Africa, Food Research Institute, Stanford University, Stanford, June 1978, p. 15, or Humphreys, Field observations, Abidjan, Bouaké, Gagnoa, and Man, 1976-77. Margins used to estimate prices not observed are based on cost data in Humphreys, "Data on Ivorian Rice Production," Stanford/WARDA Study of the Political Economy of Rice in West Africa, Food Research Institute, Stanford University, Stanford, January 1979.

[a]The low price refers to isolated farmers (50 or more km from government mills). The higher price refers to farmers close enough to receive the official government price. Buyers paying the higher price are assumed to sell to government mills. Prices in this range have been reported by Ivory Coast, Government of, Ministère de l'Agriculture, Direction des Statistiques Rurales, Commercialisation des Produits Agricoles, Abidjan, monthly. For example, during 1976, the average paddy price in small markets was 53 CFA francs per kg.

[b]The collect and distribution activities are non-existent for hand-pounding.

[c]Government milling costs are subsidized.

[d]The price of 104 implies a retail price of local rice of about 110 CFA francs/kg, which is actually observed in the markets. A price of 100 is used for rice custom-hulled rice for producers' home consumption, which is a price consistent with retail selling prices.

[e]The distribution cost (mainly transport to Abidjan) is fully subsidized by the Caisse Générale de Péréquation des Prix des Produits et Merchandises de Grande Consommation.

Table 7.--Farm Production Costs

(000 CFA francs, unless otherwise indicated)

Type of paddy production	Private costs			Social costs		
	Per mt paddy	Per mt rice[a]	Rank	Per mt paddy	Per mt rice[a]	Rank
F1 Traditional upland, manual, forest	47.3	71.7	8	47.1	71.4	5
F2 Upland, modern inputs, manual, forest	41.7	63.2	6	45.1	68.3	3
F3 Improved lowland, modern inputs, manual, forest	50.4	76.4	10	57.6	87.3	9
F5 Improved lowland, modern inputs, power tiller, forest	49.1	74.4	9	52.0	78.8	7
F9 Pump irrigation, modern inputs, tractor, forest	45.5	68.9	7	83.1	125.9	10
F10 Traditional upland, manual, savannah	38.5	58.3	4	38.4	58.2	1
F11 Upland, modern inputs, manual, savannah	37.8	57.3	3	46.6	70.6	4
F12 Upland, modern inputs, oxen, savannah	34.2	51.8	1	42.5	64.4	2
F14 Upland, modern inputs, tractor, savannah	35.0	53.0	2	50.4	76.4	6
F17 Dam irrigation, modern inputs, manual, savannah	39.7	60.2	5	56.2	85.2	8

[a]Paddy is converted to rice at the rate of 0.66.

In all cases, the private cost of producing paddy with upland techniques is uniformly cheaper than with irrigation. The divergence is greatest in the forest, where upland yields are highest; it costs farmers almost 9 CFA francs more to grow a kg of paddy in improved lowlands (F3), compared to upland cultivation (F2). Irrigation is, of course, more attractive in the drier savannah. Dam irrigation (F17), which allows double cropping[22] and high yields, is only slightly more expensive than manual, upland alternatives.

The use of modern inputs--mainly seeds and fertilizers--also lowers production costs slightly, depending on the concomitant increase in yields. Because of favorable climatic conditions, yields increase the most in the forest. As a result, private costs fall by almost 6 CFA francs/kg paddy or over 10 percent. In the savannah, where the inputs raise yields less, cost of reductions are negligible.

Production techniques that employ labor-saving mechanization are much more attractive in the savannah, despite the lower wages that prevail in that region. The least costly techniques in the savannah use oxen (F12) and tractors (F14), although cost savings are only about 10 percent. The use of power tillers in the forest zone lowers costs only slightly less and contributes little to make lowland production, which is labor intensive, competitive with upland production.

Post-harvest costs.--The private costs of the relevant post-harvest techniques are given in Table 8. Since these private costs include government subsidies, they mask the relatively high market cost of government milling and of distribution to Abidjan. Compared to small mills, a large proportion of these high costs is caused by the use of disposable plastic rice bags, higher losses, and longer storage periods. By substantially eliminating seasonal price fluctuations, government price policy has made paddy storage unattractive to private millers and merchants. Storage must

Table 8.--Post Harvest Costs[a]

(000 CFA francs per mt rice)

Marketing or milling activity	Market costs	Private costs	Social costs
Assembly to small hullers	13.5	13.5	12.3
Assembly to government mills	15.7	15.7	14.1
Milling by hand pounding - forest	30.1	30.1	30.1
- savannah	30.4	30.4	30.4
Milling by small-scale steel cylinder hullers	4.8	4.8	4.0
Milling by government industrial mills	14.5	-38.2	13.2
Village distribution - in forest and savannah	2.1	2.1[b]	2.1[b]
Government shipment to Bouaké - from forest	5.6	0.0[b]	5.6[b]
- from savannah	6.3	0.0[b]	6.0[b]
Government shipment to Abidjan - from forest	7.4	0.0[b]	6.9[b]
- from savannah	9.4	0.0[b]	8.6[b]

[a]Market costs include indirect taxes and subsidies incurred on the distribution and manufacture of inputs used in the techniques. Private costs include market costs plus government transfers made directly to the merchant or miller. Social costs exclude all taxes and subsidies and value all resources in opportunity costs.

[b]Savings in domestic resources would result if domestic production replaced imports. These savings occur because it would no longer be necessary to use domestic resources distribute the imports. In calculating social costs and profits for the activity as a whole, rather than for individual merchants, these savings would be included, thereby increasing social profitability. The savings amount to:

Village distribution	- forest	5.0
	- savannah	6.1
Shipment to Bouaké	- from forest and savannah	4.7
Shipment to Abidjan	- from forest and savannah	1.2

now be carried out by state agencies. In addition, the official selling price for rice is 27 CFA francs less than the official purchase price of paddy in rice equivalent. However, mills are subsidized by the government at a rate which more than offsets the elevated operating costs and losses caused by the official price structure. As a result, private costs are negative for government mills.

Distribution costs are basically a function of distance, but there are other differences. Costs in market prices for the private sector are lower than those in the distribution of rice from publicly owned mills primarily because losses are assumed to be only half as great. However, since the official price of rice ex-mill is the same as the official wholesale buying price, costs of government distribution are fully reimbursed by the Caisse de Péréquation. This policy reduces to zero the total private cost of rice processed in government channels. To some extent, private merchants overcome the disadvantage caused by subsidies to government mills by producing a higher quality rice which can be sold at a premium above the rice milled by the government.

Private profitability.--Table 9 gives profitability results for nine farm production techniques, combined with alternative milling techniques and marketing destinations. In all cases, net private profitability is positive, although it is very low for improved forest production that is privately hulled for village consumption. The most profitable methods for producing rice rely on oxen and tractors--as well as government milling--while the least profitable technique involves traditional upland production in the forest milled by small hullers.

Private costs are also less for rice from the savannah than from the

Table 9.--Indicators of Private and Social Profitability for Ivorian Rice Production[a]

(CFA francs/kg milled rice, unless otherwise indicated)

Description of rice production, milling, and consumption	Private cost[b]	Social cost[b]	NPP	NSP	Effective protection coefficient	Resource cost ratio
Hand pounded, farm consumption						
-traditional upland, forest	82.2	82.0	20.4	- 2.1	1.284	1.026
-traditional upland, savannah	72.1	71.9	30.5	8.5	1.276	0.895
Small hullers, village consumption						
-traditional upland, forest	91.0	88.7	8.0	-11.0	1.264	1.144
-traditional upland, savannah	75.9	73.7	23.1	4.5	1.256	0.941
Government mills, Bouaké						
-traditional upland, forest	44.6	99.5	42.4	-21.8	1.112	1.307
-traditional upland, savannah	31.7	87.1	55.3	- 9.4	1.114	1.133
Government mills, Abidjan						
-traditional upland, forest	48.1	104.4	38.9	-29.2	1.160	1.429
-traditional upland, savannah	34.8	92.7	53.2	-17.6	1.169	1.260
-upland, manual, modern inputs, forest	39.7	101.2	47.3	-26.1	1.235	1.433
-upland, manual, modern inputs, savannah	33.7	105.1	53.3	-30.0	1.289	1.531
-improved lowland, manual, modern inputs, forest	56.6	118.8	30.4	-43.7	1.160	1.641
-dams, manual, modern inputs, savannah	36.6	119.7	50.4	-44.6	1.219	1.736
-improved lowland, tiller, modern inputs, forest	50.9	111.6	36.1	-36.5	1.216	1.608
-upland, oxen, modern inputs, savannah	28.2	99.0	58.8	-23.8	1.265	1.412
-upland, tractor, modern inputs, savannah	29.5	110.9	57.4	-35.8	1.263	1.670

[a]Private costs include all taxes and subsidies; social costs both exclude taxes and subsidies and are based on the social opportunity cost of primary domestic factors. Net private profitability (NPP) equals gross revenue minus all input costs, at market prices. In calculating private profitability, domestic factor costs associated with rice imports have been subtracted from the costs of the distribution activity. Thus private profitability, as defined here, measures the net private returns to the sector as a whole as a result of import substitution. This profit will be larger than that derived directly from the budgets. Net social profitability (NSP) equals the price of imported rice minus all costs, evaluated at either world prices in the case of imports or social opportunity costs in the case of primary domestic factors. The effective protection coefficient is defined as the ratio of value added at domestic market prices to value added at world prices. The resource cost ratio equals the sum of all domestic factor costs, valued at social

Footnotes for Table 9 (continued)

opportunity costs, over value added at world prices. For a more complete explanation of these consepts, see John M. Page, Jr. and J. Dirck Stryker, "Comparative Costs and Incentives in West African Rice - and Introduction," Stanford/ WARDA Study of the Political Economy of Rice in West Africa, Food Research Institute, Stanford University, June 1978.

[b]Because the savings of domestic resources that occurs when imported rice is no longer distributed are deducted from the costs in this table, these figures are not simply the sum of costs in Tables 7 and 8.

forest. The differences between the two regions tend to be largest for rice based on traditional production, amounting to about 15 CFA francs per kg of rice. For rice from improved upland production, however, the difference falls to only 6 CFA francs, indicating that government subsidies for modern inputs decrease the private cost advantage of the savannah zone relative to the forest.

Private profitability for rice processed in government mills is clearly highest, often more than double the profitability in the small-scale sector. This result occurs because of the high government support price for paddy maintained by direct subsidies to government milling and distribution. As a consequence of these subsidies, the private cost of rice processed in state-operated mills is as much as 40 CFA francs lower than that incurred in the sector using small-scale hullers. The difference in private profitabilities is less than the difference in costs because the small-scale sector is able to sell its rice at a premium above government rice. As a result of these subsidies, the profitability of government milling and shipment to Abidjan is about 20 CFA francs/kg rice higher than hand-pounding for home consumption and about 30 CFA francs higher than milling by small hullers for village consumption. Government transfers are high enough to offset the lower quality of government rice, the higher assembly and milling costs, and the higher cost of shipment to Abidjan.

Results in Social Prices

Farm costs.--The social costs of farm paddy production are about 40-80 CFA francs per kg of paddy, but most techniques have social costs in the range of 45-55 CFA francs. The cheapest paddy is produced traditionally in the savannah, while the most expensive relies on irrigation and modern inputs.

The gap is almost 20 CFA francs, or a 50 percent cost increase.

In general, for the same type of production, costs are lower in the savannah than in the forest, although the differences between the two regions are less in social than in private costs. For traditional upland, costs in the forest are over 20 percent higher than in the savannah. The introduction of new techniques by the government also tends to diminish the cost advantage of the savannah. Within the same ecological zone, traditional techniques have lower social costs than those that use selected seeds, fertilizers, insecticides, and extension. The only exception is upland forest production using modern inputs, which has slightly lower social costs than traditional production. In this case, costs per mt fall because modern inputs appear to increase yields sufficiently to offset the additional costs per ha.

All upland techniques have lower social costs than the irrigated techniques, regardless of climate, inputs, or mechanization. The difference often exceeds 10 CFA francs, or 20 percent of production costs. Even in the more arid savannah, the higher yields with water control are insufficient to offset the high costs of investment and operation.

The use of modern inputs appears to reduce social costs only in the forest zone, and there the gain is only 2 CFA francs/kg paddy. In the savannah, modern inputs actually increase social costs per kg paddy, because the increase in yields is not sufficient to compensate for the high input costs per ha. The government input package is too expensive, given possibilities for upland production in the savannah. The use of irrigation in the savannah, which does raise yields, increases social costs more.

Results for labor-saving techniques vary. The use of power tillers on improved forest lowlands lowers social costs by over 5 CFA francs.[23] The use of oxen on savannah uplands with modern inputs also lowers social

costs by over 4 CFA francs.[24] This method of farm production is the least costly of all techniques except traditional savannah production. In both cases, the gain is due both to the increase in yields and to savings of high wage labor.

Unlike small-scale mechanization, the use of tractors increases social costs. Large-scale mechanization on savannah uplands, despite higher yields than the manual technique, remains the most costly of all upland techniques. Tractor cultivation on forest lowlands irrigated by pumps (F9--the Yabra experiment) has resulted in lower yields and is extremely costly--nearly double the cost of oxen cultivation. Even if yields could be raised to the levels in manual production, the mechanized technique at Yabra remains 30-50 percent more costly than manual irrigated production. Therefore, coupled either with expensive irrigation systems or with costly mechanical land clearing, the use of tractors and harvesters has been ineffective in lowering social costs. The use of large-scale mechanization has merely substituted more costly capital and imported inputs for labor, and hence social profitability has fallen.

Post-harvest costs.--The social costs of assembly, milling, and marketing are given in Table 8 (p. 28a). The most striking aspect of these costs is the variation in the social costs of milling--ranging from 4 CFA francs/kg rice to over 30 for hand-pounding. But because milling costs vary in part because of differences in the related techniques of paddy assembly and rice distribution, comparisons are best made with the sum of post-harvest costs. These are given below for the forest zone (in CFA francs/kg rice).

Hand-pounding, farms	30.1
Small-scale hullers, villages	18.4
Government mills, Bouaké	32.9
Government mills, Abidjan	34.2

Despite savings in assembly and distribution, hand-pounding is extremely costly in social, as well as p ivate, prices. The high costs exist mainly because of the large input of labor and the high interest charged on traditional capital tied up in on-farm storage of paddy. Compared to small hullers, there is also a substantial premium on government milling and marketing, amounting to more than 10 CFA francs/kg rice.[25] Finally, it costs almost 2 CFA francs/kg more to ship rice from the savannah than from the forest.

Social profitability.--Only two of the Ivorian rice-producing activities have positive net social profitability. These two techniques--on-farm and village consumption of traditional savannah upland production--account for less than 20 percent of national paddy output. However, other activities--of which the most important is hand-pounded traditional production on forest uplands--have a slightly negative NSP (greater than a minus 10 CFA francs per kg rice), and these produce about 40 percent of domestic output. The remainder, about two-fifths of domestic rice production, clearly causes the inefficient use of national resources. All of the activities involving government milling and distribution have significant negative net social profitability. These unfavorable results occur because the social cost of government mills is significantly higher than that of small-scale mills and because rice in the government distribution channel is stored longer, incurs greater losses, and is transported over greater distances.[26]

Because the world price of imported rice increases with the distance from the port, production and consumption that is located farther inland will be more profitable in social prices. Hence, production and consumption in the savannah is favored relative to that in the forest, which is closer to Abidjan. It also means that small-scale hullers, which produce for local

consumption, have a higher NSP than government mills, which ship rice to Bouaké and Abidjan where consumers are closer to the port. But these differences in the degree of natural protection can explain only a small share--no more than about 5 CFA francs--of the variation in NSP.

Divergences between Private and Social Costs

A comparison of private and social costs helps illuminate the impact of present government interventions in the rice sector. The ranking of farm production by private and social costs changes considerably as shown in Table 7 (p. 27b). In particular, government programs have made dam irrigation and the use of tractors relatively more attractive to farmers. Conversely, traditional production in both regions, improved upland in the forest, and the use of power tillers have received relatively little or no encouragement from government policies. Sources of these divergences between net social and private profitabilities are illustrated in Table 10 for paddy purchased and milled by the government and shipped to Abidjan. Divergences are greatest when farm production is combined with these post-harvest techniques.

The average increase in the NPP over the NSP for 7 production activities using modern inputs is about 83 CFA francs/kg rice.[27] Assuming the output is processed through the government channel, the subsidy paid to the milling sector--that is, the domestic price support policy--is the most important source. It represents over 60 percent of the total divergence. Subsidies given to farmers for modern inputs and land development are second in importance, but they average only 17 CFA francs/kg rice, or one-fifth of the total. The third most important source of the divergence is the increase in the domestic price caused by trade control. By restricting imports, the government causes 12 CFA francs to be shifted from consumers to producers for every kg of rice grown and marketed. The other major cause of the increase

Table 10.--Explanation of Divergence Between Social and Private Profitability for Production Milled by the Government and Shipped to Abidjan

(000 CFA francs per mt rice)

Farm production technique	Divergence between net social and private profitabilities		Trade effect[a]	Social minus private factor price[b]	Net subsidies[c]			
	Value	Rank			Farm	Assembly	Milling	Distribution
F1 Traditional upland, manual, forest	68.1	10	11.9	- 0.3	- 0.2	-1.6	51.4	6.9
F2 Upland, modern inputs, manual, forest	73.4	7	11.9	- 3.9	8.7	-1.6	51.4	6.9
F3 Improved lowland, modern inputs, manual, forest	79.1	6	11.9	- 5.6	16.1	-1.6	51.4	6.9
F5 Improved lowland, modern inputs, power tiller, forest	72.6	8	11.9	-11.4	15.4	-1.6	51.4	6.9
F9 Pump irrigation, modern inputs, tractor, forest	125.2	1	11.9	- 0.8	57.4	-1.6	51.4	6.9
F10 Traditional upland, manual, savannah	69.8	9	11.9	- 0.3	- 0.2	-1.6	51.4	8.6
F11 Upland, modern inputs, manual, savannah	83.3	4	11.9	- 0.6	13.6	-1.6	51.4	8.6
F12 Upland, modern inputs, oxen, savannah	82.6	5	11.9	- 0.5	13.0	-1.6	51.4	8.6
F14 Upland, modern inputs, tractor, savannah	93.3	3	11.9	- 0.5	23.6	-1.6	51.4	8.6
F17 Dam irrigation, modern inputs, manual, savannah	95.0	2	11.9	- 6.8	31.5	-1.6	51.4	8.6

[a]The trade effect equals the domestic minus the relevant import price. The domestic price used here is 87 CFA francs per kg and the import price is 75.12.

[b]These figures measure the effect of shadow prices. A negative sign indicates that private factor prices exceed social values.

[c]A plus sign denotes a subsidy, a negative sign a tax.

in NPP shown in Table 10 is the subsidy on government shipments of rice to Abidjan. The subsidy amounts to 7-9 CFA francs and results directly from the rationing required by the policy to equaliz domestic rice prices in all markets. Unlike the other divergences that increase the NPP by a constant amount, farm level subsidies vary widely--depending on the type of production--from less than 9 to more than 30 CFA francs per kg rice.

Two sources of divergence reduce the net subsidies of the other policies. The assembly activity is slightly taxed, a result caused by indirect taxes on transportation. Land rents, which are viewed here as a private but not a social cost, also reduce the divergence between social and private profits. They are important only for the irrigated techniques.

Apart from the project at Yabra (F9), which is an experiment with pump irrigation and large-scale mechanized production, the largest divergences exist for mechanized cultivation on savannah uplands and for dam irrigation in the north. Other than transfers to the milling sector, subsidies given directly to farmers constitute the bulk of these large divergences. The smallest divergences are for traditional production. Those that do exist stem almost entirely from trade protection and from subsidies to the milling and distribution activities, not from subsidies to farmers.

For improved production, divergences are consistently larger in the savannah than in the forest for similar techniques.[28] Three factors explain why government policies favor the northern region. First, the policy of equal producer prices throughout the country means that rice from the savannah must be more heavily subsidized to reach Abidjan. Second, although the government input package actually costs slightly more in the savannah than in the forest, yields are lower in the savannah, which increases the value of input subsidies per kg of rice produced by 50 percent compared to the forest.

Third, investment in dams in the savannah is more costly than irrigation in the forest. The heavy subsidization of these dams makes this type of irrigated production privately but not socially profitable.

These divergences in profitability change only slightly if different assembly techniques are used. Small-scale milling is taxed (0.8 CFA francs per kg rice) rather than subsidized, which elimates a substantial share of the total divergence. Nongovernment distribution is also taxed, depending on the distance. For rice that is not milled and distributed by state agencies, therefore, the government's major influence on the divergence is through the trade effect and subsidies on farm inputs.

The trade effect depends on the relevant import price--which is lowest at the port, and on the domestic price--which is greater for on-farm consumption and for hulled rice that sells at a premium. The trade effect is thus considerably more important for the private than for the public milling and distribution sector, because of the higher natural protection earned through home consumption and the ability of private merchants to sell local rice at a premium over imports. For rice consumed on the farm and for locally hulled rice sold in villages, the effect is roughly twice as great as that shown in Table 10.[29]

It is clear from the results that a major portion of rice grown in the Ivory Coast has negative social profits. Production occurs, especially with nontraditional farm techniques and with government milling, only because government policies cause private profits to exceed social profits. If social costs are taken as a guide to the techniques that should be encouraged, government interventions have had the opposite effect. The more costly farm production techniques receive the greatest subsidies, and the least costly receive the smallest. As a result, the most

inefficient techniques are most strongly encouraged.[30]

Government policies that give strong incentives to rice production can be evaluated by comparing these efficiency results with those of other agricultural crops. The comparisons must be made by using the RCR because of differences in units. Using a slightly different methodology, Stryker obtained the following coefficients for major agricultural activities (18):[31]

Crop	Resource cost ratio
Coconuts	0.4
Cocoa and pineapples	0.45
Coffee and oil palm	0.5
Maize, cotton, and peanuts	0.8-1.0
Rice, savannah	1.5-2.5
Rice, forest	2.0-2.5

Clearly, tree crops, fruits, oil crops, fibers, and other cereals are a more efficient use of domestic resources than is rice, even in the savannah. For other food crops, coefficients are subject to greater uncertainty owing to the lack of reliable technical and economic data. But preliminary estimates suggest that production of both cassava and banana plantains are more efficient than rice production in providing calories to substitute for rice imports. On the other hand, yams appear to be no more efficient than is rice.[32]

In order for rice to compete efficiently with these alternatives, the costs of new techniques of rice production must fall significantly below the current costs of domestic

production. However, most of the new methods of rice production promoted by the Ivorian government have higher, not lower, social costs of production.

SENSITIVITY ANALYSIS OF RESULTS

The results reported above rely on several major assumptions. The most important are the yields of paddy per ha, the shadow prices for primary domestic factors, the world price of rice, and the milling outturn. Increases in yields increase NSP, whereas increases in shadow prices have the opposite effect. Increases in the world price of rice and in milling outturn raise the NSP. The sensitivity analysis is based on estimated elasticities of changes in NSP as values of these major variables change.[33] The effects of changes in these values are presented in Table 11.

The level of yields is one of the most important variables in the analysis. Small changes in yields have a large effect on NSP, and the scope for reducing the gap between actual farm yields and feasible yields is large. Data in Table 11 show an average increase in NSP of 0.6-0.8 CFA francs per kg rice for each percentage improvement in yields. This increase is higher for irrigated than for upland rice. The range of observed yields suggests that the best farmers using improved irrigated techniques easily obtain 30 percent greater yields than those used in the analysis. If all other variables remained constant, such yield increases could raise NSP by almost 25 CFA francs, which would give most irrigated techniques a positive NSP. The scope for improvement of rainfed production is less, but yield increases of 15-20 percent would be sufficient to give positive NSPs.

However, yield increases are also associated with increases in unskilled labor costs, particularly for harvesting. These increases could amount to 15-20 percent of total unskilled labor costs for rice grown on improved lowlands, milled by the government, and shipped to Abidjan. Based on data

Table 11.--Changes in Net Social Profitability Resulting from One Percent Increases in Yields, Social Costs of Primary Inputs, and Milling Outturns

(in CFA francs per kg rice)

Technique of rice production[a]	Variable					
	Yield	Unskilled labor	Skilled labor	Capital	Land	Milling outturn
F1 Traditional upland, manual, forest	0.71	-0.60	-0.11	-0.26	-0.00	0.85
F2 Upland, modern inputs, manual, forest	0.68	-0.45	-0.18	-0.24	-0.03	0.82
F3 Improved lowland, modern inputs, manual, forest	0.86	-0.56	-0.19	-0.31	-0.05	1.00
F5 Improved lowland, modern inputs, power tiller, forest	0.78	-0.43	-0.19	-0.34	-0.09	0.92
F9 Pump irrigation, modern inputs, tractor, forest	1.25	-0.22	-0.33	-0.71	n.a.	1.38
F10 Traditional upland, manual, savannah	0.58	-0.52	-0.12	-0.21	-0.00	0.71
F11 Upland, modern inputs, manual, savannah	0.70	-0.42	-0.23	-0.22	-0.01	0.84
F12 Upland, modern inputs, oxen, savannah	0.64	-0.36	-0.21	-0.25	-0.00	0.78
F14 Upland, modern inputs, tractor, savannah	0.76	-0.18	-0.26	-0.45	n.a.	0.90
F17 Dam irrigation, modern inputs, manual, savannah	0.84	-0.42	-0.20	-0.44	-0.06	0.98

[a]These paddy production techniques are combined with assembly to government mills, where paddy is milled, and shipment of the rice to Abidjan by the government.

in Table 11, the NSP would fall by about 0.55 CFA francs for each percentage increase in labor costs in the forest and by about 0.45 in the savannah. As a consequence, the advantages from a 30 percent increase in yields would be offset by 10 CFA francs, or 40 percent. The effect caused by increased labor costs would be almost as large for rainfed production.

The costs of both unskilled labor and capital have relatively large effects on net social profitability. If wage rates were assumed to exclude important in-kind labor costs and equal only money wages,[34] most of the traditional production, representing some two-thirds of national output, would become socially profitable. In no case, however, does domestic production for consumption in Abidjan become socially profitable. On the other hand, if wage rates were to rise by 50 and 100 CFA francs per day in the forest and savannah respectively, no production would be socially profitable. Given past trends, an increase in labor costs is more likely than a decrease.

The effects of changes in capital costs are difficult to assess in terms of interest rates alone. Capital costs would fall if investments were less expensive, if equipment and irrigated land were more fully utilized and had longer lives, and if interest rates were lower. If capital charges fall by 25 percent, results change only slightly because increases in NSP usually amount to only about 8 CFA francs, which is insufficient to offset the highly negative initial results.

Since government mills already achieve fairly high outturns, an improvement to 0.68 kg of rice per kg of paddy would increase net social profitability by less than 3 CFA francs. On the other hand, more efficient small-scale hullers (attaining 68 percent outturns) would raise NSP by 7-8 CFA francs, which would be sufficient to make all traditional production that is hulled and

consumed in the producing area socially profitable.

The world rice price also has a major impact on NSP. Table 12 summarizes the effects in terms of Abidjan import prices (c.i.f., 25-35 percent brokens). If the long-run value of imported rice were to increase 25 percent, all traditional and improved upland production either consumed on-farm or hulled for local consumption would become profitable. But government milling and distribution would remain unprofitable for most farm techniques. Conversely, if the price were to fall 25 percent, no domestic production would be profitable.

The following tabulation summarizes the changes in net social profitability resulting from different assumptions:

New assumptions	Changes in NSP (CFA francs/kg rice) Forest	Savannah
Yield increases		
Irrigated rice (30 percent)	14	16
Rainfed rice (20 percent)	7	8
Increase in wages (to 500 and 450 CFA francs/day, in forest and savannah, respectively)	-5	-11
Reduction in capital charges by 25 percent	8	8
Increase in land values to market rents		
Irrigated rice	-6	-6
Rainfed rice	-4	0
Increase in world rice price by 25 percent (to $375/mt, c.i.f., Abidjan)	20	19

These values are difficult to establish precisely, but they offer an order of magnitude for evaluating the sensitivity of the results.

EFFECTS ON OBJECTIVES

As discussed by Humphreys and Rader (7), increased domestic rice output has been viewed mainly as a vehicle for furthering secondary government

Table 12.--Breakeven Prices, c.i.f. Abidjan, for Positive Net Social Profitability[a]

(US$ per mt)

Technique of rice production	Post-harvest activity			
	Hand-pounding, on-farm consumption	Small hullers, village consumption	Government mills, consumption in Bouaké	Government mills, consumption in Abidjan
F1 Traditional upland, manual, forest	329	356	399	418
F2 Upland, modern inputs, manual, forest	n.a.	342	387	405
F3 Improved lowland, modern inputs, manual, forest	n.a.	422	461	481
F5 Improved lowland, modern inputs, power tiller, forest	n.a.	386	428	447
F9 Pump irrigation, modern inputs, tractor, forest	n.a.	583	576	536
F10 Traditional upland, manual, savannah	288	296	349	372
F11 Upland, modern inputs, manual, savannah	n.a.	347	398	420
F12 Upland, modern inputs, oxen, savannah	n.a.	322	373	396
F14 Upland, modern inputs, tractor, savannah	n.a.	371	422	444
F17 Dam irrigation, modern inputs, manual, savannah	n.a.	410	457	479

[a]These prices can by converted into ones that are equivalent to Thai 5 percent brokens, f.o.b., Bangkok by the following formula:

$P_t = (P_a - 50)/0.7$, where

P_t is the price, f.o.b. Bangkok, for Thai 5 percent brokens, and

P_a is the price, c.i.f. Abidjan, for imports of 25-35 percent brokens.

objectives, notably import substitution (or balance-of-payments equilibrium) and a more equal regional distribution of income. But because the primary Ivorian economic objective is a high rate of growth of national income, it is appropriate to examine first the effect of government rice policies on this goal.

Replacement of rice imports with domestic production reduced national income by perhaps 2.7 billion CFA francs in 1975-76, which implies an average NSP of -8.4 CFA francs per kg rice, as shown below:[35]

Type of production and consumption	thousands mt rice	Average NSP (CFA francs per kg)	Economic gain (billions CFA francs)
Total production	318	-8.4	-2,658
Traditional, on-farm consumption only	167	0.8	133
Improved, all consumption	51	-31.1	-1,584
Improved, Abidjan consumption only	23	-39.2	-906
Improved upland, manual or ox	13	-18.6	-242
Lowland or dam irrigated	29	-32.9	-957
Forest, all	220	-9.5	-2,079
Savannah, all	98	-5.9	-579

The only category which does not suffer a net economic loss is on-farm consumption of traditional production, and the net gain from this category occurs only because the lower costs of savannah production offset the higher production costs (and negative NSP) in the forest. Losses to the economy from irrigated production are nearly 14 times as great as from improved upland because of the larger quantity of rice produced by irrigation. Losses stemming from forest production are about four times greater than from savannah production, owing to the larger share of rice grown in the forest.

These estimates are, of course, subject to error. But even with the more optimistic assumptions summarized in the preceding section, the initial conclusion holds: improved rice production in the Ivory Coast reduces national growth. Traditional production, even for consumption on the farm, is barely socially profitable.

Rice policy affects the government objective of a more equal regional income distribution in three ways. First, the policy of national price equalization implicitly benefits savannah farmers, since transport costs are greater from the northern region. The magnitude of this differential is about 1.7 CFA francs per kg rice, as shown in Table 10 (p. 34a). Second, farm level input subsidies, summarized below, are as much as 50 percent larger for savannah farmers (in CFA francs per kg paddy):

	Forest		Savannah	
	Investment	Inputs	Investment	Inputs
Upland, modern inputs, manual	0.0	6.5	0.0	10.0
Upland, modern inputs, oxen	--	--	1.6	9.4
Improved lowland, modern inputs, manual	6.5	5.9	7.6	6.0
Dam irrigation, modern inputs, manual	--	--	19.3	5.3
Tractor services	--	--	11.2	4.0

Investment subsidies are also higher in the north, especially for dam irrigation. In addition, subsidized government tractor services and mechanical land clearing are more widely used in the savannah than in the forest.

The third impact of government rice policy on regional income distribution is the price support for paddy, which appears as the milling subsidy in Table 10. Roughly half of this subsidy goes to farmers who sell

paddy to the government, which means that the paddy price support is about 17 CFA francs per kg.[36] Without this transfer, farm paddy prices could not be much greater than 48 CFA francs. Farmers using the least costly farm production methods benefit the most from this transfer. For the more costly techniques, like upland and irrigated production using modern inputs in the forest, the price support may be used largely to defray higher costs. To the extent that production is cheaper in the savannah, the price supports will increase incomes of savannah rice farmers compared to those in the forest. But because most paddy is produced in the forest, the major share of these price subsidies has been paid in the forest zone (7, pp. 27-28).

In summary, government input, investment, and distribution subsidies give poorer savannah farmers an extra 5-14 CFA francs per kg paddy, compared to forest farmers using similar improved techniques.[37] The margin is greatest for irrigated techniques and smallest for manual upland cultivation. These policies, therefore, have contributed to the government's goal of more equal regional income distribution whereas output price supports--for which more money has been spent--have not.

The other secondary government objective is substitution of domestic production for rice imports, with the goal of saving foreign exchange. Estimating the impact on the balance-of-payments requires more analysis than simply calculating value added in world prices, which is the difference between the value of rice imports and the cost of imported inputs used in rice production. Although these results are positive for all Ivorian rice techniques, they do not guarantee a positive net effect on the balance-of-payments. The impact of government rice policies on this objective is best evaluated by analyzing the efficiency of rice production in converting domestic resources into foreign exchange. An indicator of this efficiency

is the resource cost ratio (RCR) given in Table 9 (p. 29a). If this ratio is greater than unity, the value of foreign exchange saved is worth less than the value of domestic factors used in the process of saving it. For all the activities described--except traditional savannah production which is consumed on-farm or locally--the ratio exceeds unity. Most improved paddy production techniques coupled with government milling and shipment to Abidjan have ratios of 1.5 or greater, implying that at least 15 francs worth of domestic resources must be expended to save 10 francs worth of foreign exchange. Alternatively, at least 50 percent more foreign exchange could be saved or earned if the domestic factors used in rice production were diverted to other activities, such as coffee, cocoa, cotton, corn, or coconuts, which have RCRs less than unity. Because there are alternative uses of domestic resources that are more efficient than rice production in saving or earning foreign exchange, policies that cause these resources to be used in producing rice have a negative impact on the balance of payments. For the Ivory Coast, this impact has been strongly negative.

Virtually all of the government interventions in the rice sector have used rather than saved foreign exchange. The benefits of trade and domestic price policies have gone mostly to the forest zone, where the RCR is higher by 15 percent. The use of modern inputs, encouraged by large subsidies, have raised the RCR by as much as 20 percent when compared with production in the savannah. Investments in irrigation, even more heavily subsidized, have increased the ratio by another 15 percent compared with upland techniques using modern inputs. The effect of using tractors has been almost as large. Hence, government policies have exacerbated the inability of rice production to replace rice imports efficiently and thereby to save foreign exchange.

LESSONS AND CONCLUSIONS

An increase in the production of rice is a false indicator of the success of government rice programs because a significant share of the production of rice in the Ivory Coast is socially unprofitable with existing technology and prices. Compared to the price of rice imports, the costs of domestic production are too high, and each kg of imported rice that is replaced by domestic production results in a waste of resources and a loss of foreign exchange. General policies--trade protection and domestic price supports--to promote increased domestic production have caused a significant misallocation of resources and reduced overall growth potential.

Increases in the use of fertilizers and improved seeds, expansion of irrigated perimeters, and greater reliance on tractors are also false indicators of the success of government policies because these changes in the structure of Ivorian rice production have usually been less profitable and less efficient in saving foreign exchange than traditional techniques. Government subsidies of modern inputs have raised the social cost of production and lowered profitability of upland rice, except in the forest. Irrigation facilities have increased the social cost of rice production by 20 percent above upland production. Large-scale mechanization with subsidized hire services has increased production costs relative to those employing manual techniques and using oxen and small-scale motorization. Output subsidies that entice the delivery of paddy to government mills have increased the costs of processing domestic rice and idled capacity in the small-scale sector.

This failure of government policy has two main causes. Most importantly, the rice sector--even with traditional production techniques--cannot compete efficiently with imports. Policies to expand rice output have been largely ineffective in changing the resource constraints that make Ivorian rice production much more costly than imports.

With its low population density and its unused arable land, the Ivory Coast is clearly land surplus and labor scarce. As a result of these factor proportions, wage rates are relatively high. The share of labor in total costs of manual paddy production is also high, ranging from 40 to 80 percent. Thus, a reduction in the costs of Ivorian rice production requires that labor become more productive to offset its large share in these costs.

Government policies have not ignored the need to save labor. Labor days per mt rice decrease with the use of irrigation and modern inputs compared to traditional techniques, although these savings are smaller for irrigated production. The promotion of mechanized techniques has also reduced labor inputs. Unfortunately, this increase in the physical productivity of labor does not often coincide with an improvement in the productivity of labor in economic terms, especially when inputs and outputs are valued in social prices. These reductions in labor times have generally been paid for with increases in social costs. However, three new techniques--the use of modern inputs on manually cultivated forest uplands, power tillers, and oxen--have succeeded in lowering social costs while saving labor. But none of these techniques has lower costs than traditional production in the savannah, and the gains from the mechanized techniques depend on increases in yields.

The poor performance of new techniques can be explained by reviewing factor prices. In an economy like that of the Ivory Coast, where the wage-rental ratio is high, new techniques that increase the productivity of land more than of labor are unlikely to lower the total costs of production. Increasing the yield on land that has a zero shadow rent does nothing to reduce costs.[38] Cost reductions occur only by raising the productivity of other inputs, like labor. Because improved seeds, fertilizers, and irrigation are land-saving

innovations, they will be effective in Ivorian conditions only if they are successful in producing high yields per labor day.

However, these new innovations, which rely heavily on imported intermediate inputs and capital, are usually expensive compared to the increased output they furnish. Low population densities and widely dispersed farms increase the costs of delivering inputs. Porous soils and rolling topography increase the costs of irrigation investment. Low and irregular rainfall lowers yields of upland rice and makes multiple cropping more problematical if water control is only partial. Capital and imported intermediate inputs are costly, in part becuase the Ivorian market is limited and there are few suppliers.[39] The regular repair of mechanical farm equipment is hampered by the lack of an adequate service infrastructure, reducing service life and raising capital costs.

High costs also exist because inputs are used inefficiently. Fertilizer application rates have not been tailored to local conditions, thereby decreasing the marginal return to fertilizer. Yield potentials of the improved seeds have not been fully realized.[40] Improved seeds are unnecessarily renewed each year, raising input costs. Irrigation networks are inadequately maintained, which shortens their productive lives and increases their annuities. Cropping intensities are low on irrigated lands, and abandoned fields are numerous. The delivery of mechanical services is inadequately organized, limiting the number of ha that are cultivated by a set of equipment.

The share of capital and imported inputs in total costs of the new techniques increases from less than one-quarter in traditional production to 35-67 percent for improved techniques. If the ratio of wages to the price of capital is low, as it probably is given the high costs and inefficient utilization of these new inputs, it is unlikely that new techniques will

lower costs substantially by substituting these inputs for labor. For cost savings to occur in the production of improved rice, either the cost of these inputs must be lowered or their physical productivity raised.

Virtually none of the Ivorian policies to promote rice production has confronted the problems of increasing the economic productivity of high-wage labor, of decreasing the costs of expensive capital investments and imported inputs, and of raising the physical productivity of the new inputs. Trade controls and domestic price supports draw more resources into rice production at higher cost. Subsidies on inputs and investments encourage the adoption of new inputs, but they mask the fact that these new techniques are often more costly than traditional ones.

The reorientation of Ivorian policies suggested by this analysis of costs is threefold. If economic growth and increasing foreign exchange are strong national priorities, the rice sector--both traditional and improved--should no longer be encouraged. Second, if the growth of domestic food production is desired, crops other than rice should be promoted. Third, if the commitment to raise rice output remains unchanged, the government must engage in efforts to bring about significant technical improvements that can lower the social costs of production. Given that the government cannot alter the prices of labor and land in the short term and that both are likely to rise in the long run, efforts must be made to reduce the inputs of labor and assure that capital and other inputs have low social costs and high physical productivity. Such efforts will require a significant commitment to basic research, to the adaptation of cheaper foreign materials to local conditions, and to improvements in farm management.

Besides the use of modern inputs in the forest and of small-scale mechanization for land preparation, the analysis suggests two specific alternatives that might save farm labor efficiently. Small machines designed to save labor at harvesting currently appear to reduce costs, although only slightly.[41] Chemical herbicides conserve weeding labor (about 20 percent in irrigated production) and might raise yields if they enable more timely weed control. Empirical results indicate that even without yield increases herbicides can possibly lower social costs of irrigated rice production in both forest and savannah.[42] In addition, methods to raise yields through improved farming practices--like more timely planting--can also increase the productivity of new inputs.

Even without improvements in paddy production, the competitiveness of Ivorian rice production could be enhanced by changes in government policies to increase the use of small-scale milling, particularly to supply village markets. Hullers appear not only less expensive to operate, but their small scale permits reductions in both assembly and distribution costs.

Unfortunately, the evidence presented here indicates that savings must be large--up to 30 CFA francs per kg rice--if Ivorian rice production is to become socially profitable for consumption in Abidjan. None of the changes studied offers a large cost reduction, highlighting the need for redoubled efforts to develop other, more efficient production and milling techniques.

In conclusion, existing techniques, together with current factor costs and the world price of rice, make rice production in the Ivory Coast socially unprofitable. Government rice policies have reduced, not improved, social profitability. Despite some improvement in the regional distribution of income, policies have depressed national output and decreased the capacity to earn foreign exchange. Even improvements in income distribution have been

achieved inefficiently (7). A continuation of past efforts to expand rice output can be justified economically only if they are coupled with technical innovations that increase the social profitability of producing Ivorian rice. Hence, government policies should be reoriented to develop, adapt, and apply the mechanical, chemical, and biological technologies that can save labor without incurring offsetting increases in other costs. In the interim, savings would result if policies were changed to increase the role of the small-scale private sector in marketing and milling.

FOOTNOTES

[1]Highly detailed micro-economic budgets have been prepared for each technique and are presented in (3).

[2]Although a small amount of flooded rice is grown in the northwest, the quantity is relatively unimportant, and expected yields, given the lack of water control, are similar to upland rice yields.

[3]The local currency is the CFA (Communauté Financière Africaine) franc which is tied to the French franc. The exchange rate used in this paper is 250 CFA francs per U.S. dollar.

[4]Physical ha are area measurements only, which do not take into account the number of crops per year.

[5]The selected seed varieties for rainfed rice include Moroberekan (about 50 percent of the area), Iguapé Cateto (about one-third), and Dourado (about 15 percent). Moroberekan, with a cycle of 145 days, was developed from local varieties of O. sativa by the Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières (IRAT). It has been in use since 1960. Both Iguapé and Dourado were imported from Brazil, with cycles of 135 and 105 days, respectively. Selected seed varieties for irrigated rice include IR5 (about two-thirds of the area), CS6 (about 20 percent), and Jaya (about 10 percent). IR5 is an IRRI rice with a cycle of about 140 days. CS6 with a cycle of 115 days, was developed at the Centre de Semence at Dabou from IRRI variety IR480-14 and is being phased out. Jaya has a 120-day cycle and was imported from India where it was developed from Taichung Native 1 (TN-1). Although used in the past, IR8 is no longer recommended because of low yields. Two flooded varieties have also been used--L78 and IM16, with cycles of 150-160, respectively. The former is being phased out because of low yields, shattering, and lodging (1, 10, 14).

[6]The seeding rate for short-season varieties is 80 kg/ha.

[7]These are norms. In reality, an agent is responsible for fewer ha.

[8]Labor accounts for over half the cost. The other major cost is the capital charge on paddy stored until it is consumed, which is assumed to be for 6 months and at high, traditional interest rates.

[9]The theoretical rated capacity is 4 mt/hr. In addition, there is a small rubber roller mill at San Pedro, with an operational capacity of 0.5 mt paddy per hour.

[10]For a more extensive discussion of these combinations and their relative importance in the rice economy, see (3, Tables L1, L2, L3, and L4).

[11]The nominal protection coefficient is defined as the ratio of the c.i.f. import price, plus the implicit tariff on rice imports, to the c.i.f. import price. In the calculation, the long-run import price is 75 CFA francs per kg rice. Data come from (6, p. 16a), and the concept is explained in greater detail in (15).

[12]According to the Société pour le Développement de la Riziculture (SODERIZ), government mills may have refused to purchase as much as 80,000 mt paddy in 1976 (10). Government mills did purchase nearly 150,000 mt paddy in 1975-76 (6, p. 10).

[13]There was a brief period during April-October 1977 when the market price exceeded the official price (11).

[14]Beginning in 1977, the government adopted a program to distribute fertilizers for irrigated rice to farmers free of charge. At prices used in the analysis, this new program raises the subsidy rate to almost 60 percent of the value of the modern inputs. In addition to these farm-level subsidies, there is also a government subsidy on compound fertilizer paid at the factory. For 10-18-18, the fertilizer used on rice, this subsidy amounts to roughly

20 percent of production costs. Average subsidy levels on all fertilizers are about 25 percent higher than on rice fertilizer. For bananas, pineapples, sugar, and cotton, factory-level subsidies on fertilizer are above the average.

[15]In 1975-76, the BNDA extended hungry-season loans to nearly 90,000 farmers, with an average value per loan of about 15,000 CFA francs. State agencies also used BNDA funds to provide financing for about 90,000 farmers, each receiving on average about 40,000 CFA francs. There is considerable overlap between these two groups of farmers. See (8).

[16]The EPC is the ratio of value added in market prices to value added in world prices. See Page and Stryker (15).

[17]The subsidies included in the calculation of the EPC include those on the tradables used in paddy production and rice distribution. The net subsidy paid to government mills is considered to be part of the domestic price support policy.

[18]Social prices exclude all taxes and subsidies and use shadow prices to value domestic factors. Private prices include the effect of all taxes, subsidies, and other imperfections or distortions in the market. A third category, market prices, includes the effects of indirect taxes or subsidies, but excludes the taxes or subsidies paid directly to the farmer, merchant, or miller.

[19]The only evidence of seasonality comes from data collected by SODERIZ in its "Terrors-Test" near Touba (the western edge of the Ivory Coast, along the southern fringe of the savannah near Guinea) (10). Wages for weeding may be 30 percent less for the second crop, and wages for harvesting may in some cases be less. Reports from farmers in forest areas indicate no seasonality, probably because coffee and cocoa harvests coincide with the cultivation of the second crop of rice.

[20]During the period 1955-74, the Thai export price for 25-35 percent broken rice averaged 32 percent less than for 5 percent brokens. This discount varied from 16-26 percent in the years after 1974. These calculations are based largely on rice prices released by the Rice Committee Board of Trade in Thailand, and published by the USDA (21).

[21]This transport cost may be too high. During 1960-73, the c.i.f. price, Abidjan, averaged only $25/mt higher than the f.o.b. price, Bangkok. See (6, p. 12). On the other hand, it may be that preferential trading arrangements with Italy, which was the largest foreign supplier of rice to the Ivory Coast (17 percent of imports during 1965-76), caused actual import prices to be lower than estimated from Thai exports (6 and 17, p. 155). Since only 4 percent of rice imports came from Thailand in 1965-76, Thai exports affected Ivorian import prices only indirectly (see 6, p. 14).

[22]The average number of crops per year is about 1.85 on cultivated land. When account is taken of the 20 percent of land idled for various reasons--like lack of water--the number of crops is about 1.5 for all land in projects having dam irrigation.

[23] Without the increase in yields (0.5 mt paddy/ha) assumed to accompany the use of tillers, this technique would raise social costs by 0.5 CFA francs/mt paddy, even though labor costs are lower.

[24]Without the increase in yields (0.3 mt paddy/ha), the use of oxen would raise social costs by 2.7 CFA francs/mt paddy despite lower labor costs.

[25]This premium may be overestimated because the social costs of small-scale milling are based on the private market charges prevailing in 1975-76 which have risen by 50-100 percent in the subsequent two years. These recent market adjustments may have been lagged responses to the high inflation between 1972 and 1976, when prices rose over 60 percent (6, p. 18). As a

result, charges in 1975-76 may have been abnormally low in real terms.

[26]For example, delivery to Abidjan of government rice rather than local consumption of privately hulled rice, decreases the NSP by roughly 15-20 CFA francs per kg rice.

[27]The results are based on the following farm production techniques: F2, F3, F5, F11, F12, F14, and F17. The average is unweighted.

[28]Besides the effects of government policy, private land rents are higher in the forest than in the savannah. The treatment of land rents as private but not social costs decreases the divergence between NSP and NPP.

[29]The following figures illustrate the magnitude of this trade effect under different assumptions (in CFA francs/kg rice):

Sector and location	Domestic price	Import price	Trade effect
Government, Bouaké	87.0	77.7	9.3
Private hullers, forest	99.0	77.8	21.2
Private huller, savannah	99.0	78.3	20.7
Private hullers, Abidjan	104.0	75.1	28.9
Hand-pounding, forest	102.6	79.9	22.7
Hand-pounding, savannah	102.6	80.4	22.1

[30]The ranking of the 10 paddy production techniques by the divergence between net social and private profitabilities (Table 10) can be compared to the ranking by social costs (Table 7) through the use of the statistical test of rank-order correlations. The coefficient for these two rankings equals -0.515, which is statistically significant at a level of 90 percent. This coefficient means that the incentives created by government rice policies are strongly and negatively correlated with the social costs of production.

[31]Both the methodology and the cost assumptions used in Stryker's analysis differ from those used in this study. However, the rankings of different crops are unaffected so long as relative prices remain the same.

[32]These estimates use world prices based on the world price of rice and the proportion of calories in these foods relative to rice. Other costs are based on data similar to those used in this analysis.

[33]In interpreting these elasticities it is important to note that the relative magnitude of the elasticity of any given shadow price depends on the importance of that factor in total costs. As a result, unimportant factors have low elasticities. The absolute magnitude of the elasticities also increases as the NSP approaches zero. Therefore, elasticities should be directly compared only across techniques with similar net social profitabilities. The estimates are point elasticities, and they are probably valid only for small changes in yields and factor costs. Finally, elasticities for capital are based on changes in the value of capital in production costs rather than on changes in interest rates. Since annuities, which comprise the bulk of capital changes, are not a linear function of the interest rate, these results cannot be used to interpret the effects of changes in the interest rate. A detailed listing of the elasticities for yields, labor, capital, and land is available in (3, Tables N1, N2, N3, and N4).

[34]These low wages would be equal to 350 and 300 CEA francs per day in the forest and savannah, respectively.

[35]Theoretically, the concept of net social profitability measures the marginal social cost of producing the next unit of output. But because cost data are average costs--at least over a wide range--and because fixed input-output coefficients preclude factor substitution within the same technique, the marginal cost can be assumed to equal the average cost for each

technique. The aggregate supply curve consists of several discrete steps, each representing a different and increasingly costly production technique. Total economic costs thus equal the sum of the costs of each technique. Aggregate net social profitability equals the product of the NSP and the quantity of rice produced, summed over all the techniques. Since rice production is a relatively small share of the economy in the Ivory Coast, large changes in rice output are unlikely to affect factor prices.

[36]The milling subsidy is divided into the following categories:

	CFA francs per kg rice	CFA francs per kg paddy
Reimbursement for milling costs	14.3	9.4
Paddy price support[a]	25.8	17.0
Net surplus or profit[b]	11.3	7.5
Total	51.4	33.9

[a]This value equals the difference between total costs (paddy purchase price and milling costs) and the selling price set for mills.

[b]This value is net of other indirect taxes and subsidies. At costs used in these calculations, it represents a net profit to the government mills. The excess may come from subsidies set in an earlier period when milling costs were higher and outturns lower. This excess may now be used to offset other rice agency losses.

[37]These figures are based on the following differences in subsidies between forest and savannah (CFA francs/kg paddy):

Subsidy	Irrigated rice[a]	Upland rice
Investment	12.8	0.0
Input	-0.6	3.5
Distribution	1.7	1.7
Total	13.9	5.2

[a]These techniques are improved lowlands for the forest and dams for the savannah.

[38]The ability of land-saving inputs to reduce social costs by raising yields depends on the shadow land rent. In order for modern inputs on savannah upland and on irrigated land in both regions to give social costs of production that are no greater than those of traditional production, the social value of land would have to be about 20,000 CFA francs per ha. This value exceeds the observed private rent for forest upland by four times.

[39]Several examples illustrate the high cost of inputs used in rice in the Ivory Coast. Although the long-run price of urea, delivered West Africa, has been estimated at 43 CFA francs/kg (4), the price, c.i.f. Abidjan, prevailing in the Ivory Coast in 1975-76 was 60 CFA francs, or 40 percent higher. Power tillers usually sold for 750,000 CFA francs, although some suppliers offered them for 100,000 CFA francs less. The cost per ha of herbicides (2-4-D) in the Philippines appears to be only about one-fourth the cost in the Ivory Coast (4).

[40]For example, current experimentation by the Institute de Recherches Agronomiques Tropicales et des Cultures Vivières (IRAT) indicates that the selected rainfed varieties presently used (Moroberekan, Iguapé Cateto, and Dourado Précoce) have yield potentials of 4-5 mt paddy per ha. Varieties under development (IRAT 10 and IRAT 13) may have a potential of 5.5-6.0 per ha (14).

[41]The social costs of improved lowland production in the forest using modern inputs are tabulated below by different types of small-scale mechanization (in CFA francs per kg paddy):

Power-tiller only (F 5)	51.9
Power-tiller with motorized thresher (F 6)	52.1
Power-tiller with mechanized cutter-binder (F 7)	51.2
Power-tiller with thresher and binder (F 8)	51.5

[42]The social costs calculated for the use of herbicides (propanil and 2-4-D applied at the rates of 7.5 and 1.25 liters/ha, respectively) on different types of rice production are compared below to the social costs for manual weed control. Data are in CFA francs per kg of paddy.

	Manual weed control	Herbicides
Upland, manual, modern inputs, forest (F2)	45.1	46.2
Improved lowland, manual, modern inputs, forest (F3)	57.6	55.6
Upland, manual, modern inputs, savannah (F11)	46.6	49.6
Dam irrigation, manual, modern inputs, savannah (F17)[a]	56.2	56.0

[a]These results are estimated from the analysis of production on improved lowlands in the savannah.

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