ROBERT W. HERDT AND
TERESA A. LACSINA*

THE DOMESTIC RESOURCE COST OF INCREASING PHILIPPINE RICE PRODUCTION

Self-sufficiency in rice at roughly the current price is an important political-economic goal of policy makers in the Philippines. While no firm target date has been fixed, it is nonetheless clear that policy makers and the public believe that the sooner the goal is reached, the better. The political reasons for this objective include national pride and self-determination as well as domestic tranquility. A major economic reason for the policy objective is the desire to save foreign exchange. It is assumed that producing rice domestically, by any system, will use less foreign exchange than purchasing rice from abroad. While domestic production may save foreign exchange under some conditions, it is of considerable interest to identify the efficiency of saving foreign exchange by alternative production systems. This question becomes rather complex because of the necessity to evaluate the scarcity values of domestic resources and of tradable inputs and because subsidies and taxes cause the costs paid by producers to differ from the costs borne by the economy.

The increased production needed to make and keep the Philippines self-sufficient could be produced by large- or small-scale farm units and in different parts of the country, depending on decisions on irrigation investment, land investment and settlement, machinery investment policies, and agricultural credit. The relative economic efficiency of the alternative methods of increasing production can be determined using the domestic resource cost (DRC) approach.[1] Specifically, the DRC is a measure of the value of domestic resources needed to produce one dollar's worth of rice. In the calculation, the foreign exchange costs are subtracted from the value of production. Hence, the DRC measures the efficiency with which foreign exchange can be saved or earned in a particular production process.

*The authors are Agricultural Economist and Research Assistant, respectively, at the International Rice Research Institute (IRRI), Los Baños, Philippines.

[1] We have used papers by Pearson and Nelson (*17*) and Akrasanee (*2*) as our primary references for the methodology followed here. These papers also form the basis for the introductory essay to this collection (*18*). Other explanations of DRC and related concepts are available in Bacha and Taylor (*4*), Balassa (*5*), Bruno (*8*), and Chenery (*11*).

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The purpose of this paper is to evaluate, using the DRC approach, several apparently feasible methods of increasing rice production in the Philippines and to test the sensitivity of results to changes in the opportunity costs of land and of capital and in world prices of rice and fertilizer. This analysis will give a better idea than is now available of the value of the alternatives chosen to the economy. We do not pretend that these economic calculations will or should provide the only basis for deciding to encourage or discourage production by any particular system. But they will give an idea of the real benefits or costs to the Philippine economy of pursuing alternative courses for increasing rice production. They also provide useful insights when compared to similar estimates for other countries.

SYSTEMS FOR INCREASING PRODUCTION

In order to apply the DRC procedure, the analyst must know the costs of inputs used for production by the various alternatives under consideration. This information can best be obtained from a careful study of the production alternatives. For the present analysis, we draw on data obtained from farm management studies of the University of the Philippines at Los Baños and the International Rice Research Institute (IRRI).

We are primarily interested in comparing systems that can lead to increased rice production so we do not examine here average DRCs of existing methods of production, unless those methods can be substantially expanded. This focus on marginal rather than average DRC is justified, since it is unlikely that existing systems will be eliminated even if found to be highly inefficient. It is also useful for indicating which of several alternative new systems should be encouraged.

Because our interest lies in expanding production, we ought to confine our attention to data for the current and immediate future years. However, such data are much more difficult to obtain than for past periods. Also, from ongoing research, we know that the quantity of farm production inputs used are relatively stable over time. Variability arises from price fluctuations and yield changes due to weather. In this paper, we examine data for 1974 and then investigate what happens if the prices of certain goods change.

Additional rice output can be obtained from two sources—more rice land and higher yields per hectare. Land can be added by increasing the intensity of rice cropping (number of crops per year) on existing land, bringing new land into rice production, and converting land from the production of another crop to the production of rice. Yields can be increased by improving cultural practices, improving irrigation, or introducing new technology. We examine one system that uses additional land and three systems that generate additional rice production through higher yields.

Increasing the intensity of rice cropping and improving yields in existing rice production areas generally require an improvement of irrigation systems. Such improvement depends on investment in irrigation. The irrigation may come from large-scale gravity systems, small-scale pump irrigation systems, or some intermediate type. Because of its size and importance, the Upper Pampanga River Project (UPRP) is taken to represent large-scale systems.[2] The first alternative

[2] The UPRP is designed to provide assured irrigation to more than 80,000 hectares of rice for two crops per year beginning in September 1975 through a storage dam and system of canals. It is a project funded by the World Bank.

examined in this study represents this system of irrigation as used in the Central Luzon area, a major rice-producing region.

Pump irrigation is becoming increasingly popular throughout the country. Its use is fairly widespread in Laguna, a region for which data are available. The second alternative examined is pump-irrigated, intensified production in Laguna province.

The opening of new land has been an important source of increased production throughout the past two decades, and present government policy, expressed in General Order 47, continues to encourage potential producers to invest in rice land development.[3] This expansion of land is virtually confined to the southern Philippines location of the large-scale system that is examined in this study. This system is highly mechanized, and all investment, including irrigation, is provided from private sources.

A fourth alternative using the rates of inputs recommended by Masagana 99, the national rice production program, is included for comparative purposes. This system is expected to produce additional rice by the use of higher levels of inputs than farmers now use. It is not region specific, but is being actively pursued on Luzon as well as on other islands of the Philippines.

The four systems differ from one another in several characteristics other than size and irrigation type. These characteristics are summarized in Table 1. The small-scale units in Central Luzon depend on medium-size tractors along with carabao for land preparation and use large mechanical threshers. The Laguna farms use small hand tractors for land preparation and rely on hand threshing. The large units in Davao use large tractors for mechanized land preparation, large irrigation pumps, and large mechanical threshers with hand harvesting. A greater degree of mechanization could be obtained with aerial seeding, fertilizing, crop protection, and combine harvesting, but units with those capabilities are not yet operating in the Philippines. The Masagana 99 system is similar to the Central Luzon system, but has higher rates of inputs as recommended by the national production program.

COSTS OF PRODUCTION

Data on the private costs of production for the four systems have been obtained from a number of different sources. Every effort has been made to be as explicit as possible in the table footnotes to show whatever adjustments have been made to the original data to make them comparable. Adjustments have been necessary where data were not reported in some studies, as in the case of land preparation by animals or family labor contribution. These data have been obtained by adjusting similar data for an earlier year, examining studies from other areas, or making educated guesses.

Because we are interested in the effect of the sharp price changes of recent years, we wanted the analysis to be as current as possible. Two studies are available for 1974, but for some information we have used data that relate to 1970 and

[3] General Order 47 requires all business firms in the Philippines employing more than 500 persons and having a satisfactory profit situation to provide each of their employees with a given quantity of rice or corn. The firms have the option of producing or importing the grain. Production is supposed to take place only on previously uncultivated land. IRRI and the University of the Philippines at Los Baños have recently concluded an analysis of these production units (*10*).

TABLE 1.—CHARACTERISTICS OF FOUR ALTERNATIVE SYSTEMS FOR INCREASING RICE PRODUCTION IN THE PHILIPPINES

System	Location	Farm size (*hectares*)	Irrigation	Land preparation	Threshing	Source of added production
1	Central Luzon	3	UPRP-type	35 hp. tractor and carabao	Large mechanical	Irrigation
2	Laguna	2	Small pumps	7 hp. tractor	Hand	Irrigation
3	Davao	500	10-foot pumps	60 hp. tractor	Large mechanical	Land
4	Masagana 99 recommendation	3	UPRP-type	35 hp. tractor	Large mechanical	Inputs

adjusted them for the changes in prices that occurred through the wet season of 1974 (August-December). The technique of adjusting for price changes makes it possible to generalize the analysis for other price configurations. (Rice related prices were relatively constant between December 1974 and October 1976.)

Apportionment of production costs into domestic and foreign cost components followed the guidelines agreed upon at the June 1975 Workshop of the Political Economy of Rice Project. Briefly, these guidelines are: inputs (such as fertilizer) that are produced domestically but tradable are treated as foreign costs because their incremental output is imported; nontraded inputs and added local costs of traded inputs are divided into domestic costs and foreign costs; government input subsidies embodying real goods and services are treated as domestic costs; and depreciation is treated as a traded or nontraded input according to the foreign or domestic cost of the fixed capital asset.

Because the available input-output tables for the Philippines do not deal with all agricultural inputs in adequate detail to permit division into domestic and foreign costs, the procedure followed for most inputs was that suggested by Akrasanee (2). This technique amounts to a careful accounting and identification of the origin of costs as either domestic or foreign. Manufacturers' and customs records provided the basic information for this calculation. Where domestic cost components contained imported inputs, we accounted for those inputs as indirect foreign costs.

For each item of capital equipment, such as tractors and irrigation systems, a budget was developed showing the fixed and variable components of total annual costs with three alternative interest rates for long-term capital (12, 15, and 20 percent). The annual costs were apportioned into their foreign, domestic, and tax components. Costs per hectare were obtained by applying known capacity rates. The resulting percentage allocation of inputs costs to domestic, foreign, and tax (including tariff) sources using the "best estimate" of capital costs, is shown in Table 2.[4] The proportions are slightly different for the low and high capital costs. These data were used to develop the detailed breakdown of unit costs for each system.

The shadow price of family labor was set equal to the market wage rate of labor. The shadow price of land was derived from actual rental rates, earnings in alternative crops, and our judgment, discussed in more detail below. The opportunity cost of capital was calculated at three alternative rates. The middle or "best estimate" rate of 15 percent is the rate used by the National Economic Development Authority as the shadow price of capital in project evaluation. Short term interest rates for purchased inputs of 12, 20, and 40 percent per year were used in the cost calculations. The low rate is the level at which the national production program, Masagana 99, makes money available for input purchase, while rates in the private sector may range even higher than our high rate.

System 1

The source of farm cost data for System 1 is a field survey of 66 farmers in the Central Luzon and Laguna area carried out by IRRI in 1975 (Table 3). The survey

[4] A detailed set of Appendix tables showing the intermediate steps in arriving at these percentages is available from the authors.

TABLE 2.— ALLOCATION OF RICE PRODUCTION INPUT COSTS TO FOREIGN, DOMESTIC AND TAX SOURCES (PERCENTAGE OF FARMERS' COSTS), AT BEST ESTIMATE OF CAPITAL COST IN THE PHILIPPINES, 1974*

Input	Foreign cost	Domestic cost	Taxes, tariffs
Urea fertilizer, domestically produced	18	79	3
Urea fertilizer, directly imported	65	32	3
16-20-0 fertilizer, domestically produced	24	73	3
16-20-0 fertilizer, directly imported	83	17	0
Insecticides and herbicides	41	42	17
7 hp. hand tractors	23	68	9
35 hp. wheel tractors	41	52	7
Axial flow thresher	15	80	5
Stationary thresher	21	75	4
4" Ø irrigation pump system	26	65	9
10" Ø irrigation pump system	36	51	13
Storage dam irrigation system (UPRP)[a]	35	63	2
Marketing costs	1	99	0
Fuel and lubricants	49	31	20

*Derived from detailed budgets of costs available as appendix tables from the authors.
[a]This line shows the percentage of social costs.

is known as the "loop" survey because the respondents were selected along a stretch of highway from Los Baños, north past Manila through the western part of Central Luzon, east at the province of Pangasinan, and south down the eastern side of the Central Luzon plain. The survey respondents were widely dispersed, but all were close to a major highway. This data source is extremely useful because it gives information on family as well as hired labor and on the rates charged for hired, machine performed operations.

The data available did not show the amount of fertilizer used, but gave the total expenditure on fertilizer. We assumed that two-thirds was spent on urea, one-third on 16-20-0. The opportunity cost for family labor was taken as equal to the average wage rate paid for hired labor by the surveyed farmers. Since more than 60 percent of the labor input is from hired labor, the opportunity exists for family labor to work on other farms, or even in Manila. There is little distortion in the labor market, so market wages are taken to equal shadow wage rates.

System 2

Data for System 2 were obtained from the 1973-74 study of Laguna farms carried out by researchers of the University of the Philippines (Table 4). Data for

TABLE 3.—COST OF WET SEASON RICE PRODUCTION BY SYSTEM 1: SMALL-SCALE FARMS IN CENTRAL LUZON*

Cost component	Production cost[a]	Costs with capital valued at					
		Low		Best estimate		High	
		Foreign	Domestic	Foreign	Domestic	Foreign	Domestic
Seed	88		88		88		88
Plowing, custom rate, wheel tractor	180	81	85	83	83	85	80
Harrowing with carabao	60		60		60		60
Irrigation, UPRP type	1,040	304	563	366	653	471	804
Urea fertilizer[b]	168	109	54	109	54	109	54
16-20 fertilizer[b]	82	68	14	68	14	68	14
Herbicides	20	8	8	8	8	8	8
Insecticides	52	21	21	21	21	21	21
Preharvest hired labor	205		205		205		205
Total preharvest costs[c]	(1,895)	(591)	(1,098)	(655)	(1,186)	(762)	(1,334)
Interest on preharvest costs[d]	189	35	66	66	119	152	267
Threshing[e]	150	34	109	35	108	36	107
Harvesting labor, hired	150		150		150		150
Family labor[f]	225		225		225		225
Land rent[g]	800		800		800		800
Total costs/hectare	3,409	660	2,449	756	2,588	950	2,883

*Data from IRRI farm survey and from analysis of UPRP system in W.H. Meyers, "Alternative Patterns of Resource Use for Achieving Self-Sufficiency in Rice in the 1970's: A Linear Programming Analysis," unpublished M.S. thesis, University of the Philippines, Los Baños, October 1972.

[a] Except for irrigation, this is the cost paid by or imputed to the farmers for the input or service.

[b] Survey shows total fertilizer cost, assumed to be two-thirds urea, one-third 16-20.

[c] Farmers pay only P125/ha. for irrigation, net total cost of P1,040, so farmers average preharvest costs are P980.

[d] At 12, 20, and 40 percent per year costs, apportioned as original costs, for six months.

[e] Custom rate is 5 percent of the output, here calculated as 5 percent of 60 cavans/hectare at P50/cavan.

[f] 30 days of family labor at P7.50/day.

[g] Using best estimate of shadow price of land of P800/hectare.

the sample farms using hand tractors for land preparation were averaged for our purposes. To make the system reflect marginal costs of rice production, we assumed that irrigation would be provided by small 4-inch pumps, similar to those being successfully used by many Laguna farmers. Levels of chemical input use were somewhat higher for these farms compared to the Central Luzon farms. As for System 1, the opportunity cost for family labor was set equal to the average wage paid by the surveyed farmers.

TABLE 4.—COST OF WET SEASON RICE PRODUCTION BY SYSTEM 2: SMALL-SCALE FARMS WITH 4″ Ø IRRIGATION SYSTEMS IN LAGUNA*

Cost component	Production cost	Costs with capital valued at					
		Low		Best estimate		High	
		Foreign	Domestic	Foreign	Domestic	Foreign	Domestic
Seed	87		87		87		87
Land preparation, hand tractor	200	54	126	54	127	53	129
Irrigation cost[a]	857	247	495	257	507	273	526
Urea fertilizer	78	50	28	50	28	50	28
16-20 fertilizer	40	33	7	33	7	33	7
Herbicides and insecticides	97	40	57	40	57	40	57
Preharvest hired labor	207		207		207		207
Total preharvest costs	(1,566)	(424)	(1,007)	(434)	(1,020)	(449)	(1,041)
Interest on preharvest costs[b]	94	25	60	43	102	90	208
Harvesting and threshing[c]	500		500		500		500
Family labor	146		146		146		146
Land[d]	800		800		800		800
Total cost/hectare	3,016	449	2,513	477	2,568	539	2,695

*Data from E.P. Abarientos, N.M. Fortuna, and A.E. Siapno, "Cost of Producing Palay in Laguna," Department of Agricultural Economics, University of the Philippines, Los Baños, 1975.

[a]From capital budget for irrigation system derived from R.D. Reyes "The Economic and Technical Aspects of Water Application on Rice," unpublished M.S. thesis, University of the Philippines, Los Baños, December 1972; first column shows best estimate of capital cost.

[b]At 12, 20, and 40 percent per year, for six months.

[c]Equal to one-sixth of total value of output which is 60 cavans/hectare valued at P50/cavan. Hand harvesting and threshing with bamboo "wacking frame."

[d]Best estimate assumed rate. Reported rate on 16 farms with 11 leaseholders and share tenants was P563/hectare.

System 3

The data for System 3 may be the weakest, because large-scale, mechanized production is rather new in the Philippines (Table 5). In order to arrive at suitable figures, we have discussed the capital configuration of large-scale production units with several individuals involved with these systems of rice production. With those guidelines as a background, we budgeted the current and capital cost of a typical large-scale unit (Table 6). The input levels reflect the rates being routinely used for planning by the large-scale units. We assume a 500-hectare farm planting four blocks sequentially through the year with two complete crops per hectare. Land preparation, threshing, and drying are mechanized. Rice is

TABLE 5.—COST OF RICE PRODUCITON BY SYSTEM 3: LARGE-SCALE MECHANIZED FARMS IN DAVAO*

Cost component	Production cost	Costs with capital valued at					
		Low		Best estimate		High	
		Foreign	Domestic	Foreign	Domestic	Foreign	Domestic
Seed	80		80		80		80
Urea fertilizer[a]	420	273	134	273	134	273	134
16-20 fertilizer[a]	182	151	31	151	31	151	31
Herbicides[b]	175	72	74	72	74	72	74
Insecticides	270	111	113	111	113	111	113
Fuel and oil							
Land preparation (*100 feet/hectare*)	88	43	27	43	27	43	27
Irrigation[c]	465	228	144	228	144	228	144
Harvesting and other	22	11	7	11	7	11	7
Preharvest hired labor (*6 man-days*)	72		72		72		72
Management and office costs	100		100		100		100
Total preharvest costs	(1,874)	(899)	(782)	(889)	(782)	(889)	(782)
Interest on preharvest costs[d]	185	54	47	89	78	178	156
Annual capital costs[e]	580	250	278	282	306	336	349
Harvest labor (*11 man-days*)	88		88		88		88
Land[f]	675		675		675		675
Total cost/hectare	3,402	1,193	1,870	1,260	1,929	1,403	2,050

*Budgeted by authors based on field survey information and Table 6.

[a]General Order 47 firms must pay a higher price for fertilizer than small farmers. The difference reduces the rate of subsidy on fertilizers. The costs here are adjusted to exclude the subsidy.

[b]With direct seeded rice, a more costly herbicide required than for the transplanted rice of other systems.

[c]Liters/hour, pump averages 22 hours/hectare, 11,000 hours for the season.

[d]At 12, 20, and 40 percent annual rates.

[e]From Table 6.

[f]Derived by inflating the 1971-72 returns to land planted to sugarcane (Table 8).

broadcasted into puddled soil by hand labor. Fertilization and pest control also are carried out by hand labor. Since these units are quite capital intensive, the assumptions about their capital budgets become very critical. The capital budget is shown in Table 6 with three opportunity cost levels for capital. A study obtaining empirical data on capital and operating costs for these types of systems has recently been completed and supports the general magnitude of the capital and operating costs (*10*).

TABLE 6.—ESTIMATED ANNUAL CAPITAL COSTS FOR LARGE-SCALE SYSTEMS (500 HA., TWO CROPS/YEAR) AND THEIR BREAKDOWN AT THREE OPPORTUNITY COSTS OF CAPITAL

				Allocation of total capital cost[b]		
	Repairs[a]	Interest rate	Depreciation plus interest	Foreign	Domestic	Taxes
Tractors						
2-60 hp.	21,600	12	59,400	40,926	34,673	8,340
2-35 hp.	21,600	15	67,500	45,697	37,516	8,818
	21,600	20	81,000	53,697	42,255	9,618
Implements						
2 rotabators	2,745	12	10,481	7,566	4,691	966
1 disk plow	2,745	15	12,128	8,637	5,152	1,082
2 levelers	2,745	20	14,873	10,424	5,920	1,274
Thresher						
Stationary	3,200	12	7,467	1,486	9,035	145
	3,200	15	8,667	1,683	10,018	165
	3,200	20	10,667	2,011	8,747	197
Irrigation pumps						
10-10″ Ø	63,000	12	173,250	118,345	82,482	29,972
With engines	63,000	15	196,870	131,997	88,363	34,058
	63,000	20	236,250	154,759	98,169	40,871
Irrigation system	22,750	12	84,930	7,125	99,688	666
	22,750	15	98,580	8,136	112,206	763
	22,750	20	121,330	9,819	133,067	918
Truck						
Pick-up	1,750	12	7,700	5,402	2,427	1,620
	1,750	15	8,750	6,064	2,617	1,819
	1,750	20	10,500	7,166	2,936	2,150
Silo dryer and storage shed	27,500	12	74,666	37,469	38,506	6,188
	27,500	15	86,666	65,269	41,866	7,028
	27,500	20	106,666	78,269	47,466	8,428

System 4

The National Food and Agricultural Council has constructed a budget of costs that would be incurred if farmers followed the recommended practices of the Masagana 99 program. This budget is taken to represent System 4 (Table 7).

LAND AND FAMILY LABOR COSTS

The DRC calculation gives the social opportunity costs (in terms of domestic factors of production) of earning a net marginal unit of foreign exchange by a

TABLE 6.—ESTIMATED ANNUAL CAPITAL COSTS FOR LARGE-SCALE SYSTEMS (500 HA., TWO CROPS/YEAR) AND THEIR BREAKDOWN AT THREE OPPORTUNITY COSTS OF CAPITAL (CONTINUED)

				Allocation of total capital cost[b]		
	Repairs[a]	Interest rate	Deprecia-tion plus interest	Foreign	Domestic	Taxes
Other equipment and spare parts	1,425	12	21,600	12,271	6,959	3,793
	1,425	15	27,000	15,241	8,471	4,711
	1,425	20	36,000	20,191	10,991	6,241
Total	143,970	12	439,494	250,590	278,461	51,690
	143,970	15	506,161	282,724	306,209	58,444
	143,970	20	617,286	336,288	349,551	69,694

*Budgeted by authors based on field survey information and data from R.D. Reyes "The Economic and Technical Aspects of Water Application on Rice," unpublished M.S. thesis, University of the Philippines, Los Baños. December 1972.

[a]One-half is labor, one-half spare parts. Spare parts are allocated on same basis as depreciation plus interest.

[b]Includes repairs, depreciation, and opportunity cost of capital at interest rate shown.

particular activity (net meaning that imported inputs are deducted from the foreign exchange earned). When the value of the domestic resources so used is less than the amount of domestic currency required to purchase one dollar (the domestic cost of foreign exchange) then domestic production is efficient, and the country has a comparative advantage in rice production. If the value of the domestic resources used per dollar's worth of rice exceeds the domestic cost of foreign exchange, then the country has a comparative disadvantage in rice production.

Because of the large contribution of land and family labor to rice production, it is critical that the social costs of these inputs be accurately reflected in the cost structures of the systems evaluated. Hence, the imputation of the value of family labor and land become important. We have assumed that family labor has an opportunity cost equal to the average wage rate for hired labor. This assumption implies that no distortions exist in the market for hired agricultural labor. The practice of hiring labor in rice production is nearly universal, and the workers have alternative opportunities in most areas, so we believe that the wage for hired labor reflects the opportunity cost of family labor.

Valuing land is more difficult. Three alternatives are possible: one might argue that land planted to puddled rice during the wet season has no alternative use and, therefore, a zero opportunity cost; one might use the returns to land in another crop, most likely sugarcane, even though opportunities for substitution are limited; or one might use the rental rate paid by tenant farmers. The zero opportunity cost argument seems particularly unsuited to the dynamic export-

TABLE 7.—COST OF RICE PRODUCTION BY SYSTEM 4: MASAGANA 99 RECOMMENDATIONS WITH 10″ Ø IRRIGATION SYSTEMS, 1974*
(*P/hectare*)

Cost component	Production cost	Costs with capital valued at					
		Low		Best estimate		High	
		Foreign	Domestic	Foreign	Domestic	Foreign	Domestic
Seed	90		90		90		90
Plowing, custom, rate tractor	180	81	85	83	83	85	80
Harrowing with carabao	60		60		60		60
Irrigation cost	921	368	381	382	399	407	430
Urea fertilizer	261	170	84	170	84	170	84
16-20 fertilizer	129	107	22	107	22	107	22
Insecticides and herbicides	268	110	110	110	110	110	110
Preharvest hired labor	275		275		275		275
Total preharvest costs	(2,184)	(836)	(1,107)	(852)	(1,123)	(879)	(1,151)
Interest on preharvest costs	218	50	66	882	112	176	230
Harvest labor	140		140		140		140
Threshing machine (5 percent of output)	150	34	109	35	108	36	107
Family labor	150		150		150		150
Land	800		800		800		800
Total cost/hectare	3,642	920	2,372	972	2,433	1,091	2,578

*Derived from budget prepared by the National Food and Agricultural Council, supplemented with data from W.H. Myers "Alternative Patterns of Resource Use for Achieving Self-Sufficiency in Rice in the 1970's: A Linear Programming Analysis," unpublished M.S. thesis, University of the Philippines, Los Baños, October 1972; N.L. Orcino, "Economic Aspects of Hand Tractor Ownership and Operation," paper presented at the IRRI Saturday Seminar, Los Baños, September 12, 1970, mimeograph; and R.D. Reyes, "The Economic and Technical Aspects of Water Application on Rice," unpublished M.S. thesis, University of the Philippines, Los Baños, December 1972.

oriented economy of the Philippines. Sugarcane and coconuts are alternative crops for at least marginal rice lands in many areas.

We have used a recent study by Cabanilla (9) to estimate the returns to land and management on sugarcane farms in a district in the Visayas. In the original analysis, Cabanilla calculated returns to labor, management, and capital, using alternative assumptions. Combining these analyses, we obtained the results in Table 8. Unpaid family labor was valued at between P3 and P5 per day, depending on the operation. Average capital investment per hectare for the sampled farms was P3,343. Nonland capital was assumed to earn a return of 15 percent. The residual return to land and management is P422 per hectare. If

TABLE 8.—RETURNS TO LAND AND MANAGEMENT IN SUGARCANE PRODUCTION, VICTORIAS MILLING DISTRICT, PHILIPPINES, 1971-72*
(*in pesos*)

Component	P/hectare
Value of sugar produced	6,152.43
Loss value of share for milling	2,211.87
Cash receipts to sugar producer	3,940.56
Cash expenses	2,474.83
Return/hectare to land, capital, management, family labor	1,465.73
Unpaid family labor[a]	218.47
Return to land, management, capital	1,247.26
Depreciation[b]	324.00
Return to non-land capital at 15 percent	501.00
Return to land and management	422.26

*Data from L.S. Cabanilla, "Economics of Size in Sugarcane Farming, Victorias Milling District, Philippines, 1971-72," unpublished M.S. thesis, University of the Philippines, Los Baños, October 1974.

[a]Calculated as the average of small and large farm data since there were 45 of each type in the sample, p. 55, even though large farms used no unpaid family labor.

[b]Calculated on the basis of capital investment and assumed life.

management is valued at some amount, one can calculate the return to land, but we prefer to use the P422 as an estimate of returns to land in 1971-72. Nonland costs and agricultural prices increased by about 60 percent between 1970-71 and 1974, so we have used P675 per hectare as our best estimate of the opportunity cost of land outside Luzon. For a high land cost outside Luzon, we use P1,075 per hectare, while the low land cost is P475 per hectare, on a purely arbitrary basis, simply to evaluate the impact of different costs.

In the major rice-growing areas of Luzon, which are the represented in Systems 1, 2, and 4, the social opportunity cost for rice land must also be related to sugar production. But there are no recent studies of the returns to land planted to sugarcane on Luzon, although it is an important crop there. We believe that because of the substitution possibilities between sugarcane and rice, the market rental rate for rice land must be fairly close to the returns in sugarcane (with some time lag), and hence to the social opportunity cost of land.

The actual rentals paid by share crop tenants and leasehold tenants vary widely even within a small area in Luzon, and even among leasehold tenants the variability is high. In a comprehensive accounting of the payments of 76 farmers in Central Luzon and Laguna, the share paid to land on leasehold farms averaged 23 percent, while the share paid to land on 19 share cropped farms averaged 28 percent. We have taken P800 per hectare as our best estimate, a level slightly below the 28 percent. An upper limit estimate of 40 percent of the value of output

TABLE 9.—SUMMARY OF DOMESTIC RESOURCE COST COMPONENTS FOR ALTERNATIVE SYSTEMS OF RICE PRODUCTION IN THE PHILIPPINES, USING BEST ESTIMATE OPPORTUNITY COSTS FOR LAND AND CAPITAL,[a] 1974*

		Domestic costs		Foreign costs				
System	Total cost (*P/ton*)	Production (*P/hectare*)	Marketing (*P/ton*)	Production (*P/hectare*)	Marketing	Yield, milled rice (*tons/hectare*)	Domestic resource cost	Comparative advantage
1	2,168	2,588	484	756	12	2.00	6.000	0.869
2	2,018	2,568	484	477	12	2.00	5.650	0.807
3	1,970	1,929	361	1,260	15	2.00	5.218	0.745
4	2,198	2,433	484	972	12	2.00	6.162	0.880

*Domestic and foreign production costs taken from Tables 3, 4, 5, and 7. Marketing costs based on data in Leon A. Mears et al., *Rice Economy of the Philippines*, University of the Philippines Press, Quezon City, 1974.

[a]c.i.f. price of $350/metric ton, official exchange rate of P6.70 = US$1 and shadow exchange rate of P7.00 = US$1.

(P1,200 per hectare) and a lower limit of 20 percent (P600 per hectare) do not seem out of line with the observed range of rents.

Costs of marketing the crop are included in the final stage of the DRC calculation. As with production, these costs are allocated to their domestic and foreign components. Drying and storage, the first steps in marketing, are assumed to be completed on the large-scale farms but within the marketing system for the small-scale farms.

DRCs OF ALTERNATIVE SYSTEMS

In Table 9, we have summarized the costs of rice production by the alternative systems evaluated. The DRCs are calculated as:

$$\frac{(\text{Domestic production cost/ha} \div \text{yield}) + \text{Domestic marketing cost/t}}{\text{c.i.f. price/t} - (\text{Foreign production cost/ha} \div \text{yield} + \text{Foreign marketing cost/t})/\text{SER}}$$

where c.i.f. equals price of imported rice in \$, and SER equals shadow exchange rate (P/\$).

System 3 has a slightly lower DRC and System 4 a slightly higher one, than Systems 1 and 2 which are intermediate. System 3 also has a slightly lower total cost per ton, while the Masagana 99 system, number 4, has a slightly higher cost. These differences, however, are minor. The similarities in DRCs and costs can be attributed to the uniform assumptions about yields and major input cost. In fact, if the land costs of System 3 were equal to those of other systems, then it would have a higher cost and DRC than System 2.

These calculations show that the DRC of rice production in the Philippines in 1974 was below the cost of foreign exchange for all four systems. Table 10 shows the DRCs of the four systems with various combinations of assumptions on the shadow prices of land and capital. Only with the high shadow prices do any of the DRCs exceed the 1974 shadow price of foreign exchange (P7 = US$1).

TABLE 10.—DRCs WITH ALTERNATIVE SHADOW PRICES FOR LAND AND CAPITAL

	Shadow price of land						
	Low		Best estimate			High	
	Shadow price of capital		Shadow price of capital			Shadow price of capital	
System	Low	Best estimate	Low	Best estimate	High	Best estimate	High
1	5.37	5.75	5.71	6.09	6.94	6.77	7.66
2	5.21	5.33	5.53	5.65	5.94	6.29	6.59
3	4.62	4.82	5.00	5.22	5.70	6.01	6.52
4	5.61	5.80	5.97	6.16	6.64	6.89	7.38

To evaluate the sensitivity of the DRCs to the assumptions, we have calculated elasticities of the DRC with respect to various parameters by assuming 10 percent changes in the specified parameters. These elasticities, shown in Table 11, reveal that the DRCs are relatively insensitive to shadow prices of land, capital, and foreign exchange, but highly sensitive to crop yield and the c.i.f. price of imported rice. Since the latter two are the most variable over time, special examination is given to these variables.

TABLE 11.—ELASTICITY OF DOMESTIC RSOURCE COST WITH RESPECT TO STATED PAMETERS

	Parameters				
System	Capital opportunity cost	Land opportunity cost	Yield	c.i.f. price	Shadow exchange rate
1	.021	.022	.104	.136	.018
2	.007	.022	.095	.126	.012
3	.014	.030	.127	.160	.033
4	.010	.023	.112	.145	.024

In our base estimate, we assumed a uniform yield of 3 tons per hectare of paddy or 2 tons per hectare of rice. This yield is nearly twice the national average, but should be easily attainable under good lowland irrigated growing conditions. In the series of studies of Laguna farms on which System 2 is based, yields averaged 2.6, 2.4, 3.2, and 3.3 tons per hectare in successive wet seasons since 1970 (*1*). In the studies that provided the basic data for System 1, yields were 2.3, 2.9, and 2.7 tons per hectare on irrigated farms in 1966, 1970, and 1974 wet seasons (*12*). As noted above, very few farms of the System 3 type are in existence. Those that were operating had average yields of 2.4 tons per hectare in 1975 and 2.8 tons per hectare in 1976. It is apparent that year-to-year variability on a given set of farms is as great or greater than system-to-system differences. Since there is no conclusive evidence to indicate the contrary, an equal yield for all systems seems like the most justifiable assumption. However, the differences in DRCs between systems that appear in Tables 9 and 10 should not be considered significant because even a 10 percent real difference in yield can change the rankings of the DRCs between systems.

CONCLUSION

The sensitivity of the DRC to the world price of imported rice has very serious policy implications in light of the extreme fluctuations in world rice prices which ranged from $200 to $600 per ton during the past five years. At $600, the DRCs for the systems examined are about 3, while at $200 they are approximately 12. Prices of some imported inputs like fertilizer also have fluctuated substantially. The DRCs with prices of imported rice and imported fertilizer at two-thirds and

TABLE 12.—DRCs WITH ALTERNATIVE PRICES OF IMPORTED RICE AND FERTILIZER, ALL OTHER PRICES AS FOR BASIC CASE

System	Basic calculations	Price of imported rice (\$/metric ton)		Price of imported fertilizer (\$/metric ton)	
		263	175	190	140
1	6.09	8.67	15.20	5.76	5.90
2	5.65	7.83	12.83	5.57	5.57
3	5.22	7.94	16.80	4.73	4.52
4	6.16	9.00	16.87	5.11	5.85

one-half their 1974 levels are shown in Table 12. The reductions in the fertilizer price slightly reduce the DRCs, but the effect of the same proportional reduction in rice prices sends the DRCs shooting up.

Clearly, if the long-term price of rice is \$600 and the long-term prices of the inputs used to produce rice stabilize at their 1974 level, increased production by any of the systems identified will be highly preferable to importation, and there will be a strong incentive to produce for export. However, at a long-term rice price of less than about \$280 and with inputs at their 1974 prices, all the systems are inefficient, and the country would be able to obtain its additional rice requirements with lower resource expenditure by directly importing rice.

The political realities of the rice situation are such that, regardless of possible economic consequences, there is a very strong incentive to be self-sufficient. Because of the sensitivity of the DRCs to changes in world rice prices and because of the volatility of those prices, it is impossible to show that a policy of self-sufficiency is economically inefficient without knowledge of long-run prices. We believe that over the long run price relationships will be slightly more favorable to domestic production than indicated by our base solution, and so self-sufficiency appears to be an economically justifiable goal. The precise type of production system that should be emphasized for expansion is an issue that goes beyond the scope of the present paper, but it should be clear that decision criteria other than DRC alone must be considered. Employment, distribution of income, concentration of economic power, and the implications for all participants in the rice sector are among the factors to be considered.

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