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AGRICULTURAL GROWTH AGAINST A LAND RESOURCE CONSTRAINT: THE PHILIPPINE EXPERIENCE

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In this paper, we seek a possible route for accelerating the agricultural growth in tropical monsoon Asia in the face of increasing population pressure on limited land resources.

According to a postulate of classical economists like Ricardo [18], population pressure on limited land resources will result eventually in agricultural and economic stagnation characterized by high food prices and low real wage rates that are barely sufficient for subsistence. The classical view has been challenged by Boserup [3] and Clark and Haswell [4], who argue that the population pressure will induce changes in both agricultural technology and agrarian structure so as to increase the intensity of land utilization. Hayami and Ruttan have provided another perspective, showing how countries like Japan, unfavorably endowed with land resources, could achieve rates of growth in agricultural output as high as those favorably endowed, like the United States, by developing technology appropriate to their resources [8].

The question here is whether the mechanism for inducing institutional and technological changes in response to population pressure for increased land utilization is, in fact, operating in countries in tropical monsoon Asia today. If so, what policies would be appropriate to facilitate those changes, given the specific environmental and economic conditions in those countries?

We attempt to answer such questions by studying agricultural development in the Philippines during the past two decades. A major change in the agricultural growth pattern in the Philippines is identified: a shift from area expansion, continually opening new land for cultivation, to expansion through intensified land utilization. We try also to show that the factors underlying this basic shift are changes in the relative costs of those alternatives for increasing agricultural output.

It has to be emphasized that this paper is designed to suggest a broad hypothesis rather than to provide conclusive evidence. Our analysis is bound to be highly conjectural because of the stringent limitations of data available in the Philippines.

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I Changing Patterns of Agricultural Growth

First, we try to identify historical changes in the pattern of agricultural growth in the Philippines that have emerged as the result of population pressure.

Until the end the 1950's, Philippine agriculture followed the traditional pattern of growth prevalent in Southeast Asia. Growth was brought about primarily by expansion of the cultivated area in response to an increased world demand for export crops. Then came an increase in the area planted to food staples, such as rice and corn, because of the growth in domestic demand that resulted from an export-stimulated rise in aggregate income and population.[1]

Meanwhile, there was little gain in yield per hectare. There had been some efforts to increase yield in plantations (notably by introducing improved sugar cane varieties from Java and Hawaii), but the possibility of increasing the yields of food staples was ignored.

Expansion of the area under cultivation at a rate rapid enough to absorb the growing labor force was possible as long as large unused land areas existed. Agricultural growth in the traditional pattern was bound to be limited, however, by the closing of the land frontier.

With the rapid growth of population after World War II, the supply of unexploited land began to be exhausted. Towards the end of the 1950's, expansion of agricultural land stagnated in the Philippines, and a major change occurred in the pattern of agricultural growth (Table 1). During the 1950's, total agricultural output increased at a rapid 4·1 percent per year, accompanied by an almost parallel rise in land area under cultivation (3·4 percent). Land area expansion contributed more than 80 percent to output growth, and the increase in yield per hectare of cultivated land area accounted for less than 20 percent. The agricultural labor force (number of farm workers) increased at an annual rate of 2·7 percent. Approximately one-half of the gain in labor productivity (1·5 percent per year) was explained by the increase in area per worker.

The pattern of agricultural growth in the 1960's represents a sharp contrast to that of the previous decade. The rate of expansion of the cultivated area dropped by almost one-half, but population growth did not drop appreciably. Increases in labor productivity became totally dependent on increases in land productivity.

These data clearly suggest that Philippine agriculture experienced a transition from the traditional growth pattern, based on the expansion of the cultivated area, to a new pattern based on an increase in land productivity.[2]

The process by which land productivity has increased is shown in Figure 1. Investment in irrigation accelerated in the late 1950's when the expansion of the cultivated area decelerated and the cultivated area per worker began to decline; the result was a sharp rise in the ratio of irrigated area to total cultivated area. Increases in land productivity during the 1960's paralleled the development in irrigation. The increase in rice yield per hectare was further accelerated by the development

[1] For a lucid description of the pattern of agricultural and economic growth in Southeast Asia, see Hla Myint [14]. For illustrative data, see Crisostomo, *et al.* [6].

[2] For more detailed documentation, see Crisostomo and Barker [5].

TABLE 1

Contribution of area and land productivity to the growth in output and labor productivity in Philippine agriculture (%)

	1948-52 to 1958-62		1958-62 to 1966-72	
	Annual growth rate	Relative contribution	Annual growth rate	Relative contribution
Total agricultural output	4·1	100	3·6	100
Cultivated land area	3·4	83	1·8	50
Output per ha of cultivated land area	0·7	17	1·8	50
Agricultural output per farm worker	1·5	100	1·5	100
Cultivated land area per farm worker	0·7	50	—0·3	—20
Output per ha of cultivated land area	0·7	50	1·8	120

Source: Crisostomo and Barker [5].

and diffusion of high yielding rice varieties (HYV) and the increased application of fertilizer.[3] Improvements in the irrigation infrastructure appear to have constituted the precondition for development of a seed-fertilizer technology.

Another remarkable aspect of the change in growth pattern is that the application of modern inputs and technology, hitherto limited to export crops, began to be concentrated in staple foods. In consequence, while during the 1950's the yields per hectare of export crops, such as sugar, were increased, during the 1960's the yields per hectare of food crops for domestic consumption were increased (Table 2).

Such contrasts seem to reflect a basic change in the direction of the growth of Philippine agriculture. The demand incentive for agricultural growth shifted from a world demand for export crops to a domestic demand for food crops created by the population explosion, and the supply basis shifted from area expansion to yield increase.

The nature of the epochal change in the growth pattern of Philippine agriculture is comparable to the experience in Taiwan agriculture during the period between the two world wars. Agricultural growth in Taiwan until the mid-1920's was based on area expansion, and the increase in output per worker was accompanied by an increase in cultivated area per worker. As population growth in Taiwan rose from 1 percent per year during the 1910's to 2·5 percent in the 1930's, the possibility of area expansion was exhausted and the land/labor ratio began to deteriorate. At the same time there was a spurt in land productivity. The growth in yield per hectare of cultivated land was brought about by increased cropping intensity and the development

[3] Increases in fertilizer input before 1960 were not accompanied by increases in land productivity. This contradicition was apparently due to the use of chemical fertilizer primarily to offset the declining yields of sugar due to the expansion of sugar production to less-fertile areas. Prior to 1960, use of fertilizer was concentrated in the sugar sector.

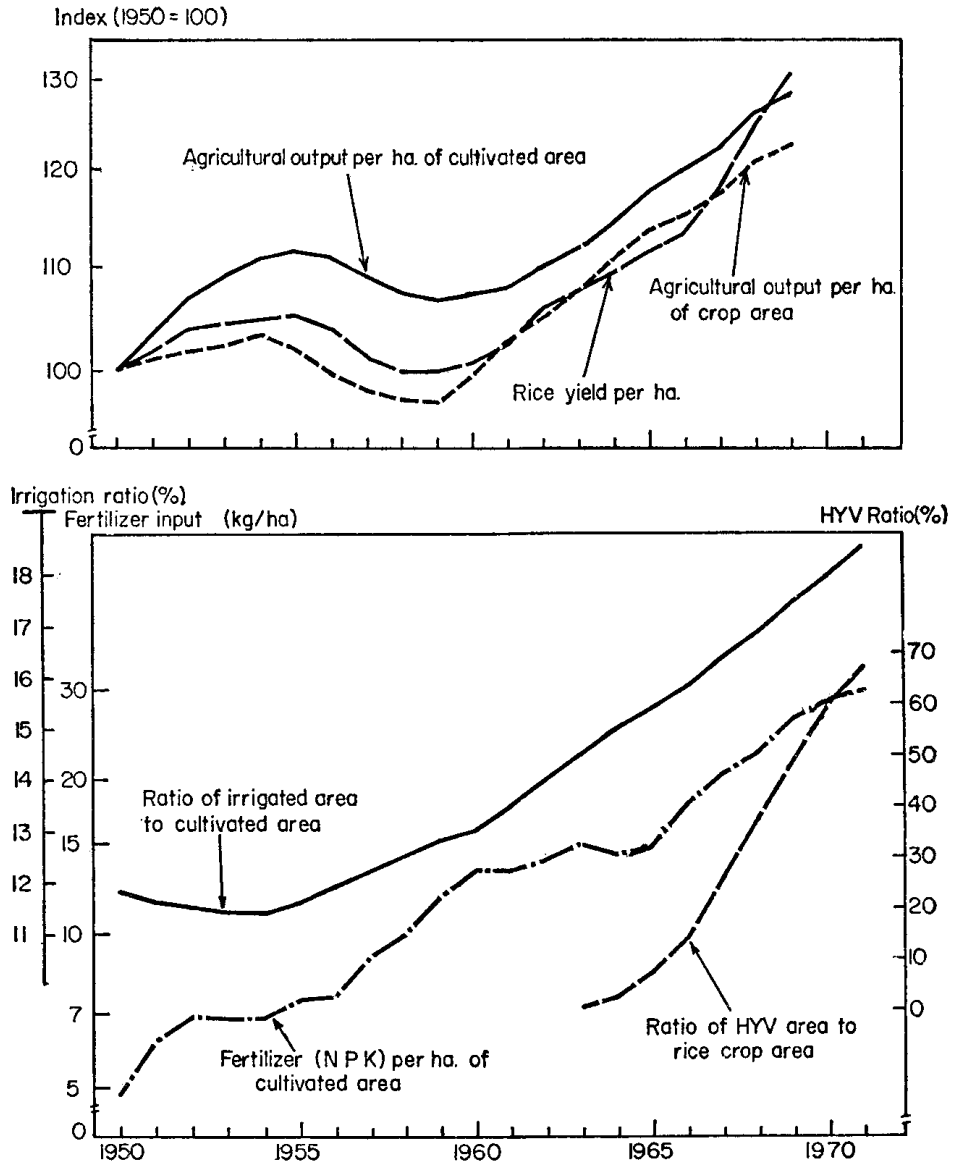

FIGURE 1—Comparison of trends in land productivity, improvement in irrigation systems, and progress in seed fertilizer technology, five-year moving averages.

Source: Anden [1] Republic of the Philippines [16], unpublished data of National Irrigation Administration and Bureau of Agricultural Economics, R. P.

and diffusion of high-yielding varieties of rice (so-called 'Ponlai varieties'). The increase in the intensity of land utilization was based on investment in irrigation, which was accelerated during the 1910's. As a result, agricultural output and productivity in Taiwan continued to rise in spite of the deterioration in the land/labor ratio.

The similarity of the Philippine and Taiwan experiences is demonstrated in Figure 2. Both Taiwan and the Philippines moved up to higher levels of labor productivity (iso-labor-productivity curves are

TABLE 2

Contributions of area and yield per ha to growth in total output of three major crops in the Philippines (%).

	Annual growth rate			Relative contribution		
	Output	Area	Yield per ha	Output	Area	Yield per ha
1948-52 to 1958-62						
Rice	3·5	3·5	–0·04	100	101	–1
Corn	6·4	7·4	–1·0	100	116	–16
Sugar	6·2	4·6	1·5	100	75	25
1958-62 to 1968-72						
Rice	2·9	–0·1	3·0	100	–3	103
Corn	5·2	2·0	3·2	100	39	61
Sugar	3·3	4·7	–1·4	100	142	–42

Source: Republic of the Philippines, Ministry of Agriculture, Bureau of Agricultural Economics [17].

represented by plotted contours) through changes in land productivity (Y/A) and land area per worker (A/L). It can clearly be seen that the turning point in agricultural growth from the pattern based on area expansion to that based on yield increase occurred in Taiwan in the mid-1920's, and in the Philippines in the late 1950's.

The change in the agricultural growth pattern in both countries seems to have occurred in response to population pressure on land in order to sustain growth in agricultural output and income.

II The Process of Intensifying Land Utilization: A Hypothesis

The shift towards more intensive cultivation involved both the efforts of farmers to increase the utilization of land and public investment to expand irrigation systems and develop a new rice technology complementary to irrigation.

Irrigation is a critical means of intensifying land utilization in monsoon Asia, especially for rice cultivation. Without an adequate water supply, the yield potential of fertilizer-responsive HYV's is not realized, and, therefore, it is not profitable to apply more fertilizer. Moreover, the risk of crop failure under rainfed conditions discourages cash expenditures for fertilizers and chemicals. In this sense irrigation represents a precondition for the introduction of the new seed-fertilizer technology.[4]

As population pressure pushes the cultivation frontier into marginal areas, we expect the marginal cost of agricultural production via expansion of cultivated area to rise relative to the marginal cost of production via more intensive land use. Eventually the economy reaches a stage at which more intensive land use becomes a less costly means of increasing agricultural output than expansion of the cultivated area. Curve A (Fig. 3) represents the marginal cost of increasing agricultural output or income by opening new land; Curve I represents

[4] Ishikawa has called this role of irrigation for facilitating the introduction of yield increasing inputs and technology a 'leading input' [12].

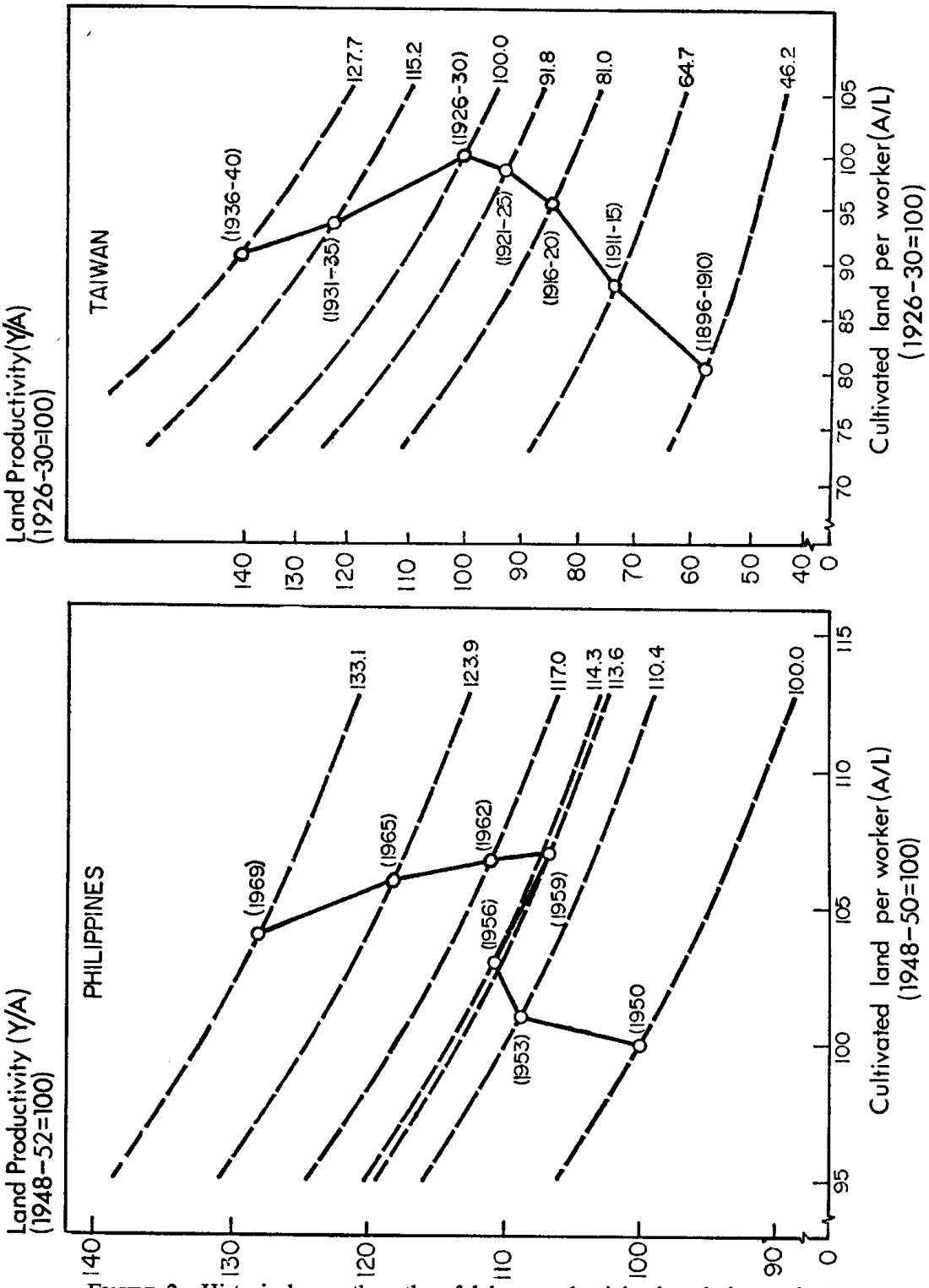

FIGURE 2—Historical growth paths of labor productivity in relation to land productivity and land/labor ratio in the Philippines and Taiwan.
Source: Crisostomo and Barker [6]; Lee [13, p. 51].

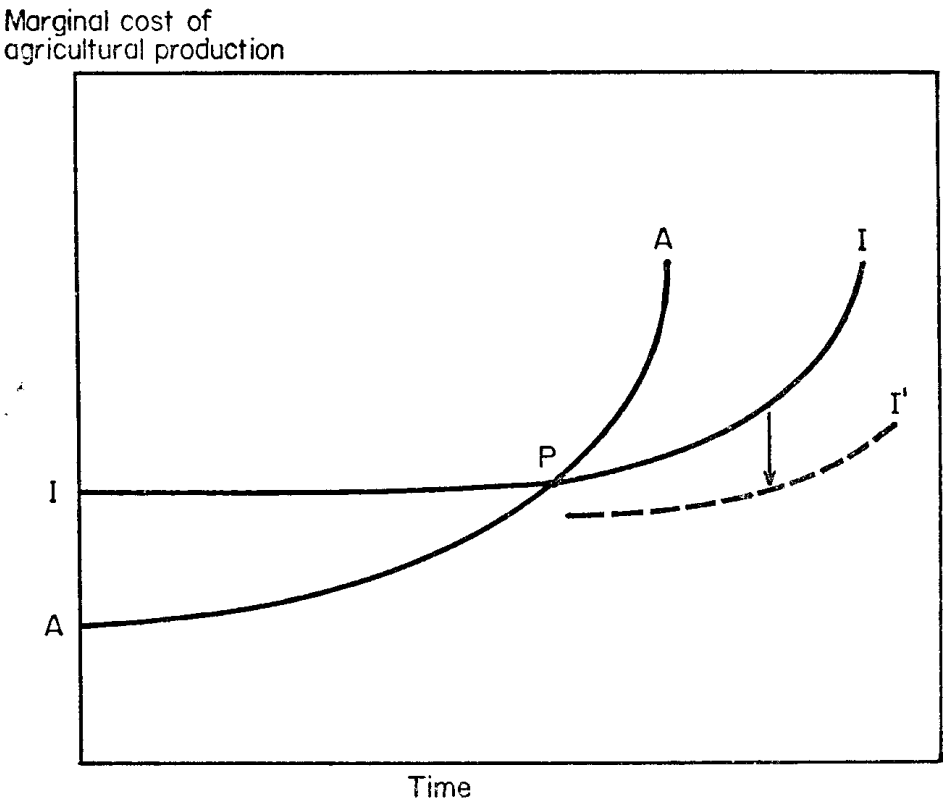

FIGURE 3—Hypothetical relations between the marginal cost of agricultural production by opening new land (A) and by building irrigation systems (I). When A climbs above I (at P) irrigation becomes a more profitable means of agricultural growth than opening new land. I' represents the reduced marginal cost of irrigation due to the impact of new seed-fertilizer technology.

the marginal cost of raising agricultural production by constructing irrigation facilities. With abundant land resources, Curve A would remain horizontal and below Curve I, indicating a relative advantage of area expansion over intensification. As unused land resources are exhausted and the cultivation frontier moves from superior land to inferior land, Curve A would rise and cross Curve I. When the economy reaches the crossover point P, irrigation becomes a more profitable base for agricultural growth than the opening of new land.

Philippine agriculture appears to have reached this stage in the late 1950's when the expansion of the cultivated area slowed down and government investment in irrigation accelerated. The relative profitability of irrigation was enhanced by the new seed-fertilizer technology developed during the mid-1960's. Fertilizers and HYV's reduced the cost of irrigation required to produce a unit of additional income (as illustrated in Figure 3 by the shift of the irrigation cost curve downwards from I to I').

Growth in total output and output per worker in Philippine agriculture continued through the 1960's in spite of the sharply rising

marginal cost of area expansion. It is hypothesized that the improvement in the relative profitability of more intensive land use by irrigation investment was induced by the rise in the cost of land relative to the cost of labor. The underlying force was the population pressure on land.

Since the late 1950's, improvements in the irrigation infrastructure which have led to more intensive land use have been accomplished primarily by expanding relatively simple gravity irrigation systems. As the area under irrigation expands, irrigation construction moves from the relatively easier and less costly projects to the more difficult and more costly. This implies that the marginal cost of irrigation will have a rising trend (Figure 3). Unless there are developments of new technology to shift the cost curve downward (from I to I'), agricultural growth may also be constrained by rising irrigation costs.

III Costs and Benefits of Irrigation Development Vs. Land Opening

As a test of the hypothesis postulated in the previous section, we have attempted to estimate Curves A, I and I' in terms of the marginal costs of irrigation development and land opening to produce an additional unit of income (gross value added) from agricultural production.

The estimates of Curve I and I' are shown in Table 3. The cost consists of the annual service flow of capital investment in irrigation, including the cost of maintenance and operation. On the benefit side, gross value added is calculated by subtracting the cost of seed, fertilizers and chemicals from the value of rice output produced on the new irrigated area. Both output and input values are measured in 1970 prices.

Two estimates of the increases in value added are used. They involve alternative assumptions about the cost of additional labor required for the second rice crop that dry season irrigation makes possible. In Case A, it is assumed that the opportunity cost of farm labor in the dry season is zero, hence the additional labor cost is not deducted in the calculation of value added. In Case B, the full imputed cost of labor at market wage rates is deducted. These two cases represent the boundary estimates for the actual cost of additional labor due to the increase in cropping intensity. For each case, increases in gross value added are estimated for various levels of technology (traditional varieties vs HYV) and of fertilizer inputs (5, 15, 20, and 60 kg of nitrogen per hectare). The basic trends are similar for the two cases, but the estimated marginal irrigation costs for Case A are about 20 percent lower than for Case B (Table 3).

Based on the estimates for Case A, Figure 4 shows changes in the marginal irrigation cost per peso of agricultural income over time. These empirical relationships correspond to Curve I and Curve I' in Figure 3. The upper curve (Figure 4) marked as 'traditional, 5 N' indicates the trend of the marginal cost of irrigation to produce an additional peso of income if the whole area serviced by the constructed irrigation system were planted in traditional varieties with negligible application of fertilizers. The lower curves designated as 'traditional, 15 N,' 'HYV,

TABLE 3

Changes in the costs of building irrigation systems required to produce an additional peso of agricultural income in 1970 constant prices.[a]

Varieties planted	Case A				Case B			
	Traditional		HYV		Traditional		HYV	
Nitrogen input level[b]	5N	15N	20N	60N	5N	15N	20N	60N
	peso/peso							
1951-1955	0·48	0·47			0·61	0·60		
1956-1960	0·52	0·51			0·65	0·64		
1961-1965	0·53	0·56			0·72	0·71		
1966-1970	0·67	0·65	0·35	0·31	0·84	0·83	0·39	0·35
1970-1974	0·74	0·73	0·39	0·34	0·93	0·92	0·44	0·39

[a] Costs refer to the construction projects by the National Irrigation Administration that are completed during the specified years.
[b] Kg of N per hectare of rice crop area.
Source: Appendix.

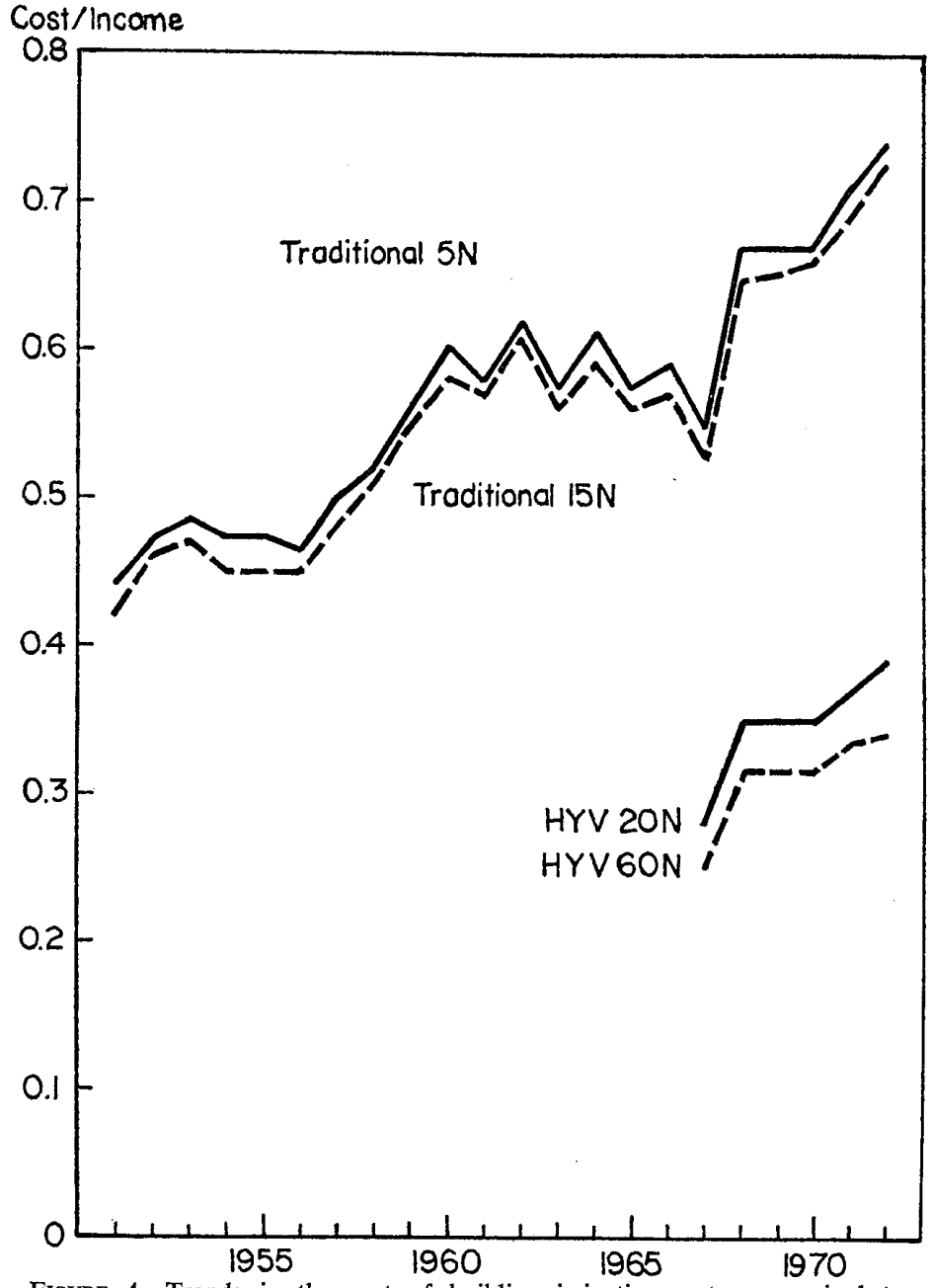

FIGURE 4—Trends in the cost of building irrigation systems required to produce an additional peso of agricultural income under alternative levels of rice technology, in 1970 constant prices, five-year moving averages.
Source: Appendix.

20 N,' 'HYV, 60 N' represent the costs of irrigation per peso of incremental income under the alternative assumptions of the irrigated area planted in 'traditional varieties with application of 15 kilograms of nitrogen per hectare,' 'HYV's with 20 kilograms of nitrogen,' and 'HYV's with 60 kilograms of nitrogen' respectively.

Figure 4 indicates a rising trend in the real cost of irrigation per

TABLE 4

Comparsion of the marginal costs of land opening and irrigation construction to produce an additional peso of income in agriculture.[a]

	peso/peso	
Land opening:		
Planted with rice[b]	1·21	
Planted with corn[c]	0·83	
Irrigation:	Case A	Case B
Traditional 5N	0·74	0·93
Traditional 15N	0·73	0·92
HYV 20N	0·39	0·44
HYV 60N	0·34	0·39

[a] Land opening costs refer to the projects of the Bureau of Land Resettlement completed in 1973. Irrigation costs refer to the projects of the National Irrigation Administration completed in 1970-1974. Both costs and income produced from those projects are valued at 1970 constant prices.

[b] Assume one crop of upland rice planted in the opened land.

[c] Assume two crops of corn planted in the opened land.

Source: Appendix.

peso of income from rice in the Philippines. However, the rising marginal cost of irrigation has been more than compensated by the successive downward shifts in the marginal cost curve due to the development of seed-fertilizer technology. Those shifts represent the empirical estimates of the shift from Curve I to Curve I′ in Figure 3.

Historical data are not available to estimate Curve A in Figure 3, which represents a cost curve for opening new land for cultivation.[5] However, the hypothesis that Curve A is located above Curve I in recent years is supported by Table 4. This table compares the costs per peso of income generated from the government's irrigation projects versus land resettlement projects. Approximately one peso of investment in land resettlement projects is required to open a new land area that produces one peso of agricultural income. This implies that no net benefit to the society results from opening new land.

Even allowing for substantial measurement errors, it is safe to say that with HYV's and higher fertilizer application, the construction of irrigation is much more profitable or less costly than the opening of new land as a means of generating an additional flow of income in agriculture.[6] Although the historical data are not available, it does not seem unreasonable to infer that the cost of land opening has risen more sharply than the cost of irrigation as cultivation frontiers moved to marginal areas, so that Curve A has crossed Curve I from below.

IV Conclusion and Implication

Our historical analysis has revealed a major change in the pattern of agricultural growth in the Philippines from the 1950's to the 1960's.

[5] Another major data limitation was the unavailability of historical time series of land prices which would reflect the increasing scarcity of land.

[6] The decline in the cost of irrigation per peso of benefit due to the development of HYV technology is not of course, a manna from heaven. It is the product of agricultural research that requires productive resources. For the cost-benefit analysis of rice research in the Philippines, see Flores, Evenson and Hayami [7].

During the earlier decade the increase in output was brought about primarily by the expansion of area under cultivation; in the later, output growth resulted primarily from an increase in yield per hectare. The major cause of yield growth has been identified as investment in irrigation infrastructure, which was accelerated when area expansion was decelerated.

The analysis in the previous section, though not conclusive due to the stringent data limitations, is not inconsistent with a hypothesis that the spurt in irrigation investment in the late 1950's was induced by the lower cost of building irrigation systems relative to the cost of opening new land for cultivation. Our analysis also shows that the rising cost of irrigation as more cultivated area is irrigated has been counteracted by the development of a new rice technology. If there had been no such developments, the Philippines would have been trapped in a Ricardian stagnation resulting from a sharply rising cost of agricultural production under strong population pressures and land resource constraints.

Population growth will continue to press hard on the limited land resources in Asia as in the Philippines. Escape from the Ricardian trap is through 'internal augmentation of land' by improving land quality, and developing a land-saving technology. The key to sustained agricultural growth is intensified investment by the public sector in irrigation, and in research on the compelling need of the economy for internal land augmentation. The experience in the Philippines seems to suggest that such a response did occur, even though it might not have been as effective as desired.

APPENDIX

Estimation of the Cost/Benefit Ratios for Investment in Irrigation and Land Opening

The marginal costs of building irrigation systems and opening new land for cultivation required to produce a peso of agricultural income are calculated as the ratio of the costs (in flow terms converted from capital investments) to the gross value added that was produced from the investments. Costs and benefits are deflated separately by the price indices (1970 = 100) for the cost and the income. By applying different deflators, we intend to wash away the effects of changes in relative prices among products and inputs on the profitability of irrigation investments, and thereby, to single out the effects of changes in the real cost relative to the real income. The formula used is:

$$\frac{C}{R} = \left[\frac{i\,(1+i)^n K}{(1+i)^n - 1} + M \right] / R$$

where:

C: Flow cost of investment per hectare
R: Increase in value added per hectare
K: Capital cost per hectare
M: Operation and maintenance cost per hectare
i: Interest rate (assumed 10 per cent)
n: Period of usable life

Irrigation

The capital costs of irrigation (K) are those of building the gravity systems of the National Irrigation Administration (NIA). Data on the total capital costs of the newly constructed systems, the periods of construction, and the areas to be irrigated by the systems are provided by NIA. The total costs are allocated over the years of construction by assuming a uniform distribution; then they are compounded into a value in the year completed using a 10 percent interest rate. The capital costs, thus estimated, are deflated by the GNP implicit deflator for investment in construction with $1970 = 100$.

Operation and maintenance costs of irrigation systems (M) are assumed to be 60 pesos per hectare per year in 1970 prices based on the irrigation fee.

The productive life of irrigation systems (n) is assumed to be 50 years.

Increases in value added per hectare due to the irrigation systems (R) are calculated by subtracting the increases in rice production costs from the increases in rice output. Case A includes the cost of current inputs such as fertilizers, chemicals and seeds in the production cost. Case B includes both the current input costs and the labor costs for the dry season crop. The procedure for estimating increases in value added is summarized in Appendix Table A. The fertilizer response function of rice for HYV in irrigated farm fields is from Atkinson and Kunkel [2]. The response functions for traditional varieties in irrigated fields based on 200 experiments at experiment stations during 1962-72 are reported with an average function ($Y = 2927 + 19N - 0{\cdot}2427N^2$) in Pisithpum [15]. In order to adjust for yield differences between farmers' fields and experiment station fields, the average function was lowered by 45 per cent. The 45 per cent adjustment is based on the comparison of the Atkinson-Kunkel function for HYV in farmers' fields and the average function for HYV in experiment fields reported by Pisithpum. The response function for traditional varieties in unirrigated fields is estimated by lowering the function for traditional varieties in irrigated fields by 30 per cent. The 30 per cent adjustment is based on the differences in the yields of traditional varieties between irrigated and unirrigated fields according to the sample surveys of the Bureau of Agricultural Economics.

The resulting estimates of marginal costs of irrigation per peso of income, together with the estimates of capital costs per hectare of irrigated area, are shown in Appendix Table B.

Land Opening

The capital costs of opening new land (K) are based on land resettlement projects of the Department of Agrarian Reform completed in 1973. The costs cover land survey, land clearing, transportation and housing infrastructure, subsistence ration for one year, and medical assistance. The data are provided by the Census and Statistics Division, Bureau of Land Resettlement, Department of Agrarian Reform. The total capital cost for the project period was compounded into the cost of 1973 using a 10 per cent interest rate, assuming an average gestation period of two years. The costs in 1973 prices are converted into 1970

APPENDIX TABLE A

Estimates of increases in value added to rice production due to irrigation construction.

Level of technology	Nitrogen input N	Rice Yield Y[a]	Increase in value: First Crop: Rice output[b]	Increase in value: First Crop: Current input costs[c]	Increase in value: Second Crop: Rice output	Increase in value: Second Crop: Current input cost	Increase in value: Second Crop: Labor cost[d]	Increase in value added[e]: Case A	Increase in value added[e]: Case B
	(1)	(2) kg/ha	(3)	(4)	(5) peso/ha	(6)	(7)	(8)	(9)
Unirrigated land:									
Traditional varieties									
N = 5 kg	5	1276	—	—	—	—	—	—	—
Irrigated land:									
Traditional varieties									
N = 5 kg	5	1662	161	0	693	14	212	345	275
N = 15 kg	15	1746	196	27	728	41	226	354	279
High-yielding varieties									
N = 20 kg	20	2476	500	41	1032	54	239	667	588
N = 60 kg	60	2920	686	150	1218	163	262	750	664

[a] Paddy terms. Derived from the response functions: Traditional varieties in unirrigated field; $Y = 1238 + 8N - 0{\cdot}100N^2$
Traditional varieties in irrigated field; $Y = 1610 + 11N - 0{\cdot}130N^2$
High-yielding varieties in irrigated field; $Y = 2150 + 18N - 0{\cdot}086N^2$

[b] Rice price = 0·417 Peso/kg (18·33 Peso/cavan, 1969-71 average).

[c] Nitrogen price = 1·70 Peso/kg, 1969-71 average, and total cost of current inputs = 1·6 × nitrogen cost.

[d] Labor requirements for second crop are assumed as: Traditional varieties in irrigated field; N = 5 kg: 64 mandays/ha
N = 15 kg: 68 mandays/ha
High-yielding varieties in irrigated field; N = 20 kg: 72 mandays/ha
N = 60 kg: 79 mandays/ha.

Daily wage rate = 3·32 Peso/man-day, 1969-71 average.

[e] Case A: 0·75 [(3) − (4)] + 0·33 [(5) − (6)] Case B: 0·75 [(3) − (4)] + 0·33 [(5) − (6) − (7)]
where 0·75 and 0·33 are the irrigation rates (ratio of actually irrigated area to irrigation system command area) for the first and the second crops respectively.

Sources: Rice price data are from Anden [1, Table 12].
Nitrogen price data are from Anden [1, Table 30-a]. Data on the ratio of total current input cost to nitrogen cost is from IRRI [11, pp. 312-314].
Labor requirements fo second crop are based on the farm survey conducted by the Department of Agricultural Engineering at IRRI.
Daily wage rate data are from Anden [1, Table 34-a].
Irrigation rates for first and second crop are from IBRD [9].

APPENDIX TABLE B

Estimates of capital costs per hectare of irrigated area and flow costs per peso of agricultural income due to irrigation construction.

	Capital cost per hectare (1)	Flow cost per peso of value added: Traditional 5N (2)	Traditional 15N (3)	HYV 20N (4)	HYV 60N (5)	Flow cost per peso of value added: Traditional 5N (6)	Traditional 15N (7)	HYV 20N (8)	HYV 60N (9)
	peso/ha					peso/peso			
1951	1181	0·44	0·42			0·55	0·54		
1952	1295	0·47	0·46			0·59	0·58		
1953	1345	0·48	0·47			0·61	0·60		
1954	1289	0·47	0·45			0·59	0·58		
1955	1289	0·47	0·45			0·59	0·58		
1956	1256	0·46	0·45			0·57	0·56		
1957	1392	0·50	0·48			0·62	0·61		
1958	1471	0·52	0·51			0·65	0·64		
1959	1616	0·56	0·55			0·71	0·70		
1960	1733	0·60	0·58			0·75	0·74		
1961	1685	0·58	0·57			0·73	0·72		
1962	1819	0·62	0·61			0·78	0·77		
1963	1660	0·58	0·56			0·72	0·71		
1964	1711	0·61	0·59			0·76	0·75		
1965	1661	0·59	0·56			0·72	0·71		
1966	1702	0·59	0·57			0·74	0·73		
1967	1570	0·55	0·53	0·28	0·25	0·69	0·68	0·32	0·29
1968	1983	0·67	0·65	0·35	0·31	0·84	0·83	0·39	0·35
1969	1984	0·67	0·65	0·35	0·31	0·84	0·83	0·39	0·35
1970	1996	0·67	0·66	0·35	0·31	0·84	0·83	0·40	0·35
1971	2112	0·71	0·69	0·37	0·33	0·89	0·87	0·41	0·37
1972	2240	0·74	0·73	0·39	0·34	0·93	0·92	0·44	0·39

prices by the GNP implicit deflator for investment in construction. It is assumed that maintenance cost (M) is zero and productive life (n) is infinite for the opened new land.

Benefits from opening land (R) are estimated as 95 per cent of total output values produced in the opened land, assuming a value added ratio of 95 per cent. Output is valued at 1970 prices. Two cases are assumed for crops planted on the new land: (a) planting one crop of upland rice, and (b) planting two crops of corn. Average yields of rice and corn per hectare are assumed as 897 kg and 810 kg respectively. These yields are based on the national average yields on upland fields for 1969-73.

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