C. PETER TIMMER

EMPLOYMENT ASPECTS OF INVESTMENT IN RICE MARKETING IN INDONESIA*

It is not surprising that economists have given little notice to the employment aspects of marketing change. After all, the appropriate questions are how well the marketing system allocates commodities over time, place, and form. *These* are the outputs of the system. Labor is an input. It has received little more attention than any other cost involved in marketing.[1]

But analyzing any of the costs of marketing is a haphazard job. The only effective analytical tool we have as economists in this effort is the production function, which requires a relatively small number of homogeneous factors of production and a single output (although it can be expressed in value terms) to be empirically operational. Yet marketing in the normal sense certainly confounds these assumptions, for the physical output of the marketing system is multidimensional. Also, the underlying production functions for the three dimensions of marketing—space, time, and form transformations—are not even remotely similar. Rice milling, haulage, and warehousing cannot usefully be approximated by a single production function.

If an economist wants to examine factor costs for the entire marketing system, he is left then without much of an analytical framework. To look at a single aspect of the system, where the tools are relevant, is to miss the interactions which make marketing the very glue that holds the economy together. Nevertheless, I have opted for tools in the belief that there is a great deal to be learned by such an approach. The following paper uses the traditional microeconomic theory of the firm and of multimarket equilibria (7, Chaps. 3 and 5) to examine the Indonesian rice milling system, especially the optimum capital-labor ratio for new

* This paper was presented at the Agricultural Development Council/Research and Training Network (ADC/RTN) Workshop on Rural Marketing held at Stanford University, April 13–15, 1972. I would like to thank all the participants at that Workshop for helpful comments, and especially William O. Jones and William C. Merrill. I am also indebted to John Harris for pointing out an error in an earlier draft and to William Janssen, U.S. Agency for International Development (USAID), Djakarta, for being a sympathetic critic.

Material for the analysis was gathered while the author was a member of the Harvard Advisory Group, Indonesian National Planning Agency (BAPPENAS), April 1970 to August 1971.

[1] It is a commentary on the heightened awareness of our profession of the social and political problems accompanying economic development that L. A. Mears's now classic 1957 study *Rice Marketing in Indonesia* was primarily concerned with modernizing the marketing system and reducing margins, to the benefit of both farmers and consumers (*13*). The employment impact of changes in the rice marketing system is the primary focus of this paper, a topic not even listed in the Index.

facilities. I am aware that there is a good deal more to rice marketing than this and that there are important employment issues in these neglected areas. This paper is only a start.

The reason for beginning with milling is that a USAID-financed rice marketing study conducted by Weitz-Hettelsater Engineers has just been submitted to the Indonesian Government (*19*). This report recommends, in the facilities section, a package of milling investments that would begin the modernization of the Indonesian rice marketing system by introducing a number of large (by Indonesian standards) bulk storage, drying, and milling facilities.

After a quick review of the analytical tools and methodology available for relating the labor intensity of a facility to its output, this paper will apply these tools to the Indonesian rice milling sector. It is the intent of this analysis to provide some policy guidance on the type of investment program in rice milling that is appropriate in Indonesia, and to appraise how the recommended package of the rice marketing study fares.

Something more than a job-counting review of the rice marketing study is attempted here. The study provides ample engineering data of a sort the economist needs but seldom has in order to specify an efficient choice of technology. Such a specification can be made by using appropriate factor prices in the evaluation, although this may mean shadow-pricing unskilled labor on Java at approximately zero. It will become clear that going this far in the analysis is simply good economics and does not have to be justified in any sense by a concern for social goals.

In the Indonesian context it is possible to focus social concern about market development and personal equity on the labor intensity of market change. On Java, where two-thirds of Indonesians live, a highly unequal distribution of income has not yet been generated by the growth process (although the beginnings are clear), and the grossest social inequities are presently between unskilled laborers with and without jobs. Substantially reducing unemployment in a productive manner would be a very large first step in solving income distribution inequities, at least for the short-run of the 1970s.

I must emphasize, however, that this solution does nothing to prevent longer-run income distribution inequities, and may conceivably make them worse. A recent paper by D. B. Keesing forcefully argues that full employment in a developing country is perfectly consistent with the most glaring of income distribution inequities, because of the low economic value of unskilled and highly available labor. In fact, Keesing reaches one conclusion that must be troublesome to many economists: "Socially 'correct' price signals and intelligent efforts to solve problems of employment, market size, agricultural productivity and the quality of human resources may only aggravate the problem of equity" (*9*, p. 4).

Indonesia has not yet reached the level of sustained growth necessary for the mechanisms Keesing outlines to lead to major inequitable distributive effects. But that time may be soon, perhaps no later than the next decade. Groundwork and policies laid down now can make the problem of redistribution to achieve even minimal social justice a decade from now less explosive if they reach toward a rural-based, employment-intensive strategy of production gains. How far one goes in this strategy is only partly a matter of economic analysis. But one of the

surprising results of my analysis is just how far down this road economics takes us under the factor availabilities of Indonesia.[2]

A METHODOLOGICAL FRAMEWORK

For any given income distribution, society maximizes its economic output (and, by assumption, its well-being) when firms pay factors of production their marginal revenue product and are paid for their output a price equal to marginal cost. This Pareto optimal view of the world will be used in the following discussion, and its marginal decision-making criteria will be employed even though areas of the Indonesian economy clearly do not satisfy them. In essence, I am ignoring the whole issue of the "second-best." This assumes that the economy comes closer to maximum output as more sectors fulfill the underlying conditions for Pareto optimality.

In the context of decision-making in the rice milling sector, the important question is how efficiency (output per unit of inputs) varies with the factor proportions, especially labor intensity. There is more than one way to view efficiency —Chart 1 shows four.

The vertical axis measures the efficiency frontier with respect to each of the four "views"—engineering, market, economic, and social. Engineering efficiency is measured by the ratio of physical output to physical input(s). In rice milling, for example, this is taken to be the proportion of milled rice to rough rice. It is not inevitable, given this definition of efficiency, that the relationship with labor intensity be as depicted in Chart 1. In fact, millions of peasants with razor blades and pumice stones "milling" each grain separately might have a higher efficiency by this definition. Chart 1 is based on the further assumption, which is certainly true for rice milling technology and probably much more widely, that the evolution of equipment to maximize engineering efficiency also tended to reduce labor inputs because of relative factor prices prevailing in the economies that developed the machines. Consequently, the shape and location of the engineering efficiency curve in Chart 1, while not logically necessary, is an historical fact.[3]

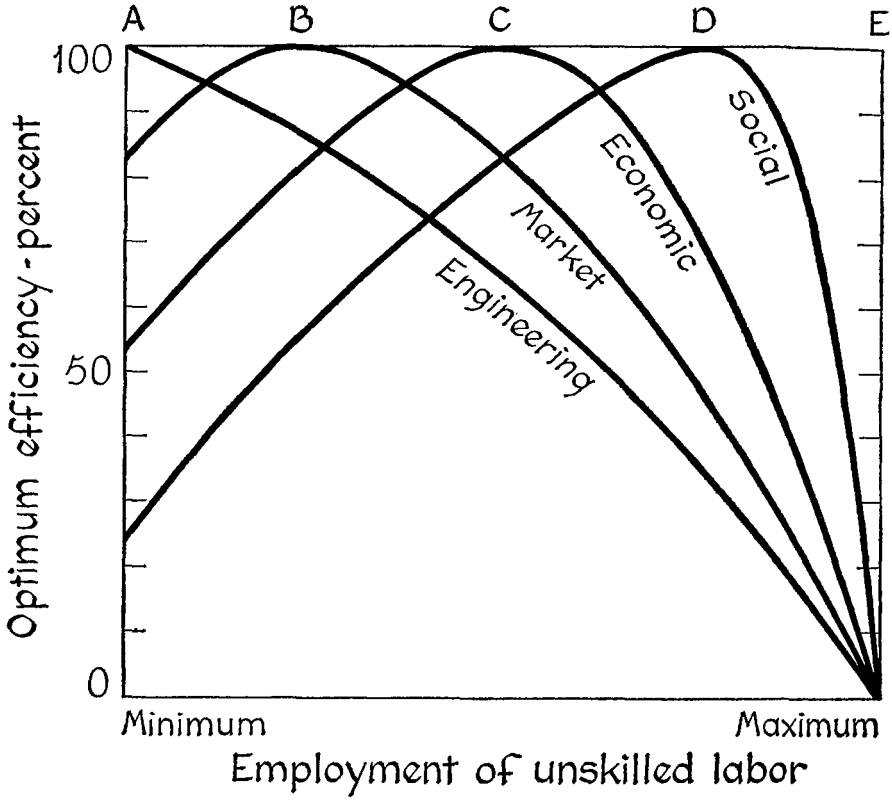
Market efficiency can be measured by the private rate of profits. Since Chart 1 depicts a labor surplus economy in which the market wage rate used by private entrepreneurs to decide on factor proportions is higher than the true economic cost to the economy, the peak market efficiency is less labor intensive than the peak economic efficiency. The latter would be determined by an economic planner using a shadow wage rate substantially lower than the market rate.

Lastly, in a country with substantial unemployment, the social wage rate (implicitly) used by a policymaker concerned about social equity (and stability) is assumed to be even lower than the economic shadow wage.

[2] There is no real conflict here with W. P. Falcon's view of the magnitude of employment problems on Java: "Although economists often overplay the role of prices, and clearly correction of prices alone will not solve unemployment difficulties in regions such as Bengal and Java, price distortions are nevertheless a major cause of unemployment in many parts of the world" (*4*, p. 11). I will argue in both the methodological and empirical parts of this paper that a substantial impact can be made on employment *even on Java* if appropriate prices are used in decision-making analyses for investments in marketing changes. But of course, accelerated employment in rice marketing alone will not solve Java's unemployment problems.

[3] This is only a slight extension of the induced development model put forward by Yujiro Hayami and V. W. Ruttan (*6*).

CHART 1.—FOUR VIEWS OF THE TRADE-OFFS BETWEEN EFFICIENCY AND EMPLOYMENT



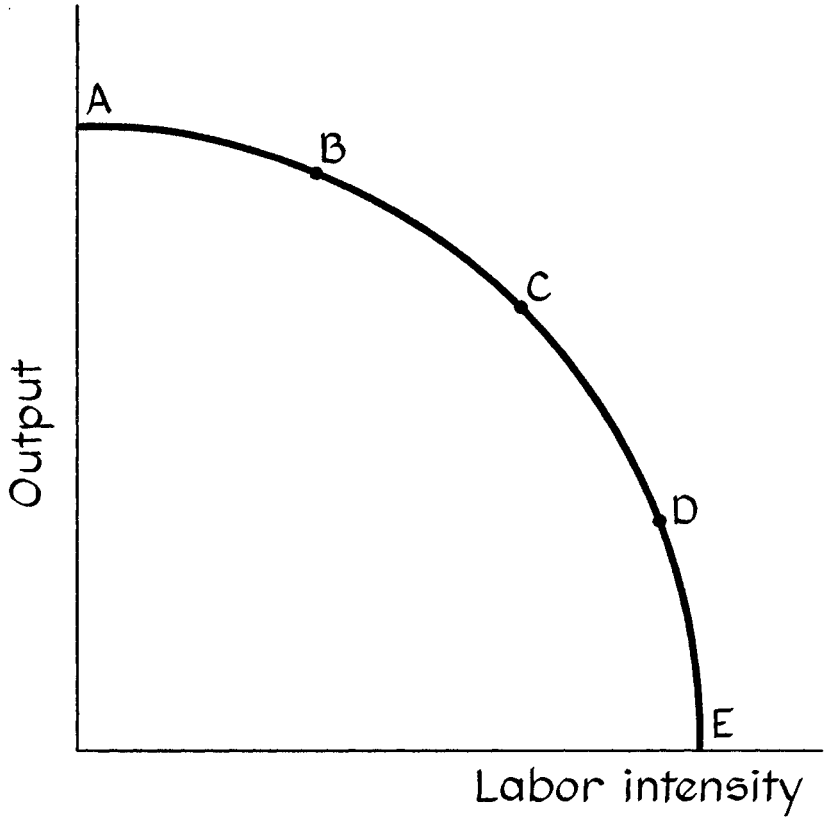
The point of Chart 1 is not to relate efficiency of one view to that of another, but to show how the optimal level of employment of unskilled labor rises (in a labor surplus economy) as correspondingly more appropriate decision criteria are used that reflect factor availabilities. It is important to remember that, although the ordering of market, economic, and social efficiencies is a function of economic logic, the position of engineering efficiency relative to labor intensity is a function of the specific technology under discussion. Engineering efficiency is, by the definition used here, neutral with regard to labor inputs.[4] However, placing the peak in engineering efficiency at the lowest labor intensity closely represents the real state of affairs in rice milling and probably much more widely.

The results of these assumptions, which I argue are a fairly accurate representation of the situation in several countries in Southeast Asia and perhaps Latin America, can be translated into more familiar form in Chart 2. Now it is necessary to measure all points of view with the same standard. Chart 2 might use, for example, the quantity or value of milled rice delivered to the consumer per unit of rough rice input as the measure of output. Labor intensity could be specified as hours of unskilled labor required per ton.

Underlying the downward sloping curve of Chart 2 are two further assump-

[4] I am indebted to W. O. Jones for emphasizing this point.

CHART 2



tions that must be made explicit. First, the technological process being considered (in this example, rice marketing in general and milling in particular) is amenable to various combinations of labor and capital. R. S. Eckaus argues that the substitutability of labor for capital varies by industry (*3*), but even casual empiricism confirms that it is possible for rice milling. Second, more labor-intensive technology has lower output per unit of raw material input. The evidence here is by no means overwhelming even for rice milling and is almost certainly not true in general, either for marketing or industrial processes. But the greater waste, less efficient conversion, and loss of by-products with the more labor-intensive huller and hand-pounding rice milling techniques argue that the assumption is reasonable in this particular instance. We will return to this later.

It would appear from Chart 2 that policymakers are faced with a trade-off between output and employment (which is also a trade-off between output and equity in the Indonesian context)[5] right from the start. Unless engineering "state of the art" facilities are used, with minimal employment of unskilled labor, output is lower than at A.

This is true as far as it goes, but it does not go far enough. The trade-off in Chart 2 reflects a very myopic view of the economy. In fact, it represents only

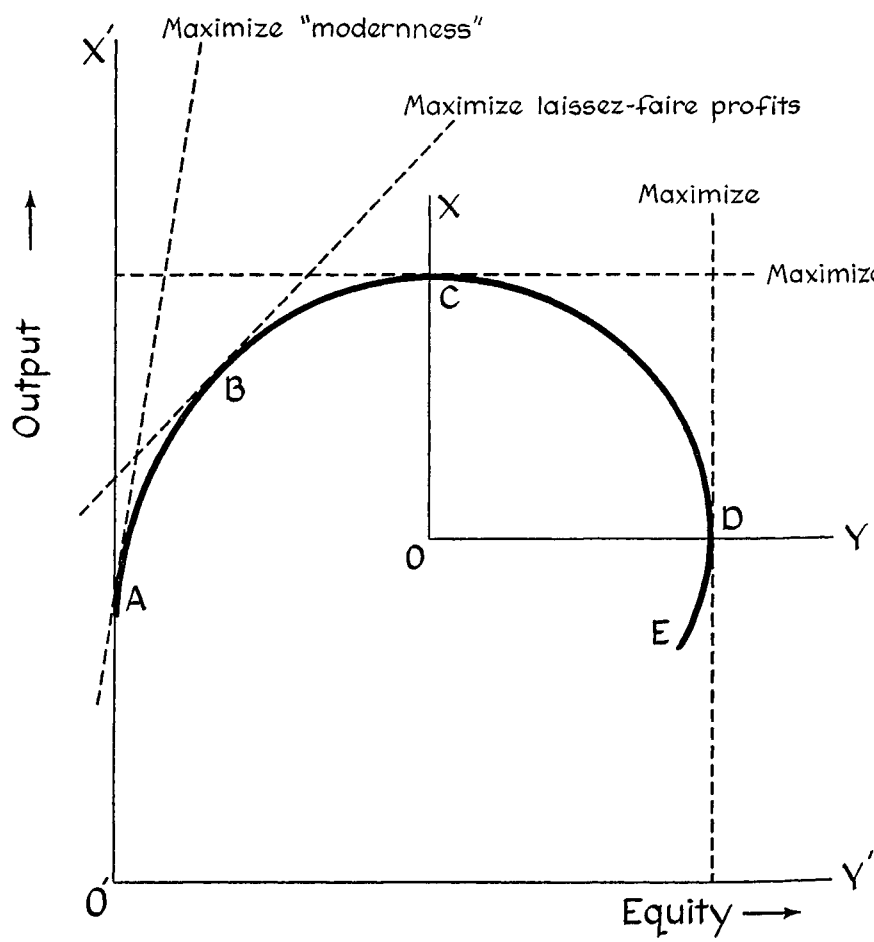
[5] M. C. McGuire and H. A. Garn also interchange employment and equity in their paper on regional equity in the United States (*12*).

what is happening in the rice milling sector and ignores completely what output decisions are being made in the rest of the economy. And since the capital necessary to invest in technique A (and possibly the labor needed to operate at D or E) has alternative uses in other sectors, this myopic view seriously biases the choice of an efficient technology.

Chart 3 corrects this narrow vision by showing what happens to total output in the economy as different techniques are used in the milling sector. Output in Chart 3 refers to the entire output of the economy. It is thus a price-weighted index, and maximizing this output requires maximization for the entire economy, not just the marketing sector. On the other hand, the curve ABCDE refers to what is happening in the milling sector, assuming appropriate policies and maximization in the rest of the economy. It is extremely important to realize that the solutions indicated in Chart 3 are dependent on general equilibrium at appropriate factor prices, not a partial equilibrium view of the marketing system only.

It is also worth noting that the horizontal axis no longer measures labor in-

CHART 3



tensity, as in Chart 2, but now has been transformed to an amorphous "equity" axis. The reason for doing this is simply to show that there are some labor intensities (as in technology E, e.g., hand-pounding) so great as to create an inequitable distribution of income. This could occur, for example, if there were higher paying jobs outside the milling sector which hand-pounders could take if they were not needed to pound rice.[6] So although labor intensity is higher in E than in D, as shown in Chart 2, the distribution (and levels) of income in D would be socially preferable to those in E.

Chart 3 also helps clarify the discussion about the trade-off between equity and output. Four different objective functions are shown in Chart 3, varying from a loosely defined "maximize modernness," with tangency at A, to an equally loosely defined "maximize equity," with tangency at D. Maximizing profits according to prevailing market prices leads to B, and maximizing the (social) value of output according to prices that accurately reflect factor scarcities leads to C. If there were no divergence between private and social prices, then B and C would be the same in a competitive economy.

Now it is clear that the trade-off between output and labor intensity from A to E in Chart 2 was only apparent, due to the partial equilibrium approach implicit in that diagram. From society's point of view, a trade-off between output and employment does not occur until the range between the C and D technologies. Much of the literature talks of the trade-offs between equity and output as if the only relevant segment of the relationship is contained in the XOY quadrant. In fact, this neat convex trade-off presupposes a substantial amount of economically sophisticated decision making that is extremely unlikely to have taken place. It is premature to face up to the trade-off between equity and output when the economy is operating somewhere on segment AC rather than the CD.

But Chart 3 also helps to illustrate the inevitable difficulties we face, as economists, in determining the optimal trade-off between output and equity, i.e., where on segment CD society should be. Even if we were to be told, for example, that Indonesia places the same weight on equity as on output (growth) in its social welfare function, what would this mean? Surely not a 45° line tangent to CD, because neither axis has an immutable scale. At our present stage of knowledge, in fact, there is no single quantitative measure that captures the entire concept of interpersonal equity.[7]

Why does Chart 3 look so different from Chart 2? The answer is that although

[6] I am not arguing that this could come about through natural market forces. However, a government-enforced ban on hullers and rice mills might bring about such a situation.

[7] Although there have been suggestions that a simple decision rule such as maximizing the sum of the logarithm or square or higher roots of personal incomes should be used, there is no theoretical or empirical justification for this yet (see *9*). McGuire and Garn use an interesting form for weighting employment and income separately (*12*).

$$\lambda^i = a\left|\frac{\bar{E}}{E^i}\right|^{\alpha} + b\left|\frac{\bar{\gamma}}{\gamma^i}\right|^{\beta}, \text{ where}$$

λ^i = area need indicator;
$\bar{E}$ = national average employment rate;
E^i = area employment rate;
$\bar{\gamma}$ = national median family income;
γ^i = area median family income.

They set the parameter values somewhat arbitrarily but argue that a policy-level decision maker could use his own weights.

output is higher in the marketing sector in situations A and B than it is in C, output is lower in the rest of the economy in A and B because of misallocation of resources (and simple unemployment of some, especially labor). Only when "true" factor prices are used in all sectors to make investment and output decisions, as in C, is total output for the entire economy maximized.

Now it is apparent why maximizing output in a partial equilibrium framework leads to such disastrous employment effects if market (or planning) factor prices do not reflect accurately the true factor availabilities.[8] Sectoral planners (or private investors) maximize output in their sector only, leading to situations A or B.[9] On an economy-wide basis, this leads to less output and less employment than is possible, as is shown in the general equilibrium perspective of Chart 3. This is obviously inefficient. There is no reason to make a choice between output and equity until the trade-off is forced in fact, as in segment CD of Chart 3, rather than only apparently, as in segment AC of Chart 2.

The discussion so far has focused only on the trade-off between employment and output in the present time period. The analysis is static. A second trade-off has also been discussed in the literature, and that is between employment and the rate of growth of output. The argument can be simply put: the marginal propensity to save out of returns to capital (profits) is higher than out of unskilled laborers' wages. The rate of economic growth depends on the rate of savings, so the greater the wage bill for unskilled laborers (greater equity), the lower the rate of growth. This approach is the basis of A. K. Sen's discussion for example (*14*).

The growth versus equity issue is only of limited importance in the present discussion, however. In the static context, the first step is to maximize the total volume of profits from a given amount of capital. This is the point of view of Chart 3, which maximizes total output from the entire economy rather than in a single sector, such as is done in Chart 2. While total reinvestable profits would, in theory (but not necessarily in practice), be highest in A of Chart 2, out of the five possibilities shown there, they would be even higher in B or C when appropriate investments are made in the rest of the economy. Total *share* of profits in the economy may well be lower because of the greater overall output. But in a world where entrepreneurs are assumed to maximize profits and not rate of return, this is immaterial. Consequently, the amount of growth (but perhaps not the rate, because of the larger base) would be largest in B or C as well.

One last methodological point is in order before moving on to the empirical discussion. Total employment in rice milling in Indonesia, while not large by comparison with rice cultivation, is not insignificant. If the total quantity of rice were hand-pounded, more than half a million peasants would be more or less fully employed just by this task. Since hand-pounded rice is still sold in significant

[8] Wrong factor prices in planning are, unfortunately, not the worst that can happen. There are many instances where even the prevailing factor prices show capital-intensive techniques to be unprofitable relative to more labor-intensive ones, and yet aid donors or outside advisors recommend the more "modern" investments. J. C. Abbott notes that most research on processing and storage is done by engineers (*1*). Not unnaturally, they tend to apply engineering criteria in their recommendations.

[9] This partial equilibrium analysis tends to produce the "let-someone-else-worry-about-it" approach discussed by Falcon (*4*).

quantities in rural markets, this is an important source of cash income for the farm family. So the question of an appropriate choice of technique for rice milling can have major welfare impact in and of itself.

But perhaps more importantly, both the analytical technique used here and the major thrust of the conclusions are likely to be highly relevant to the rest of rice marketing, other agricultural marketing, and even agricultural production.[10] The welfare significance extends well beyond what is said about rice milling per se.

RICE MILLING IN INDONESIA

The procedure followed in this empirical part of the paper is to trace the sequence of steps that leads from the construction of an empirical analogue to Chart 2 to an approximation of Chart 3. These steps require a careful blending of engineering and economic data contained in the rice marketing study (*19*), impressions gained in my observation of the rice economy of Indonesia, and some empirically based assumptions about the rest of the economy. Wherever relevant and possible, sensitivity analysis is conducted on these assumptions, impressions, and occasionally on the data. The results appear at first to be a confusing mélange of endless alternatives, but closer inspection reveals a very strong pattern of uniformity throughout the calculations: the overwhelming economic dominance of highly labor intensive techniques over highly capital intensive techniques.

The first step is identification of the different milling techniques that make up a technically efficient production function.[11] Table 1 shows the engineering and cost data for the five techniques that determine the frontier. A description of each technique is contained in the rice marketing study, but briefly, Z is hand-pounding, A uses small hullers, G uses larger Japanese-type mills with mechanical drying, H-1 is a small bulk storage and drying unit (4,500 tons of gabah[12]) with conventional multi-stage milling equipment, and K-1 is a larger bulk storage and drying unit (15,000 tons of gabah) with similar milling facilities. The K-1 unit is not large by United States standards—it is only half the size required to make concrete silos economically superior to the recommended steel bins. The code letters used are from the rice marketing study, with the exception of Z for hand-pounding.

The rice marketing study analyzes seven other milling technologies in addition to the five reported in Table 1. These include three small units similar to the A huller, two smaller Japanese-type mills, and smaller versions of the H-1 and K-1 bulk facilities. With two exceptions, these other techniques are dominated (use more capital *and* labor) by the techniques (or linear combinations of the techniques) shown in Table 1. The exceptions are two small huller-husker

[10] I am indebted to B. F. Johnston for convincing me of this.

[11] For a discussion of the concept of technical efficiency and the means by which it can be measured, see (*16*).

[12] As is common in most Asian countries, Indonesia has a precise word to describe each of the various stages that rice moves through from seed to cooked rice. The two of particular relevance here are "padi," which means harvested rice still attached to the stalk. To avoid confusion, I shall use the term "stalk padi" for rice at this stage. Next, "gabah" is threshed "stalk padi" with the husk still on, thus corresponding to "rough rice" or "paddy" in international nomenclature. I will use the term "gabah" throughout the empirical section to avoid any misunderstandings.

TABLE 1.—TECHNOLOGICAL SPECIFICATIONS OF VARIOUS MILLING FACILITIES*

	Hand-pounding Z(s)[a]	Huller A(s)[a]	Japanese mill G(s/m)[a]	Small bulk unit H-1(m)[a]	Large bulk unit K-1(m)[a]
			PER UNIT		
Milling capacity *(tons per year)*[b]	—	650	2,500	7,200	21,600
Investment cost *(U.S. dollars)*[c]	0	6,776	90,511	453,283	2,605,926
Operative laborers *(number per shift)*	—	8	16	27	39
			PER 1,000 TONS OF GABAH INPUT PER YEAR		
Investment cost *(U.S. dollars)*	0	10,425	36,204	62,956	120,645
Operative laborers *(number)*	40.00[d]	12.31	6.40	3.75	1.81

* Data from Weitz-Hettelsater Engineers, "Rice Storage, Handling and Marketing Study: Economic and Engineering Aspects," (advance draft), Dec. 1971.

[a] The "s" in parentheses indicates the facility uses sun drying; "m" indicates mechanical drying.

[b] Milling capacity is measured in tons of rough rice (gabah) input per year, assuming the facility operates 8 hours per day and 300 days per year.

[c] Includes cost of buildings and machinery, but not of land.

[d] Assumes one worker can hand-pound 80 kg. of gabah input per day, yielding approximately 50 kg. of rice.

units which, according to the data shown in the Study, dominate all techniques except the large bulk facilities (K-1). There is probably some misspecification of requirements in these two cases (the labor inputs seem extremely low), and they have been excluded from the analysis.[18]

When the data in Table 1 are graphed, Chart 4 results. This confirms the assumption that, at least in terms of input capacity, there is ample scope for substitution of capital and labor. Rice milling (and drying) is most emphatically not a technical process subject to fixed capital-labor coefficients.

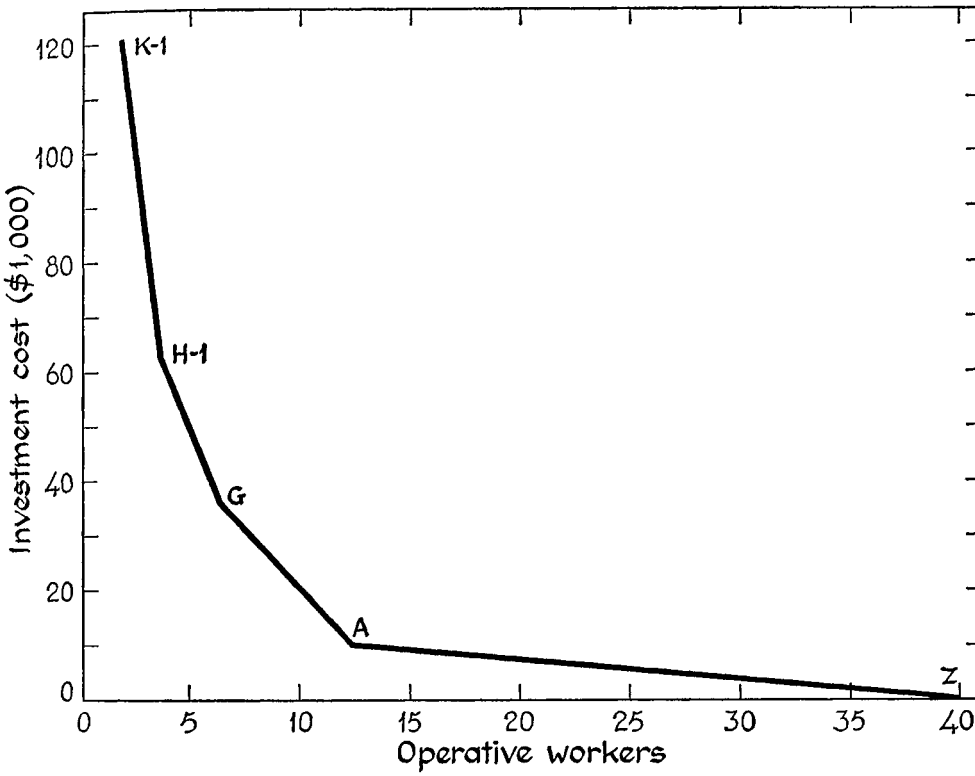
Table 2 moves the discussion from input capacity to size and value of output per 1,000 tons of input. The results are shown in Chart 5, which is the empirical analogue of Chart 2. It is clear that in terms of both physical output and market value per 1,000 tons of gabah input there is a strong negative relationship between output and labor intensity. Any decision criterion that emphasized output per unit of input within the milling industry only would inevitably lead to the large bulk facilities (K-1) as the best choice for modernizing the Indonesian milling industry. Such a criterion is, as emphasized in the methodological discussion, myopic. A broader perspective is required.

The means by which such a perspective is achieved is to construct a unit isoquant relating inputs of capital and labor to a unit of value added. This is done in Table 3 and pictured in Chart 6.

Table 3 calculates the value added by rice milling for each technique. This in-

[18] This is equivalent to specifying a probabilistic frontier production function with 17 per cent (2/12) of the extreme observations eliminated (*17*).

CHART 4.—CAPITAL AND LABOR INPUTS PER 1,000 TONS OF GABAH PROCESSING CAPACITY



volves substracting an assumed price for gabah from the market value of output. The lowest gabah price shown—Rp 16 per kilogram—corresponds to the floor price for "village dry" gabah at the mill. Since each facility, even hand-pounding (Z), has sufficient labor (or machinery) included in the coefficients to dry gabah from "village dry" (perhaps 16–18 per cent moisture) to mill dry, this is an appropriate price for rice surplus areas during the harvest. The higher prices correspond to deficit areas and non-harvest periods (but when very little gabah is marketed). A gabah price of Rp 18 per kilogram is used in Chart 6 as representative of the price of "village dry" gabah during the greater part of the year.

Table 3 shows that as gabah prices are increased for a given market price, a squeeze on the value added of labor-intensive facilities results. This is due to the very substantial losses, both physical and monetary, incurred by these facilities. The large bulk unit (K-1) is assumed to have 17.5 per cent higher physical recovery from 1,000 tons of gabah than hand-pounding and 13.6 per cent higher than the huller (A). In addition, it sells its output at a market price 25 per cent higher than do hand-pounders and 11 per cent higher than hullers. The total market receipts per 1,000 tons of gabah are then *46.9 per cent higher for large bulk units (K-1) than for hand-pounding (Z) and 25.9 per cent higher than for hullers (A)*. Although these savings in losses cover drying and storage as well as milling

TABLE 2.—AMOUNT AND VALUE OF OUTPUT PER 1,000 TONS OF GABAH INPUT FOR VARIOUS MILLING TECHNIQUES*

	Hand-pounding Z	Huller A	Japanese mill G	Small bulk unit H-1	Large bulk unit K-1
Physical conversion *(tons)*[a]	570	590	630	650	670
Market price *(rupiahs per kg.)*	40.0	45.0	48.0	49.5	50.0
Market value of output *(million rupiahs)*	22.8	26.6	30.2	32.2	33.5

* Adapted from Weitz-Hettelsater Engineers, "Rice Storage, Handling and Marketing Study: Economic and Engineering Aspects," (advance draft, submitted to the Republic of Indonesia, Dec. 1971). The physical conversion ratios overstate the actual differences achieved between the various techniques. This is partly compensated for by the neglect of by-products which are recoverable in the G, H-1 and K-1 techniques. Since the by-products are consumed by humans when the rice is hand-pounded or, to a lesser extent, processed by a huller, with corresponding nutritional benefits to the poorer parts of the population, the recoverability of the by-products may have little social advantage. Rp is the symbol for the Indonesian rupiah.

[a] Tons of milled rice per 1,000 tons of gabah.

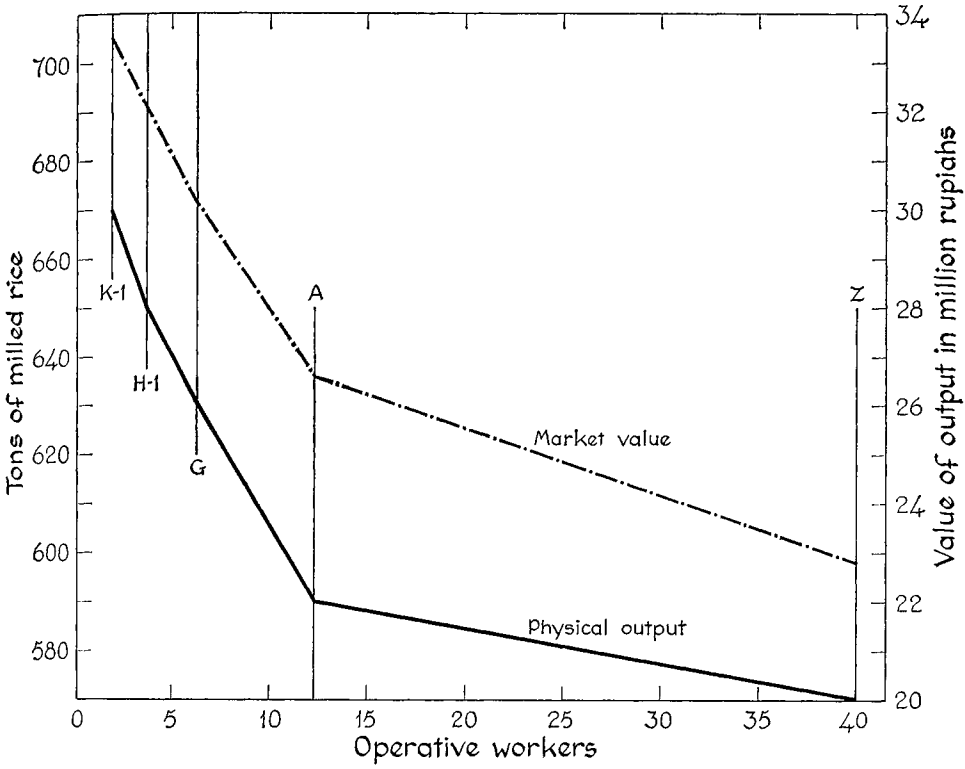
per se, they are very generous indeed. The squeeze on the labor-intensive facilities as gabah prices increase is likely to be less severe in fact than is indicated in Table 3.

A familiar result from the conditions for Pareto optimality is that the rate of factor substitution along an isoquant should be equal to the wage rate relative to the cost of capital. Because investment cost and not an annual capital charge is being used relative to labor requirements per year, the appropriate wage is the discounted present value of one laborer for the lifetime of the investment, say fifty years.

The alternative would be to convert investment cost into an annual capital charge, but then issues of spare parts, utilization of capacity, maintenance, and the like would be raised. These issues can be handled, but they are complex. Since treating capital on an annual flow basis would raise the capital intensity of each technique, except hand-pounding (Z), the bias introduced into the analysis by working on present investment cost versus discounted present value of labor is in favor of adopting more capital-intensive facilities at any given wage rate. Despite this bias the results conclusively favor very labor-intensive facilities.

Three wage rates are shown in Chart 6. They were determined by using the average wage assumed by the rice marketing study for operatives in Japanese rice mills (G)—Rp 76,000 ($200) per year including all fringes—and calculating the discounted present value of this wage for a 50-year period. Time discount rates of 12, 18, and 24 per cent were used. The present unsubsidized rate of interest from the Central Bank of Indonesia is 24 per cent to 30 per cent per year, although a limited volume of 12 per cent credit is available for medium/long term investments in priority areas. There is virtually no price inflation at present in Indonesia, although bankers, borrowers and savers may still retain expectations of inflation. Consequently, 24 per cent is a realistic estimate of the rate of time discount, and 18 and 12 per cent are progressive underestimates.

CHART 5.—OUTPUT PER 1,000 TONS OF GABAH INPUT AND LABOR REQUIREMENTS FOR VARIOUS MILLING TECHNIQUES



It can be noted in Chart 6 that the point of (corner) tangency between the isoquant and the relative wage rate is insensitive to the discount rate. Under either rate the optimal solution (that minimizes the economic cost of producing the amount of output that defines the unit isoquant) is at hullers (A). In Table 4 the discounted present values of three alternative yearly wage rates are calculated. The value of $200 per year used by the rice marketing study is well over the market rate for unskilled operatives, especially those suitable for the less skill-intensive huller and hand-pounding techniques. Day labor can presently be hired in Indonesia for about Rp 100 per day, or approximately $80 for a 300-day year. The present value of this wage rate is $664, $444, and $333 for 12, 18, and 24 per cent discount rates respectively. This compares with $1,661, $1,111, and $833 for the wage rate assumed by the study.

Lastly, considering the widespread unemployment in Indonesia, it seems appropriate to use a shadow wage rate for public policy planning and major investment purposes. A wage of $40 per year, one-half the market rate, is used for this purpose.[14] The present values under the three discount rates are $332, $222, and $167.

[14] This amount would be sufficient for a family of three to buy 120 kg. of rice per capita per year, but nothing else. It may be close to a minimum substance wage for a single individual in a rural, rice surplus area.

TABLE 3.—DERIVATION OF A STANDARDIZED ISOQUANT*
(U.S. dollars, and number of operatives, except as otherwise indicated)

	Hand-pounding Z	Huller A	Japanese mill G	Small bulk unit H-1	Large bulk unit K-1
Inputs per 1,000 tons of gabah input per year					
Investment cost	0[a]	10,425	36,204	62,956	120,645
Operatives	40.00	12.31	6.40	3.75	1.81
Market value of output of 1,000 tons of gabah input *(million rupiahs)*	22.8	26.6	30.2	32.2	33.5
Value added from 1,000 tons of gabah at various gabah prices *(million rupiahs)*					
Gabah price *(rupiahs per kg.)*					
16	6.8	10.6	14.2	16.2	17.5
18	4.8	8.6	12.2	14.2	15.5
20	2.8	6.6	10.2	12.2	13.5
22	0.8	4.6	8.2	10.2	11.5
Inputs required to produce 10.0 million rupiahs in value added[b]					
Gabah price *(rupiahs per kg.)*					
16 Investment cost	0	9,831	25,488	38,844	68,888
Operatives	58.8	11.6	4.5	2.3	1.0
18 Investment cost	0	12,124	29,651	44,321	77,816
Operatives	83.3	14.3	5.2	2.6	1.2
20 Investment cost	0	15,794	35,480	51,624	89,398
Operatives	142.8	18.7	6.3	3.1	1.3
22 Investment cost	0	22,664	44,169	61,697	104,961
Operatives	500.0	26.8	7.8	3.7	1.6

* Calculated from Tables 1 and 2.

[a] For the purposes of the calculations the investment cost in hand-pounding is assumed to be zero. In fact, it is only near zero because wood and a laborer's time are required to make the mortar and pestle.

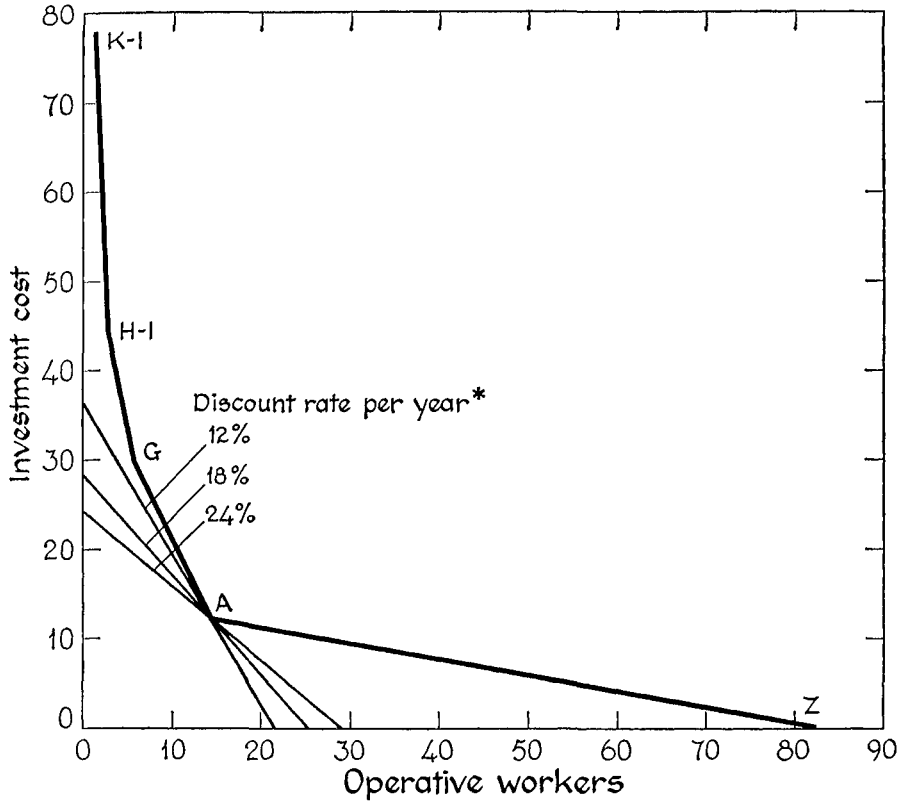
[b] The calculation assumes linear homogeneity from the observed isoquant to the standardized isoquant.

Table 5 shows the range of present value of wages that yield corner tangencies to each of the five rice milling techniques. At either prevailing market wages or even the high wage assumed by the rice marketing study team, hullers (A) are economically optimal for all reasonable gabah prices. The Japanese mill (G) becomes optimal when gabah prices reach Rp 20 per kilogram, money is available at only 12 per cent per year, and the investor pays $200 per year wages for unskilled labor.

Thus the economic analysis performed here corroborates the recent evidence from the countryside: small hullers (and other small-scale facilities) are being

CHART 6.—ISOQUANT RELATING INVESTMENT COST AND OPERATIVE WORKERS NEEDED TO PRODUCE 10.0 MILLION RUPIAHS IN VALUE ADDED

(Assuming gabah costs 18 rupiahs per kilogram)



* Market cost of labor relative to capital, assuming the average wage level for "G" mills of 76,000 rupiahs ($200) per year, and three different rates of time discount to calculate present value of the cost of labor.

installed where market prices prevail, but the Japanese rice mills (similar to G) become (barely) optimal and are installed if the prices are sufficiently distorted.

Finally, there are circumstances where hand-pounding (Z) remains optimal. If we believe that unemployment is a serious problem (and it is) and we believe in the economic rationality of shadow pricing, then hand-pounding makes economic sense in many poor, crowded rural areas of Java. And this is not lost on the peasants. If market wages must be paid for hand-pounding, it is not profitable even for gabah prices of Rp 16 (unless the discount rate is more than 3 per cent per month). So it is not difficult to understand why hand-pounding as a cash-hire activity is rapidly being replaced by the village huller unit. But it is still often profitable for the farmer or his wife to do the hand-pounding themselves if the opportunity cost of the labor is significantly less than the market wage. And in fact, many rural families still do hand-pound their own rice.

Now it is possible to place the rice milling sector within a general equilibrium perspective. Table 6 reproduces the necessary calculations. It reflects, even more

TABLE 4.—PRESENT VALUE OF ALTERNATIVE WAGE RATES*
(*U.S. dollars*)

Assumed wage levels per year	Discounted present value of wages[a]		
	12 per cent discount rate	18 per cent discount rate	24 per cent discount rate
200 (marketing study)[b]	1,661	1,111	833
80 (market)	664	444	333
40 (shadow price)	332	222	167

* See text for derivation.

[a] The present worth factor for 50 years is as follows:

Discount rate (*per cent*)	Present worth factor
12	8.304
18	5.554
24	4.167

[b] See Weitz-Hettelsater Engineers rice marketing study (*19*).

so than previous tables, a profound lack of quantitative knowledge about the Indonesian economy. The output-capital and output-labor ratios are no more than guesses, although the range of four values for each ratio probably brackets the true values.

J. Vanek and A. H. Studenmund, for example, note that the inverse *gross* incremental capital-output ratio for Indonesia, as reported by the New York Secretariat of the United Nations Conference on Trade and Development, is 0.54 (*18*, p. 463). Using the formula developed by Vanek and Studenmund to calculate the inverse *net* incremental capital-output ratio yields an estimate between 0.785 and 1.31, depending on whether the average life of capital assets is 20 years or 10 years.[15] Thus the range of 0.1 to 2.0 used in Table 6 is extremely likely to contain the true values, with 0.5 and 1.0 more likely than either extreme.

The basic assumption underlying Table 6 is that resources not utilized in the rice milling sector are available for use outside that sector. Thus Rp 45.85 million in investment funds (the cost of large bulk facilities, K-1) and 40 laborers (for hand-pounding, Z) are assumed to be available for every 1,000 tons of gabah processing capacity desired. If the decision is to invest in large bulk facilities (K-1), then no investment funds are "freed," but 38.19 laborers per 1,000 tons of capacity are available to the outside economy. If the decision is for hand-pounding (Z), then none of the labor is available, but all of the capital that would have been used in the large bulk facilities (K-1), Rp 45.85 million per 1,000 tons of capacity, is freed for use outside the rice milling sector. The intermediate technologies have varying amounts of both capital and labor available to the outside economy, as is shown in Table 6.

[15] The formula is $k = k_o\,(1 - [1 + r]^{-A})$, where

k = inverse gross capital-output ratio;
k_o = inverse net capital-output ratio;
r = rate of growth of the economy;
A = life of capital investments.

In the calculations cited, r was assumed to be 6 per cent per year, A was 10 or 20 years, and k was 0.54, as reported by Vanek and Studenmund *18*. It is k_o, the net incremental output-capital ratio, that corresponds to the numbers discussed in the text and shown in Table 6.

TABLE 5.—MAXIMUM VALUES OF WAGES LEADING TO CORNER TANGENCIES*
(*U.S. dollars*)

Corner solution at . . .	Maximum present value wage at which the indicated facility is optimal for various gabah prices (*rupiahs per kg.*)			
	16	18	20	22
Hand-pounding (Z)	208	175	127	48
Huller (A)	2,205	1,931	1,590	1,135
Japanese mill (G)	6,082	5,638	5,050	4,241
Small bulk unit (H-1)	23,472	22,786	21,772	20,553
Large bulk unit (K-1)[a]	. . . greater than the value shown for H-1 . . .			

* See text for derivation.

[a] Just for comparison, it is worth noting that the discounted present value of $6,000 per year at 8 per cent is $73,400. Thus the relative capital intensity of even the large bulk units (K-1) is low by United States standards.

If all of the investment funds are generated internally, the assumption above seems quite reasonable. It is open to some debate if a significant portion of the investment funds comes from foreign sources, especially aid donors. There has been at least an historical tendency for such funds to be tied directly to specific items of capital equipment, e.g., a certain number of large bulk facilities (K-1), with the money simply unavailable under other investment strategies. This tendency, of course, has been a primary source of large investments with grossly distorted factor proportions *relative to internal factor prices*. The factor proportions are not so distorted if the capital has a zero opportunity cost (although it seldom does, since most must be repaid). Fortunately there seems to be some evidence that the major aid donors are now aware of this bias and are seeking to redress it. If so, the assumption that the capital will be available for alternatives other than the most capital-intensive technology is appropriate.

The question of how much net output (value added) the capital can produce per year in the outside economy has already been discussed. Four output-capital ratios are used in Table 6, from 2.0 to 0.1. In an economy where substantial rehabilitation of existing physical plant (from factories to roads and railroads to estates) remains to be done, a value of 2.0 is not unreasonable for certain investments, although it is too high for an average. The value of 0.1 is used as a lower bound—it is lower than the value of 0.38 for Canada—the lowest that can be calculated from the data shown by Vanek and Studenmund.

The other factor that can be made available to the outside economy is unskilled labor. This is obviously a mixed blessing. It is a resource that will contribute to output if gainful employment is available. Otherwise, it is a welfare cost, although no negative contribution has been used in Table 6. The lowest output-labor ratio is zero, which simply assumes that the labor will be unemployed if not utilized in rice milling, but will not reduce outside economic output through a welfare drain. This is, unfortunately, the most realistic assumption that can be made for Indonesia at the moment. The three positive rates of contribution—Rp 38,000, Rp 76,000 and Rp 190,000, or $100, $200 and $500 per year—are increasingly optimistic.

Direct and indirect output from rice milling per 1,000 tons of gabah is then

TABLE 6.—DIRECT AND INDIRECT OUTPUT FROM RICE MILLING PER 1,000 TONS OF GABAH INPUT*

(Million rupiahs, except as otherwise indicated)

	Hand-pounding Z	Huller A	Japanese mill G	Small bulk unit H-1	Large bulk unit K-1
Capital funds available for investment outside rice milling[a]	45.85	41.88	32.09	21.92	0.00
Value of output generated outside rice milling by marginal investment funds:					
Output-capital ratio					
2.0	91.69	83.77	64.18	43.84	0.00
1.0	45.85	41.88	32.09	21.92	0.00
0.5	22.92	20.94	16.04	10.96	0.00
0.1	4.59	4.19	3.21	2.19	0.00
Surplus workers available for outside rice milling (*number*)[b]	0	27.70	33.60	36.25	38.19
Value of output generated outside rice milling by surplus workers:					
Output-labor ratio[c] (*rupiahs per worker*)					
0	0	0	0	0	0
38,000	0	1.05	1.28	1.38	1.45
76,000	0	2.11	2.55	2.76	2.90
190,000	0	5.26	6.38	6.89	7.26
Market value of milled rice	22.8	26.6	30.2	32.2	33.5

	Hand-pounding (Z) Output-capital ratio				Huller (A) Output-capital ratio				Japanese mill (G) Output-capital ratio				Small bulk units (H-1) Output-capital ratio				Large bulk units (K-1) Output-capital ratio			
	2.0	1.0	.5	.1	2.0	1.0	.5	.1	2.0	1.0	.5	.1	2.0	1.0	.5	.1	2.0	1.0	.5	.1
Value of direct and indirect output from rice milling: Output-labor ratio																				
0	114.5	68.6	45.7	27.4	110.4	68.5	47.5	30.8	94.4	62.3	46.2	33.4	76.0	54.1	43.2	34.4	33.5	33.5	33.5	33.5
38,000	114.5	68.6	45.7	27.4	111.4	69.5	48.6	31.8	95.7	63.6	47.5	34.7	77.4	55.5	44.5	35.8	35.0	35.0	35.0	35.0
76,000	114.5	68.6	45.7	27.4	112.5	70.6	49.6	32.9	96.9	64.8	48.8	36.0	78.8	56.9	45.9	37.2	36.4	36.4	36.4	36.4
190,000	114.5	68.6	45.7	27.4	115.6	73.7	52.8	36.1	100.8	68.7	52.6	39.8	82.9	61.1	50.1	41.3	40.8	40.8	40.8	40.8

* Calculated from Tables 1–3, as explained in text. Conversions to rupiahs from U.S. dollars at 380 rupiahs per U.S. dollar.

[a] Assumes the capital is available for investment in K-1 facilities. If these facilities are not used, the funds are assumed to be available to the outside economy.

[b] Assumes the workers are available for hand-pounding. If not used, they are assumed available for employment outside rice milling.

[c] These ratios represent, in order, zero employment opportunity in the outside economy; one-half the assumed wage level in G-type facilities; the assumed wage level in G-type facilities, and two and a half times the wage level in G-type facilities.

the sum of the output contributed by the "freed" capital, the output contributed by the freed labor, and the market value of output generated by the indicated milling technique from the 1,000 tons of gabah.[16] The value of the output generated by the rest of the economy is a scale factor that could be added to show total output in the economy, but it would not change the results in any way.

The range in total output shown in Table 6, aside from any scale factor, is quite wide. The high is Rp 115.6 million and the low is Rp 27.4 million. Most of the variation is accounted for by the varying amounts of capital available to the outside economy and which output-capital ratio is used. The peak level of output (which would correspond to point C in Chart 3) tends to appear in hand-pounding (Z), and hullers (A), although it reaches all the way to the small bulk facilities (H-1) on the assumption of extremely low capital productivity in the economy, as is shown below:

Technology with Maximum Output for Total Economy

	Output-capital ratio				
Output-labor ratio	2.0	1.0	0.5	0.25	0.1
0	Z	Z	A	G	H-1
38,000	Z	A	A	G	H-1
76,000	Z	A	A	G	H-1
190,000	A	A	A	G	H-1

Three especially interesting cases are plotted in Chart 7, which is the empirical analogue to Chart 3. This figure in some sense is the culmination of the analytic work in this paper. It shows the external economic conditions under which various milling technologies maximize total output for the entire economy. When labor has zero alternative employment opportunities, and capital has a high productivity (O/C ratio equal to 1.0), maximum output is reached at hand-pounding (Z). The conditions under which hullers (A) are optimal range from an O/L ratio of Rp 190,000 with an O/C ratio of 2.0, all the way to an O/L ratio of zero and an O/C ratio of 0.5, thus confirming the cost minimization analysis of Chart 6. Over almost the entire range of reasonable assumptions hullers (A) are economically dominant.

The almost inescapable conclusion from Charts 6 and 7 is that huller facilities (A) should make up the bulk of any modernization program for the Indonesian rice milling sector. Consideration of some less tangible factors strengthens this conclusion. The most important is the interaction of rice milling, which is the part of marketing that transforms the product in form, with the other two aspects of marketing, transformation in time and place. Little can be said about time transformation (storage) except that bagged storage is much more labor-intensive than bulk storage. The data are not available to make a detailed analysis, but judging from the above analysis of rice milling, bagged storage is likely to be economically superior to bulk storage.

The question of place transformation (transportation) is somewhat clearer,

[16] This is the gross value of output from the 1,000 tons of gabah because no deduction is made for the cost of the gabah. This probably biases the results against the smaller, labor-intensive facilities because some evidence from India suggests they buy their raw materials at lower unit costs than the larger facilities (*10, 11*).

although again no detailed analysis is possible here. Transportation costs are an important part of total marketing costs, and hence of the total margin between farmers and consumers. These costs will vary according to the pattern of milling facilities (and consumption, which is effectively determined by population distribution) that develops, and some consideration must be given to the demands on the transportation system of each type of facility.

The essential point is that the closer milling is to the point of production, the lower the transportation costs. Hand-pounding and small hullers can be very widely scattered around the countryside—every village could have at least one huller, for example. And to paraphrase W. P. Falcon, who was speaking of subsistence agriculture, "Although virtually nothing complimentary has ever been written about 'small rice huller facilities,' they do have one redeeming feature: they help to minimize transportation needs" (adapted from 5, p. 383).

The cost minimization works from two directions: first, because the lesser bulk of milled rice makes it cheaper to move than gabah, the closer the milling point is to the point of production, the lower the total transportation costs; second, if the milling point is sufficiently close to the farmer, he can provide the transportation himself, at near zero opportunity cost to the economy (and substantial savings in trucks). Only the milled rice for urban consumption need be trucked away, and it is more efficient for trucks to make calls at one or two milling facilities in each village for milled rice than at each farm (or even several collection points) for stalk padi or gabah.[17]

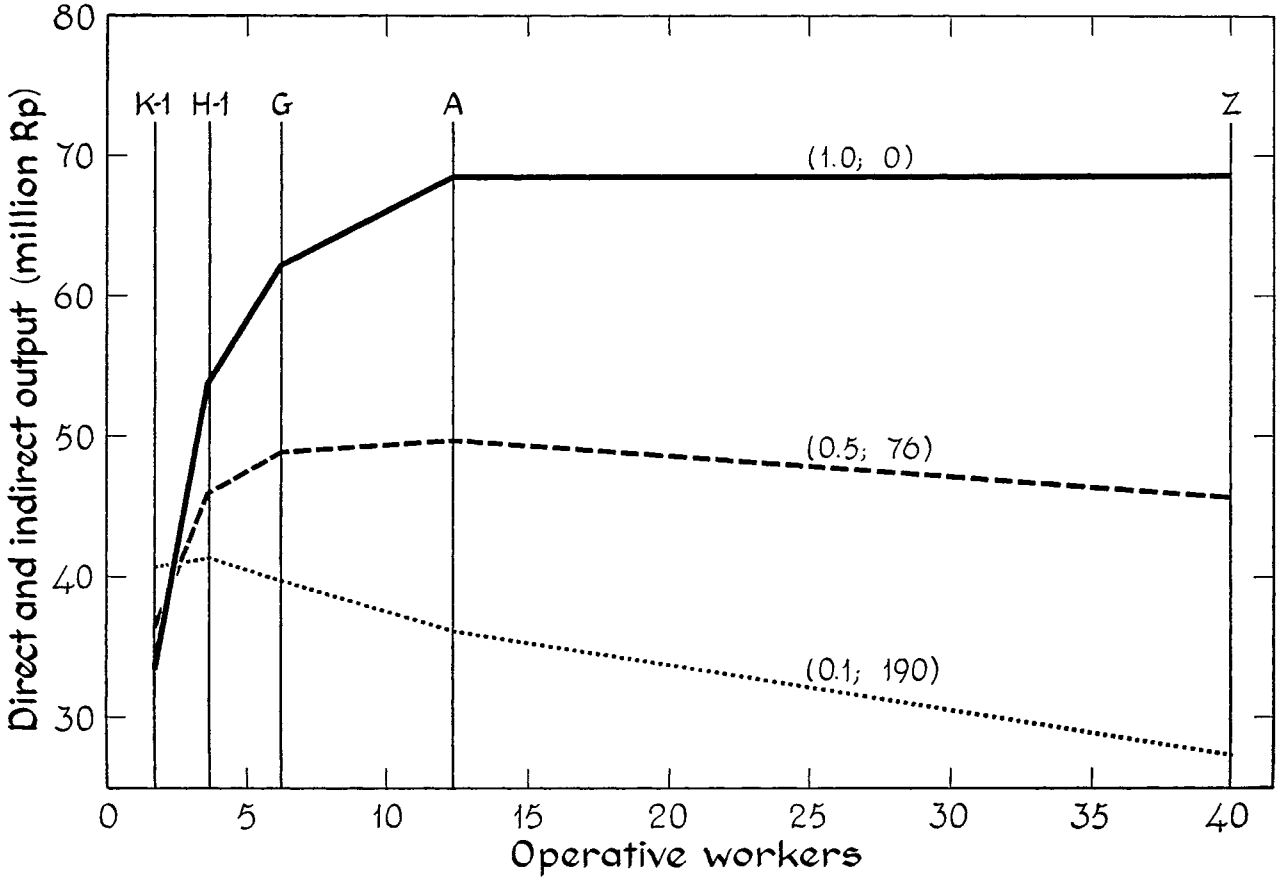
In addition, there is an employment aspect to transportation. Since hullers can be much more widely scattered than other mills, and hence be within reach of most farmers by foot or bicylce, most of the stalk padi or gabah is likely to arrive in just that manner—on a shoulder pole or bicycle. This will provide an additional productive outlet for the farmer's time, thus partly recouping the income formerly earned from hand-pounding.

These further considerations on the optimal rice marketing system for Indonesia are, admittedly, less firmly based than the solid economic analysis of the rice milling facilities alone. But they buttress, not weaken, that analysis. This is partly because of the interlocking and integrated nature of a marketing system, where all of the parts depend on compatible technologies for efficient linkages. Beneath it all, the underlying factor availabilities exert strong pressure on all aspects of marketing processes to use reinforcing and not contradictory techniques.

The last set of considerations that must be treated is the extent of "external benefits" generated by the different patterns of milling and marketing. External benefits are usually invoked at the same place where the preacher made a marginal note in his sermon—"point weak, shout like hell." At the risk of appearing to shout for a weak proposition, the following real or imaginary external benefits of labor intensive techniques are offered:

[17] A counterpoint might be that it is somewhat less efficient to collect the byproducts, mostly bran, from many small huller units than from larger and fewer mills. The larger mills are also better able to recover the byproducts efficiently. However, the bran can be trucked away from huller facilities as easily as the milled rice. It is more likely that it will continue to be used as at present—mostly as scavenger feed for chickens. The lower recovery rate of bran by hullers means that more is left on the rice kernel, with beneficial nutritional effects for the consuming population.

CHART 7.—DIRECT AND INDIRECT OUTPUT FROM RICE MILLING PER 1,000 TONS OF GABAH*



* Numbers shown on the three curves indicate assumptions used to calculate output as follows: (Output-Capital Ratio; Value of output of worker outside rice milling, in thousands of rupiahs). For further details, see Table 6.

1. It is true that the more capital-intensive facilities will require highly specialized managers and some very skilled workers. Individuals found and trained for these roles would constitute a resource for Indonesia's development. But they would be poorly used in rice milling. Their contribution would be much higher in sectors where no substitute can be found for skilled management and labor. Rice milling can perform satisfactorily without them, provided investments are not made in facilities that require their services.

2. Uma Lele has presented some striking evidence that large mills have substantially higher *unit* costs than small mills due to lower utilization of capacity, higher rough-rice costs, and higher labor costs (*10, 11*). Similar impressions are gained in Indonesia. The calculations presented so far make no allowance for this reality, and so are somewhat biased against the smaller, more labor-intensive facilities.

3. Little reference has been made to drying technology. A primitive stalk padi drying barn is likely to do a satisfactory job in circumstances where sun drying proves inadequate or inappropriate. Such a primitive system also would be extremely labor intensive, which is not fully reflected in the analysis so far (only the labor for sun drying at the mill is included).

4. An additional advantage of many smaller facilities would be an increased degree of competition for the farmer's produce, and possibly better prices for him. The absence of a single large mill buying all of the farmer's surplus would surely decrease farmers' general animosity toward the whole marketing system.

5. Most of the huller machinery is produced domestically while the machinery for any of the larger facilities must be imported. The current exchange rate is a fairly good indicator of the scarcity value of foreign exchange, and no special shadow price needs to be applied to the imported components. But the backward linkage effects of the domestically produced huller units are significantly greater than for the imported machinery. A small-scale machine shop industry has grown up that manufactures hullers and services the many units already in operation, in a fashion similar to the domestic industry producing tubewells in West Pakistan.

The above discussion points toward a technology that is compatible with a rural based, tradition-oriented society. Such a society offers the best hope for a satisfying life for the millions of Indonesian peasants who are now, and will be for decades to come, locked to or near the land in their struggle for survival. Traditional Indonesian village life offers a richness of rewards, but only when the daily anxiety over adequate food and shelter is attenuated. Safe water, public health facilities and schools would add further to the satisfactions of life. My concern is that the rice marketing system which links farmers with villagers and the cities need not be an agent designed to destroy this traditional life, but serve as a web that helps to hold it together and to encourage it to grow.

EXCEPTIONS TO THE ANALYSIS

The analysis conducted to this stage has been based on aggregate economic parameters that in some sense reflect the "overall" or "average" economic conditions in Indonesia. Fairly wide-ranging sensitivity analysis has demonstrated that the single best rice milling facility, huller unit (A), for currently prevailing

average economic conditions in Indonesia is also best for a wide variation of conditions on both sides of the average.

Still, Indonesia is an extremely diverse country. Economic conditions, and perhaps more importantly, institutional factors vary considerably from island to island, province to province, and between the cities and the countryside. In view of this variation it is necessary to recognize three important modifications of the aggregate results of the analysis.

Rural Hand-Pounding

A very considerable amount of hand-pounding of rice is still done, with most of it concentrated in the deficit or small-surplus rural regions of both Java and the outer islands. A substantial proportion of the hand-pounding in these areas is done by family labor, which has an extremely low opportunity wage.

As rice production and the marketed surplus in these regions grow, the incomes of farmers, harvest labor, and participants in the marketing chain will increase. Hullers are unlikely to supplant hand-pounding for home consumption in many heavily populated rural areas until this increase in incomes is achieved.

Mills Producing for Export

Although Indonesia does not now export rice and there seems little likelihood of any necessity to export in the next few years, current trends in production and consumption indicate that exporting rice may be a reality for Indonesia toward the end of the decade. In addition, Indonesia currently could arbitrage in the international rice market by exporting special varieties, such as Tjiandjur, that command a high price premium while importing 20 per cent broken rice from Thailand at less than half the price.

To realize the full returns from either export strategy will require high quality rice with especially low percentage brokens which can only be produced in units with better quality control than hullers provide: the G, H-1, or K-1 facilities. Consequently, if exporting becomes a reality, some investment in these more capital intensive facilities will be necessary. Of course, these facilities need to have only enough capacity to handle the volume of exports, not the entire marketed surplus of the country.

The Government Price Support Program

Indonesia currently pursues a rice price stabilization program that involves defending a floor price for farmers and a ceiling price for consumers by means of a buffer stock operation (for a description and analysis of those programs see 2). Storage time is especially important for a buffer stock operation. The Japanese facilities (G), with their mechanical drying, can achieve somewhat better quality control of the gabah than huller operations can achieve with sun drying and primitive drying sheds. Consequently, they can produce a better quality milled rice that will store longer than the rice from hullers. For this reason a combination technique (P) is proposed later in this paper that utilizes 31 per cent Japanese mills (G) and 69 per cent hullers (A). The reasons for just these proportions are explained there, but they center around the requirements of

BULOG, the National Food Logistics Board that implements the rice price policy, for a higher quality rice than is consumed on average.

This argument can, of course, be overextended. One fairly simple option that would minimize the problem created by short storage life of huller-milled rice would be for BULOG to buy and store gabah, and mill only as distributions and market injections are required. The strategy would ensure fuller utilization of rice mills all year long but would involve somewhat higher transportation costs.

EMPLOYMENT TRENDS IN RICE MILLING

For all the discussion so far about labor-intensity and employment impact, there has been no attempt yet to look at actual levels of employment in rice milling. Table 7 introduces this discussion.

Two different employment issues are considered there. First, the numbers of workers needed to operate each of the milling techniques for the entire 1970 harvest of 17.27 million tons of gabah are calculated. These vary from 690,000 full-time equivalent workers if the entire harvest were hand-pounded, to only 31,000 workers if large bulk facilities (K-1) handled the entire harvest. It must be emphasized that these are workers in rice milling only. No account is taken of the jobs that would be created by alternative uses of the investment capital if it were not used in large bulk facilities (K-1).

Also, there is no suggestion that any of the numbers of workers shown represent the actual situation in Indonesia in 1970. A mix of techniques was used, with the real employment level somewhere between the two extremes. Calculations in Table 8 indicate a base employment in 1970 of 542,300, assuming 70 per cent hand-pounded (Z), 25 per cent milled in hullers (A), and 5 per cent milled in Japanese rice mills (G). This is an artificial number, too—no actual employment statistics are available—but it is probably not too far wrong as an order of magnitude.

The other set of employment figures shows the inputs required for each technique to mill 1,197,000 tons of gabah, the actual capacity of the investment package recommended by the rice marketing study.[18] It costs $63.2 million and would employ 7,300 operatives in the facilities themselves. If any one of the five techniques were used alone to handle this capacity of gabah, employment would vary from 47,900 in hand-pounding (Z) to 2,200 in the large bulk facilities (K-1). This range is dramatic. Equally dramatic are the investment costs, which vary from zero to $144.4 million, respectively. It is worth noting that the employment content of the Recommended Package is marginally lower than for Japanese

[18] The Recommended Package includes:

Number	Type of facility	Annual gabah input capacity (*tons*)	Total capacity (*1,000 tons*)	Proportion of total capacity
9	Large bulk units (K-1)	21,600	194.4	0.162
59	Small bulk units (H-1)	7,200	424.8	0.355
122	Japanese mills (G)	2,500	305.0	0.255
420	Hullers (A)[a]	650	273.0	0.228
Total			1,197.2	1.000

[a] The actual facility recommended was a C-type flash/husker with pearler/polisher, but for comparison with the rest of the paper an equal number of A-type hullers is used. These A-type facilities have a smaller capacity (and cost) than the C-type facilities.

TABLE 7.—TOTAL EMPLOYMENT IN THE RICE MILLING SECTOR*

	Hand-pounding Z	Huller A	Japanese mill G	Small bulk unit H-1	Large bulk unit K-1	Recommended Package RP[a]
Inputs required per 1,000 tons of gabah						
Investment cost (*U.S. dollars*)	0	10,425	36,204	62,956	120,645	52,790
Operatives (*number*)	40.00	12.31	6.40	3.75	1.81	6.06
Total inputs required for 1970 harvest[b]						
Investment cost (*million dollars*)	0	180	625	1,087	2,084	—
Operatives (*thousands*)	690[c]	213	111	65	31	—
Change in total inputs required by the RMS "Recommended Package," plus alternatives						
Investment cost (*million dollars*)[d]	0	12.5	43.3	75.4	144.4	63.2
Operatives (*thousands*)	47.90	14.7	7.7	4.5	2.2	7.3

* Calculated from Tables 1–4, and Weitz-Hettelsater Engineers, "Rice Storage, Handling and Marketing Study: Economic and Engineering Aspects" (advance draft), Dec. 1971. The employment figures shown are for the rice milling sector only. They do not include the additional employment created by investing funds saved from less capital intensive facilities than K-1. Depending on what capital-labor ratios are used, this outside employment can be substantially larger than employment in rice milling.

[a] RP represents the "Recommended Package" of the rice marketing study. It includes:

Number	Type of facility	Annual gabah input capacity (*tons*)	Total capacity (*1,000 tons*)	Proportion of total capacity
9	Large bulk units (K-1)	21,600	194.4	0.162
59	Small bulk units (H-1)	7,200	424.8	0.355
122	Japanese mills (G)	2,500	305.0	0.255
420	Hullers (A)†	650	273.0	0.228
		Total	1,197.2	1.000

† The actual facility recommended was a C-type flash/husker with pearler/polisher, but for comparison with the rest of the paper an equal number of A-type hullers is used. These A-type facilities have a smaller capacity (and cost) than the C-type facilities.

[b] This assumes the entire 1970 production of 17.27 million tons of gabah was processed by the indicated technology. This is obviously to show alternative magnitudes, not an indication of reality.

[c] This is the full-time employment equivalent required for hand-pounding. More than 690,000 laborers would be needed if hand-pounding is done only part-time.

[d] These are the inputs required by each of the indicated technologies to mill 1,197,200 tons of gabah (the listed capacity of the "Recommended Package").

facilities (G), although the investment cost is considerably higher. This is because of the inclusion of the K-1 and H-1 facilities in the package.

Perhaps the more interesting employment question is what might happen over time, as rice production increases and alternative investment strategies are pursued. This is laid out in detail in Table 8, which presents the results generated by an extremely simple simulation program that explores various alternative processing programs. The employment figures were calculated for each year from 1970 to 1980, but only the 1975 and 1980 levels are shown. The 1970 base figure is 542,300 under all assumptions.

It is difficult, and perhaps fruitless, to comment in detail on Table 8. One especially striking conclusion is the significant, not to say disastrous, decline in employment if hand-pounding is totally eliminated by the end of the decade. Even if hullers (A) are the sole facility in the replacement, and gabah production increases by 4 per cent per year, employment in 1980 would drop from the base of 542,300 to 309,600, a decrease of 232,700 or more than 40 per cent. Displacing workers at such a rate would surely tax the welfare facilities of the nation, and possibly its social stability as well.

An essentially static employment picture results if hand-pounding (Z) is reduced from 70 per cent to only 50 per cent of base production. It is obviously a significantly lower percentage of total production because it is assumed that hand-pounding is not used for any increases in output. If hullers only were used in the investment program and gabah production increased 4 per cent per year, employment would decline for the first five years as the loss of hand-pounding employment more than offset the new employment in huller units generated by the increased production. But after 1975 the reverse would be true, as the absolute size of the production gains increased and the loss from hand-pounding remained the same each year.

SUMMARY AND CONCLUSIONS

As an analysis of choice of technique, this paper is straightforward to an extreme. A review of the appropriate decision-making criterion for choosing a technique for rice milling suggested that serious labor-displacing biases would exist in a labor-surplus economy if a general equilibrium approach with appropriate labor and capital costs were not used. This vantage point, plus the engineering data needed to construct a unit isoquant for rice milling, permitted an unequivocal determination of small huller units as the optimal milling technique for average Indonesian conditions. Several extensions to this analysis made the results more realistic without altering the fundamental nature of the analysis.

The only conclusion that seems possible is that the labor-intensive huller units have substantial economic and social advantages under a wide variety of Indonesian circumstances. Any rice milling modernization program should be planned to reap these advantages.

TABLE 8.—EMPLOYMENT IN RICE MILLING ACCORDING TO VARIOUS ASSUMPTIONS: PROJECTIONS FOR 1975 AND 1980*

(Thousand workers)

Annual production increase (*per cent*)[a]	Alternative (*number*)[b]	Base[c]		Hand-pounding Z		Hullers A		Japanese mill G		Small bulk unit H-1		Large bulk unit K-1		Recommended Package RP[d]		"Preferred" P[e]	
		1975	1980	1975	1980	1975	1980	1975	1980	1975	1980	1975	1980	1975	1980	1975	1980
2.5	I	613.5	694.2	633.0	735.7	570.2	601.8	556.8	573.3	550.8	560.4	546.4	551.1	556.0	571.6	566.1	593.1
2.5	IIA	—	—	—	—	522.4	506.2	498.8	457.2	488.2	435.2	480.4	419.1	497.4	454.3	515.1	491.8
2.5	IIB	—	—	—	—	462.6	386.6	426.2	312.1	409.9	278.7	398.0	254.2	424.1	307.8	451.5	363.8
2.5	IIC	—	—	—	—	402.8	267.1	353.7	167.0	331.7	122.2	315.4	89.3	350.9	161.3	387.8	236.4
3.0	I	628.6	728.8	652.3	779.9	576.1	615.4	559.9	580.3	552.6	564.6	547.3	553.0	558.9	578.3	571.2	604.7
3.0	IIA	—	—	—	—	528.3	519.7	501.8	464.2	490.0	439.3	481.3	421.1	500.3	461.0	520.2	502.7
3.0	IIB	—	—	—	—	468.5	400.2	429.3	319.1	411.7	282.8	398.8	256.2	427.0	314.5	456.5	375.4
3.0	IIC	—	—	—	—	408.7	280.6	356.8	174.1	333.5	126.3	316.4	91.3	353.8	168.0	392.8	248.0
3.5	I	644.1	764.9	671.9	825.9	582.2	629.6	563.0	587.7	554.5	568.9	548.2	555.1	561.9	585.2	576.3	616.8
3.5	IIA	—	—	—	—	534.3	533.9	505.0	471.6	491.8	443.6	482.2	423.2	503.3	468.0	525.3	514.8
3.5	IIB	—	—	—	—	474.6	414.4	432.4	326.5	413.6	287.1	399.7	258.3	430.0	321.5	461.7	387.5
3.5	IIC	—	—	—	—	414.8	294.8	359.9	181.5	335.3	130.6	317.3	93.4	356.8	174.9	398.0	260.1
4.0	I	659.8	802.7	691.9	874.0	588.3	644.4	566.2	595.4	556.3	573.4	549.1	557.3	565.0	592.5	581.6	629.4
4.0	IIA	—	—	—	—	540.5	548.7[f]	508.2	479.3	493.7	448.2	483.1	425.4	506.3	475.3	530.6	527.5
4.0	IIB	—	—	—	—	480.7	429.2	435.6	334.2	415.4	291.6	400.6	260.5	433.1	328.8	466.9	400.1
4.0	IIC	—	—	—	—	420.9	309.6	363.1	189.1	337.2	135.1	318.2	95.6	359.8	182.2	403.2	272.7

* Calculated from previous tables. Base employment in 1970 is 542,300. It was calculated by assuming that the 17.27 million tons of gabah produced in that year were milled by three technologies in the following fashion:

Technique	Percentage milled
Hand-pounding (Z)	70
Hullers (A)	25
Japanese mills (G)	5

It should again be emphasized that no employment generated outside rice milling through investment funds saved by not using the most capital intensive facilities is counted here.

[a] Annual percentage increases in gabah production.

[b] The various alternatives are defined as follows:

I: All of the increase in gabah production is milled by the indicated technique with the remainder continuing to be milled by the combination "Base" technique.

II: The techniques except "Base" and "Z" are extended faster than in I, so that the final (1980) proportion of Z—hand-pounding *in the base production* is:

A—50 per cent
B—25 per cent
C— 0 per cent

For example, under assumption IIA hand-pounding decreases from 70 per cent of 1970 gabah production to 50 per cent of 1970 gabah production in 1980, in equal 2 per cent per year declines. The Table shows, for each of the indicated milling techniques, the employment needed for 1) the hullers and Japanese mills assumed to be used in the 1970 base—this remains constant, 2) hand-pounding—this obviously declines linearly from 1970 to 1980, 3) the technique indicated to replace the milling capacity lost by the elimination of hand-pounding—this increases linearly from 1970 to 1980, and 4) the same indicated technique to mill the increased production of gabah—this increases exponentially at 2.5 per cent to 4.0 per cent per year.

[c] The "Base" technique uses the facility proportions indicated above.

[d] This is the "Recommended Package" of the rice marketing study. For details, see footnote *a* on Table 7.

[e] This is my preferred combination of technologies for future investment in rice milling in Indonesia, based on the economic calculations already done. It is composed of 31 per cent of capacity in Japanese facilities (G) and 69 per cent in huller facilities (A). The labor requirement per 1,000 tons of gabah input is 10.50. This combination was determined by the assumption that one million tons of gabah input capacity (about 650,000 tons milled rice equivalent) should be available in 1975 that was capable of producing a high quality milled rice with at least one year storage life. This reduces waste in the buffer stock program operated by BULOG, the National Food Logistics Board (for details, see 2). One million tons of gabah in 1975 is 31 per cent of the increase over 1970 production assuming a 3.5 per cent increase per year. The remainder (69 per cent) is milled in huller units (A), which earlier analysis has shown to be most appropriate under Indonesian factor conditions.

[f] Note that under these assumptions employment first declines from the 1970 level of 542,300 and then rises. This is because the absolute size of the production increase after 1975, coupled with the labor-intensive huller technology, more than offsets the small annually identical decline in hand-pounding.

CITATIONS

1 J. C. Abbott, "The Development of Marketing Institutions," in *Agricultural Development and Economic Growth*, ed. by H. M. Southworth and B. F. Johnston (Ithaca, N.Y., 1967).

2 Saleh Afiff and C. P. Timmer, "Rice Policy in Indonesia," *Food Res. Inst. Studies*, X, 2, 1971.

3 R. S. Eckaus, "The Factor-proportions Problem in Underdeveloped Areas," *Am. Econ. Rev.*, Sept. 1955.

4 W. P. Falcon, "Agricultural Employment in Less Developed Countries: General Situation, Research Approaches, and Policy Palliatives" (Memorandum prepared for The World Bank, Apr. 1971).

5 ——— "Programming Models for the Planning of the Agricultural Sector: Comment," in *The Theory and Design of Economic Development*, ed. by Irma Adelman and Eric Thorbecke (Baltimore, Md., 1966).

6 Yujiro Hayami and V. W. Ruttan, Agricultural Development: *An International Perspective* (Baltimore, Md., 1971).

7 J. M. Henderson and R. E. Quandt, *Microeconomic Theory* (New York, 1958).

8 A. O. Hirschman, *Development Projects Observed* (Brookings Inst., Washington, D.C., 1967).

9 D. B. Keesing, "Causes and Implications of Growing Inequality of Incomes within Developing Countries" (Memorandum No. 127, Res. Center in Econ. Growth, Stanford Univ., Stanford, Calif., Feb. 1972).

10 Uma Jayant Lele, "A Case Study in Agricultural Marketing: The Modern Rice Mill in India" (Occas. Paper 49, Dept. Agric. Econ., Cornell Univ., Ithaca, N.Y., 1971).

11 ———, "Modernisation of the Rice Milling Industry: Lessons from Past Performance," *Econ. and Pol. Weekly*, V, 28, 1970.

12 M. C. McGuire and H. A. Garn, "The Integration of Equity and Efficiency Criteria in Public Project Selection," *Econ. J.* (London), LXXIX, 316, 1969.

13 L. A. Mears, *Rice Marketing in the Republic of Indonesia* (Djakarta, 1961).

14 A. K. Sen, *Choice of Techniques* (Oxford, 1960).

15 C. P. Timmer, "Estimating Rice Consumption," *Bull. Indonesian Econ. Studies* (Canberra) VIII, 2, 1971.

16 ———, "On Measuring Technical Efficiency," *Food Res. Inst. Studies*, IX, 2, 1970.

17 ———, "Using a Probabilistic Frontier Production Function to Measure Technical Efficiency," *J. Pol. Econ.*, 79, 4, 1971.

18 J. Vanek and A. H. Studenmund, "Towards a Better Understanding of the Incremental Capital-Output Ratio," *Quar. J. Econ.*, Aug. 1968.

19 Weitz-Hettelsater Engineers, "Rice Storage, Handling and Marketing Study: Economic and Engineering Aspects," (advance draft, submitted to the Republic of Indonesia, Dec. 1971).