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THE CONSEQUENCES OF SMALL RICE FARM MECHANIZATION PROJECT

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# A TECHNICAL AND ECONOMIC EVALUATION OF RICE MILLS IN WEST JAVA, INDONESIA

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*ABSTRACT*

*In the past ten years rice milling technology in Indonesia has changed from traditional to mechanized method. A study was conducted in the Subang and Indramayu Districts of West Java to evaluate the technical and economic aspects of the rice milling sector. The units surveyed typically consisted of a mill, rice huller and a polisher. Ninety-six percent of the rice mills were privately owned. Seventy percent had a capacity of less than 5 quintals/hr and 30 % greater. Small mills operated 190 working days per annum and milled 395 tons of paddy. Large mills operated 214 days and milled 503 tons. Net revenue per ton was US$5.78 for small mills and US$3.97 for large. Investment appraisal revealed a breakeven requirement of 362 tons of paddy/year for small mills and 639 for large, together with an internal rate of return of 40% for small mills and 22% for large.*

## INTRODUCTION

Development of the agricultural sector is given the greatest emphasis in Indonesia's five year development plan (PELITA). To achieve food self sufficiency, this plan emphasizes intensification, extensification and diversification. Production may be increased by raising yield/ha and harvested area. At the same time improving post harvest technology can contribute to rural development by reducing production losses both in the field and off the field.

Importance of rice milling. In the past ten years rice milling technology has spread rapidly throughout Indonesia and has resulted in a change in the method of processing rice. In 1968 only 22% of Indonesian total rice output was milled by machine while the other 78% was processed by traditional method - either hand pounding or water milling (Sudarjono, 1980). By 1974 the share of total production milled by machine had increased to 50% (Sudarjono, 1980). Rice mills have spread particularly rapidly in West Java. In 1979 there were 11,725 units with an estimated milling capacity of 5,256 m. tons of paddy, compared to a total provincial output of 5,861 m. tons of paddy (Agricultural Extension Service, 1979). These data imply 90% of total rice production in West Java was milled by machine.

Objectives of the study. It is evident that the mechanical rice mill has become an important part of the village level food processing technology. This study evaluates the technical and economic aspects of this service sector in order to better understand the characteristics and performance of these rice milling operations.

## Data Collection

Site. In order to complement ongoing research, this study was conducted in the same eight village in Subang and Indramayu Districts that are included in the West Java site of the Indonesia/IRRI "Consequences of Small Farm Mechanization" project. This is a high productivity lowland rice area. All fields are irrigated, modern technology (fertilizer, modern varieties, insecticide) is widely adopted and farmers produce two rice crops/year with yields ranging from 3-5 t/ha/season (Consequences Team, 1981).

Sampling. After compiling a list of all rice mill owners, three were randomly chosen in each village, giving a total of 24 rice mill owner respondents. This sample represents about one-fourth of the population of mills in the area (Table 1). On the average, each mill serves 114 ha of rice land, although the range is from 73-149 ha/mill (Table 1). Each owner was interviewed during the 1979 dry season and 1979/1980 wet season to obtain basic information about this individual and the performance of his mill. Before analyzing the data, the respondents were stratified according to the capacity of their mills. Seventeen respondents owned units capable of milling less than 5 quintals (qt)/hour and seven with a capacity of more than 5 qt/hour[1].

## Results

Characteristics of mill owners. The respondents were relatively wealthy to have enough capital to invest in a rice mill. In addition, the average value of the respondents house and yard was US$ 4,853 and vehicle US$ 1,193 (Table 2). The respondents earned US$ 293/year from off-farm income sources. The average age of the respondents was 45 years. Only 13% were illiterate, most (46%) had attended school for 3-6 years, and 17% for more than 6 years. Of the 24 owners, 79% were common farmers, 17% key farmers (leaders in the Bimas production program) and one was only a rice mill owner-operator.

Characteristics of rice mills. The rice milling units in the sample typically consisted of a mill, rice huller, and polisher with a belt used for transmission of power. The gravitational method is typically used to clean the paddy before milling. Only three small and six large mill owners had cleaners for properly cleaning paddy before milling. Village level millers generally do not have additional facilities such as mechanical threshers, dryers, separators and transport vehicles. One reason is because these units serve small farmers who typically mill only 1-5 qt of paddy and landless or harvest laborers who often mill as little as only 1 qt/visit. Consequently, the simple equipment meets the needs of these clients who bring paddy to be milled and carry away the processed product.

All rice mills in the sample were imported, although locally manufactured units are now available in Indonesia. Seventy percent of the mills had a capacity of less than 5 quintals/hr and 30% with a capacity of

[1] Most units classified as "less than five quintals" had a capacity of 3.5 qt/hr, and most classified as "greater than 5 qt/hr" had a capacity of 6 qt/hr.

greater than 5 qt/hr. Owners preferred these smaller units because they were less expensive and easier to operate. At the time of the study, the mills ranged in age from 1-8 years, with the average age 3.8 years (Table 3). All of the mills used rubber rollers.

Diesel engines were the prime mover for all mills in the sample. The small machines used 8-15 hp.engines and the larger units were powered by 10-40 hp.engines. In Indonesia, small mills usually are driven by 6-7 hp. motor and large mills by a 15-17 hp. engine. Consequently, it appears that the respondent's power supply exceeded theoretical requirements.

Capital investment. Ninety-six percent of the rice mills were privately owned with one unit owned by a village cooperative. Most of the mill owners purchased their units with cash, although a larger proportion of the small units (75%) were bought for cash than were larger mills (57%). This is probably because the mills with a capacity of greater than 5 qt/hr required a greater capital outlay. Of the seven units purchased on credit, all but one respondent financed his purchase through the mill dealer who extended a loan for about five months on 50% of the cash cost.

Investment costs for milling operations included land, building and machinery. The average value of the land plus drying floor (569 $m^2$) and buildings (257 $m^2$) associated with the milling operations was US$ 748 and US$ 4,112, respectively. These buildings only housed the equipment and included no special room for an office or rice storage. Capital costs of the small and large mills averaged US$ 2,800 and US$ 4,000, respectively.

Rice mill performance. In the 1979 dry season and 1979/80 wet season, the small mills operated 190 working days and milled 393.2 t of paddy (Table 4). By comparison, the large mills ran 214 days and milled 503.4 tons of paddy. Although the large mills had a greater capacity, they milled an average of only 2.3 t/working day compared to 2.07 t/day for the small mills. Almost all of this paddy was milled for customers as none of the owners bought substantial amounts of paddy to process and market.

The data suggests that the technical performance of the larger units was superior to the smaller ones. For the large machines, bran as a percent of total milled paddy averaged 5.7% compared to 7.3% for the small units (Table 4). In addition, broken grains as a percent of total milled rice averaged 1.3% for the large mills and 2.1% for the small units.

Breakdowns and Repairs. The rice mills operated with a minimum of repair and maintenance problems. Breakdown occurred an average of 1.7 times/year and the problems were small in nature. In 70% of the cases, repairs and maintenance were carried out by a mechanic hired by the owner, 37% by the owner, and 4% by the dealer.

Most spare parts are now produced in Indonesia. Seventy-nine percent of the respondents reported that spare parts are available locally in adequate supply. On the other hand, 21% reported difficulties in obtaining replacement parts. For the sample of 24 owners the repair costs averaged US$ 165/year.

Revenue and variable costs. Sources of revenue for rice mills are milling charges[2] and the sale of bran and broken rice as by-products. For small mill owners, gross revenue averaged US$ 4,353/year with 55% coming from fees, 27% from bran and 18% from broken rice (Table 5). For large mill owners, gross revenue averaged US$ 4,804 with 62% coming from fees, 25% from bran and 13% from broken grains. From the owners point of view, there is no incentive for achieving a high level of technical performance. Revenue/ton was 16% higher for the small mills which gave a higher percent of broken grains. This paradox arises because the mill owner keeps the broken grains which are sold at a relative high price — approximate one-third the market price of whole cleaned rice.

Operating costs include fuel, oil, labor, repairs and maintenance and rubber roller replacement. For small and large mills total operating expenditures/year averaged US$ 2080 and US$ 2,805 respectively (Table 5). The largest share of these expenses is for labor(37 - 43%),fuel and oil (27-30%) and rubber roller replacement (23-27%).

Net revenue/year (gross revenue minus variable expenditures) was higher for small mills (US$ 2,273) than large mills (US$ 1,999) even though large mills milled a greater volume of paddy. This was because small mills had higher gross revenue and lower variable costs/t. Consequently, the small mills gave a substantially higher net revenue/ton — US$ 5.78 compared to US$ 3.97 for large mills.

## Investment Evaluation

The economic feasibility of a capital investment can be evaluated from several perspectives. Five approaches are presented below, based on the following assumption. First, in Indonesia the standard depreciation period assumed for rice mills is five years. Yet, since one-third of the mills in the sample were already five years or older, such a short depreciation period seemed unrealistic. Consequently, analysis is presented assuming both a five and ten year depreciation period. Second, when applicable, the opportunity cost of capital is assumed to be 20%/year. Third, machinery was depreciated using the straight line

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[2]Both small and large mills charged approximately US$ 6.00/t in both wet and dry seasons.

method and given a salvage value equal to 10% of the capital cost. Finally, building were charged an annual repair cost equivalent to 5% of their original value and given a salvage value equal to the original capital outlay.

Break even analysis. This approach estimates the milling volume that is required to cover all fixed and variable costs. Based on results in Tables 4, 5 and 6, the small rice mills must process 362 tons of paddy/year and the large mills 639 t/year, assuming a five year depreciation period (Table 7). For the small mills, this is equivalent to 92% of present utilized capacity and for large mills equal to 127% of present utilized capacity. With a 10 year depreciation period, the capacity utilization required to cover all costs falls to 81 and 109% for small and large mills, respectively.

Pay-back period. This measure estimates the number of years required to pay back the initial capital investment, including annual interest charges. For the small mill, capital costs are repaid in 7.8 years and for the large mill in 12.8 years.

Benefit cost. This analysis estimates the present worth of benefit relative to the present worth of costs and is useful in comparing investment alternatives. The analysis (Table 7) indicates that while both units have high B/C ratios, the small mills have a 14-16% higher B/C ratio than the large mills and the B/C ratio increases as the assumed depreciation period increases.

Internal rate of return. This measure estimates the yearly rate of return on capital invested and provides a basis for evaluating the profitability of an investment relative to alternative uses of capital. These results show that assuming a five year depreciation period, the small mill owner earns a 40% return/year on his investment — 18% more than the large mill owner (Table 7). As the depreciation period is increased to 10 years, the internal rate of return increases by 3-5%/year.

Comparative cost. Rice may be milled by manual or mechanical methods. The rapid expansion of the mechanized sector may be largely explained by the relative cost/t the consumer would pay to obtain a similar product. Based on this study, milling cost $6/t in 1980. Hand pounding requires about one woman day/40 kgs processed (Cain, 1979). In order to cost the same price/kg of output the maximum wage rate that could be paid is $0.24/day, which is at least 50% below the wage paid for typically for female agricultural operation such as handweeding rice.

## Conclusion

Rice mills have spread rapidly throughout Java in the past 10 years and have virtually eliminated the hand pounding of rice. An important reason for this development is that milling reduces the cost of rice processing to the consumer.

From the private point of view, rice mills are relatively profitable enterprises. Repair and maintenance and availability of spare parts — frequently constraints in mechanizing agriculture — are not problems in the study area. On the other hand, small mills are more profitable than large ones. The breakeven output was slightly below the existing capacity for the small mills and slightly above the existing capacity for the large mills. The payback period was 40% shorter, the B/C ratio about 15% greater and the rate of return on capital invested roughly 16-18% greater for small, compared to large mills. It is possible that small mills are more economically viable than large mills because the prime movers for the large mills generally exceed the theoretical power requirements. In conclusion, this study indicates that the milling sector has not expanded beyond the capacity to be supported by local demand for rice milling services and has no major problem requiring policy adjustments. It is of interest to note that rice milling sector in these villages has developed without government subsidies.

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Table 1. Number of rice mills and rice area (ha) in eight sample villages, West Java, Indonesia, 1980[a].

| Village | Rice mills (No.) | Rice area (Ha) | Ha/mill |
|---|---|---|---|
| Anjatan | 22 | 3,281 | 149 |
| Gabus Kulon | 19 | 2,395 | 126 |
| Tambakdahan | 16 | 1,139 | 71 |
| Sukra | 15 | 1,394 | 93 |
| Bojong Tengah | 14 | 1,018 | 73 |
| Mariuk | 12 | 1,116 | 93 |
| Pemanukan Hilir | 6 | 503 | 83 |
| Sukadana | 5 | 445 | 89 |
| Total | 99 | 11,291 | 114 |

[a]Based on the village data.

Table 2. Basic information about 24 rice mill owner respondents in West Java, Indonesia, 1980.

| Item | | |
|---|---|---|
| | Years | Percent |
| Age | 45 | |
| Education | No. | |
| Illiterate | 3 | (13) |
| Less than 3 years | 6 | (25) |
| 3-6 years | 11 | (45) |
| More than 6 years | 4 | (17) |
| Financial assets/resources | US$ | |
| Vehicle | 1,193 | |
| House plus land | 4,853 | |
| Off farm income/year | 293 | |
| Occupational status | No. | Percent |
| Common farmer | 19 | (79) |
| Key farmer[a] | 4 | (17) |
| Rice mill employer/operator only | 1 | ( 4) |

[a]Farmer given special responsibility to communicate technical information to common farmers participating in the government's BIMAS production program.

1 US$ = Rp. 625,-

Table 3. Year of purchase of village rice mills by machine capacity, 24 respondents in West Java, Indonesia, 1980.

| Year purchased | Milling capacity | |
|---|---|---|
| | < 5 qt/hr (N = 17) | >5 qt/hr (N = 7) |
| 1979 | 3 | 0 |
| 1978 | 1 | 4 |
| 1977 | 3 | 1 |
| 1976 | 3 | 1 |
| 1975 | 4 | 0 |
| 1974 | 1 | 0 |
| 1973 | 2 | 0 |
| 1970 | 0 | 1 |

Table 4. Village rice mill performance by capacity of machine, 24 rice mills in West Java, Indonesia, 1980.

| Item | Milling capacity | |
|---|---|---|
| | <5 qt/hr (N=17) | >5 qt/hr (N=7) |
| **Wet Season** | | |
| Working time (days) | 88 | 94 |
| Paddy milled (tons) | 187.5 | 233.8 |
| Bran (tons) | 13.5 | 13.6 |
| Broken rice (tons) | 3.4 | 3.2 |
| **Dry Season** | | |
| Working time (days) | 101.6 | 126.0 |
| Paddy milled (tons) | 205.7 | 267.6 |
| Bran (tons) | 15.1 | 14.9 |
| Broken rice (tons) | 4.9 | 3.6 |
| **Total** | | |
| Working time (days) | 189.5 | 214.3 |
| Paddy milled (tons) | 393.2 | 503.4 |
| Bran (tons) | 28.6 | 28.6 |
| Broken rice (tons) | 8.4 | 6.8 |

Table 5. Revenue and variable costs for village rice mills, 24 respondents in West Java, Indonesia, 1980.

| Item | Milling capacity | |
|---|---|---|
| | <5 qt/hr (N=17) | >5 qt/hr (N=7) |
| Gross revenue (per year) | US$ | US$ |
| Milling fee income[a] | 2401 | 2990 |
| Bran sales[b] | 1187 | 1185 |
| Broken rice sales[c] | 765 | 629 |
| Total (US$/year) | 4353 | 4804 |
| (US$/ton) | 11.07 | 9.54 |
| Variable costs (per year) | | |
| Fuel | 301 | 453 |
| Oil | 252 | 376 |
| Labor | 907 | 1027 |
| Repairs and maintenance | 148 | 185 |
| Rubber rollers | 472 | 764 |
| Total (US$/year) | 2080 | 2805 |
| (US$ | 5.29 | 5.57 |
| Net revenue (US$/year) | 2273 | 1999 |
| (US$/ton) | 5.78 | 3.97 |

[a]US$ 5.90 - 6.10/t

[b]Valued at approximately US$ 41/t

[c]Valued at approximately US$ 91/t

1 US$ = Rp.625

Table 6. Net returns analysis of village rice mills, 24 respondents in West Java, Indonesia, 1980.

| Item | Milling capacity | | | |
|---|---|---|---|---|
| | <5 qt/hr (N=17) | | >5 qt/hr (N=7) | |
| Capital Investment (Total) | US$ | | US$ | |
| Machinery | 2800 | | 4000 | |
| Building | 4112 | | 4112 | |
| | 6912 | | 8112 | |
| Gross revenue/year | 4353 | | 4803 | |
| Variable costs/year | 2080 | | 2805 | |
| Fixed costs/year | Rice mill depreciation period | | | |
| | 5 years | 10 years | 5 years | 10 years |
| Depreciation | | | | |
| Machinery[a] | 504 | 252 | 720 | 360 |
| Building[b] | 206 | 206 | 206 | 206 |
| Interest[c] | | | | |
| Machinery[a] | 560 | 560 | 800 | 800 |
| Building[b] | 822 | 822 | 822 | 822 |
| Total | 2092 | 1840 | 2548 | 2188 |
| Total costs/year | 4172 | 3920 | 5353 | 4993 |
| Net returns/year[d] | 181 | 432 | -550 | -190 |

[a]Annual machinery depreciation calculated as capital cost minus salvage value (10% of capital cost) divided by estimated useful life (5 and 10 years).

[b]Annual building maintenance cost calculated as 5% of initial investment.

[c]Interest charged at 20%/year, assumed opportunity cost of capital.

[d]Gross revenue minus total costs (fixed plus variable).

1 US$ = Rp.625

Table 7. Economic analysis of village rice mills, 24 respondents in West Java, Indonesia, 1980.

| Parameter | Milling capacity | | | |
|---|---|---|---|---|
| | <5 qt/hr (N=17) | | >5 qt/hr (N=7) | |
| | depreciation period | | | |
| | 5 years | 10 years | 5 years | 10 years |
| Breakeven analysis (t/year)[a] | 362 | 318 | 639 | 548 |
| Payback period (years)[b] | 7.8 | | 12.8 | |
| Benefit/cost ratio[c] | 1.17 | 1.24 | 1.03 | 1.08 |
| Internal rate of return[d] | 40 | 43 | 22 | 27 |

[a]Fixed costs/year divided by net revenue/t.

[b]Total capital costs divided by (gross revenue/year minus variable costs/year minus interest/year)

[c]

$$\text{B/C ratio} = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+i)^t}}$$

$B_t$ = benefits, year t

$C_t$ = Costs, year t

t = 1, 2, .....n

n = number of years

1 = interest (discount) rate

[d]$$\text{Internal rate of return} = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t} = 0$$

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