PN-AAN-554
ISN: 31735

THE CONSEQUENCES OF SMALL RICE FARM MECHANIZATION PROJECT

Working Paper No. 22

FINANCIAL ANALYSIS OF POWER TILLER OWNERSHIP IN MARIUK VILLAGE, WEST JAVA, INDONESIA

By

Aten Hurun
Central Research Institute for Food Crops
Indonesia

1981

The Consequences of Small Rice Farm Mechanization Project is supported by the United States Agency for International Development under Contract tac-1466 and Grant No. 931-1026.01 and is being implemented by the International Rice Research Institute and the Agricultural Development Council, Inc.

ABSTRACT

A study on the profitability of owning a tiller was conducted in Mariuk Village, West Java, Indonesia, during the wet season, 1980. The objectives were to estimate the profitability of owning tillers, to describe the credit system in the area, to identify the reasons influencing farmers in purchasing a tiller, and to identify any technical problems that might influence the profitability of ownership. The results show that the B/C ratio for the gasoline tiller was 1.14 in the wet season and 0.9 in the dry season, and for the diesel tiller was 0.9 in wet season, 0.6 in dry season. The internal financial rate of return was 7.2% for the gasoline tiller and below 1% for the diesel tiller. The breakeven points were 11.3 and 9.7 in wet and dry season for the gasoline tiller, while for the diesel tiller they were 19.3 and 18.6 in wet and dry season. Technical problems included difficulties in finding spare parts and the high cost of replacement parts.

I. INTRODUCTION

In Indonesia increasing food production is still an important goal, as the country has been unable to achieve self-sufficiency in rice during the past several years. Consequently, in the third five year development plan (Pelita III), the Government gives high priority to the development of the agricultural sector in order to increase (1) farmer's income; (2) labor/land productivity; (3) food production; (4) rural employment; and (5) regional development (Rijk, 1980).

In addition, the Government has supported small power tiller mechanization in the belief that this will increase the timeliness of land preparation which would in turn permit crop intensification and increase yields.

Farm mechanization, particularly tractorization, has been a major issue of debate in Indonesia in recent years (Rijk, 1980; Sinaga 1978; Sinaga, 1979; Simatupang, 1981; Consequences Team, 1981). Some of the studies suffer from a small sample size and others from a long recall period. Also, it is difficult to draw policy conclusions from studies done in other provinces because of site specific characteristics. Consequently, this study was initiated to evaluate the profitability of power tiller ownership in Mariuk, a village in Subang, West Java where a large number of tillers have been introduced during the past five years.

II. OBJECTIVES

This study focuses on five objectives related to the advantages and problems facing power tiller owners. Specifically, the study

1) describes the characteristics of power tiller owners
2) identifies non-economic reasons that influence the farmer's decision to purchase a power tiller
3) describes the credit system in the area that supports tiller mechanization.
4) identifies technical problems that tiller owners face — such as repair services and availability of spare parts — which may influence the profitability of ownership, and
5) estimates the profitability of owning a tiller in terms of rate of return on capital invested.

III. METHODOLOGY

Study area. The research was conducted in Mariuk village, Binong Sub-District, Subang District, West Java. Mariuk is located on the north coastal plains of Java, which is the most intensive rice growing area in Indonesia. The study area was irrigated by the Jatiluhur Dam. Two crops are normally grown each year, mostly lowland rice. Mariuk was chosen as the study area because most of the tillers in Subang District are concentrated in this village. While one farmer purchased a tiller in 1965, the first unit introduced by the Government did not arrive until 1967. Most of the farmers in this village purchased tillers for cash in 1978, 1979 and 1980.

Sampling. A list of all power tiller owners was obtained from the village agricultural staff and all 46 owners with 54 units were initially selected as respondents. Twelve owners were later excluded from the analysis because their tiller was broken (2), they had sold the unit, (2) or the data was judged too unreliable (8). The final sample included all owners who had purchased tillers in 1978, 1979 and 1980. Data about activities in the 1980 dry and 1980-81 wet season was collected during November and December 1980, through personal interviews with the tiller owners and their answers were recorded on a standardized questionnaire. If an owner operated two units, performance data was only collected on one tiller.

IV. RESULTS

Characteristics of power tiller owners. The respondent sample included 24 who owned gasoline and 10 who owned diesel units. Based on the data, there is little difference between these two groups (Table 1). The average age of tiller owners was about 40 years. Most (70%) had a primary education. All of the respondents reported their main occupation was farming and that they had been farmers for 20 years. The average farm size operated by tiller owners was extremely large (8-9 ha), compared to the typical non-owner who farmed 1.0 ha or less (Consequences Team 1981). Purchase of the tiller had almost no impact on area cultivated by the owners since the area farmed before and after purchase was almost the same. On the other hand, since all of the tillers were recently purchased, there may not have been enough time to observe this potential effect.

Reason for purchasing power tillers. Most owners felt that labor was becoming increasingly scarce. Consequently, the most frequent reason reported for purchasing a tiller by both gasoline and diesel owners was "difficulties in finding labor for land preparation" (50% gasoline and 30% diesel) as shown in Table 2. The second most frequently reported reason was they "felt the price was low" while others purchased a tiller to make land preparation easier and faster. On the other hand, only 8-10% of the respondents said they bought a tiller to reduce the cost of labor.

Characteristics of power tillers. Of the final respondents, 24 owned gasoline and 10 owned diesel tillers. The 24 gasoline units were almost all manufactured by Honda and had a 6.5 hp. rating (Table 3). Most were new and purchased in 1978 or later. The average purchase price was US$ 1,586 although 58% of the units cost between US$ 1,600 - 2,400, The 10 diesel tillers were made by Kubota (6) and Satoh(4) and rated at 7.5 or 8.5 hp. These were also mostly new with 80% purchased in 1979 or 1980. While the average price paid was US$ 3,737, 20% of the owners paid less than US$ 2,400 and 50% more than US$ 4,000. In addition to the differences in price due to brand, year of purchase and horsepower, some of the tiller owners purchased used units from neighbors at a discounted price.

Power tiller utilization. Actual utilized capacity largely determines the profitability of tillers. In Mariuk, the gasoline tillers cultivated an average of 15.8 ha in the wet season and 8.4 ha in the dry season — giving a yearly realized capacity of 24.2 ha (Table 4). The diesel tillers plowed 16.5 ha in the wet season and 9.4 ha in the dry season — giving a yearly capacity of 26.0 ha.

The demand for tiller services is significantly higher in the wet season than in the dry season. For both gasoline and diesel owners, about 65% of the hectares plowed were done in the wet season. This suggests a significant under utilization in the dry season (Table 4).

The data also shows that the owners primarily used the tillers to cultivate their own land. While in the wet season 62% and 52% of the land plowed by the gasoline and diesel tillers were owned by the tiller owners, in the dry season the share rose to 87 and 63%, respectively (Table 4). This suggests there is almost no demand for custom land preparation services in the dry season — even though the area is almost completely double cropped to rice.

The type of land preparation operations performed by the hand tillers vary by type of unit and season. For the gasoline tiller plowing and harrowing is required 11.9 and 10.5 hours/ha respectively (Table 5). In the dry season, plowing and harrowing are not required — only puddling, requiring 21 hours/ha. This is because in the area farmers typically use a minimum tillage system (walik jerami) that involves cutting the straw close to the ground and stomping the straw stumps into the mud. With the introduction of the tiller, this last

operation is performed mechanically (gelebeg). The gelebeg method brings the field into planting condition in two days while plowing plus harrowing would require 10-14 days. For diesel tillers, the standard operation is rotavating in both the wet and dry seasons, which requires 21.6 hours/ha. Consequently, the gasoline tillers operate an estimated 353 hours in the wet and 177 hours in the dry season, for a total of 530 hours/year. The diesel tillers operate 357 hours in the wet and 203 hours in the dry season, for a total of 560 hours/year.

Performance test on field capacity. In order to obtain accurate data on field capacity, a performance test in a fully irrigated field was conducted on a sample of gasoline and diesel tillers (Table 6). For land preparation, the gasoline units use a moldboard plough (one pass) for plowing and a comb harrow for harrowing (two passes). They consumed 1.5 l/hr for plowing and had a field capacity of 6.9 hrs/ha. For harrowing, fuel consumption was 1.3 l/hr and the capacity was 7.2 hrs/ha. For land preparation, the diesel tillers used only a rotavator (two passes). Fuel consumption was 0.8 l/hr for the first rotavating, requiring 9.5 hours/ha For the second rotavating, fuel consumption averaged 1.1 l/hr and the field capacity was 6.1 hrs/ha. Consequently, fuel consumption averaged 10.4 and 9.4 l/ha for the gasoline tillers for plowing and harrowing and 7.6 and 6.7 l/ha for the diesel units for the first and the the second rotavating. This performance data is valid only for wet season activity as the measurements were taken in the wet season, November 1980.

There was a substantial difference in the number of hours/ha required for land preparation reported by the tiller owners, compared to the performance test results. This can be partially explained by the tendency of the operator to work more quickly when being timed and the fact that the test plots were small. Also, the farmers estimate includes time required for field maintenance, resting and probably travelling to the field.

Problems in ownership, operations and maintenance. Tiller owners reported several problems associated with operating their units. Of those owning gasoline tillers, 42% felt fuel consumption was high and gasoline was expensive, 25% complained that their units frequently broke down and 25% noted it was difficult to find spare parts, which, if available, were expensive. Among diesel tiller owners 70% reported no problems. Yet, frequency of breaking down (20%) and difficult to find spare parts (10%) were the most commonly reported problems. It appears that the availability of spares is a major constraint. Even though a large number of tillers have operated in the area for several years, owners must frequently go to Jakarta (150 km) or Bekasi (120 km) because the local dealer in Sub-District Pamanukan does not carry a complete set of replacement parts.

Financial arrangements and credit characteristics. In Mariuk all of the 24 farmers who owned gasoline tillers purchased their units for cash, but all of the 10 diesel tillers were purchased on credit. Those paying cash mostly obtained the money by selling their paddy (46%) or both their paddy together with their carabao (45%). The farmers who bought on

credit obtained it from the dealers (40%) or the bank (60%). In order to get credit, the farmer must own at least 2.50 ha of lowland rice fields. If he gets credit from the bank, the first payment is US$ 160. If he gets the credit from dealer, the initial payment is 50% of the cost of the tiller. After completing necessary paper work, the unit is delivered in 15 - 30 days.

Power tiller operators. Almost all of the tillers were operated by someone hired by the owner. Typically 2-3 persons operate one unit, relieving each other as they become tired. Almost all of the owners reported it was easy to find an operator and about 70-75% of these individuals had prior driving experience (Table 6). On the other hand, none had ever received any formal training in operating or maintaining tillers. In addition, 33-40% of the owners reported that they had changed the operator since buying the unit, suggesting a possible lack of continuity in maintenance (Table 7).

Custom activities. As noted previously, almost all of the tiller owners did custom plowing to earn additional income. In order to find work, it was necessary to travel as far as 7 km from home (Table 8). The rate charged for custom land preparation averaged US$ 44.28/ha for gasoline and US$ 43/ha for diesel units. Contrary to expectations the standard contract rate has fallen from US$ 48/ha in 1977 and 1978, to US$ 40/ha in 1979-81 (Table 9) in spite of increases in fuel costs and inflation. Hence, in terms of 1977 dollars, the plowing rate was only approximately $26/ha in the 1980-81[1)] wet season. The owners reported charging the same rate no matter the distance from home and did not give discounts to promote additional work. Most of the customers paid in cash, but about 30% were permitted to pay after harvest.

V. ECONOMIC EVALUATION

Budget Analysis.

Capital investment. The average price paid by the tiller owners was US$ 1,752 for gasoline and US$ 3,943 for diesel units (plus implements) (Table 12). These prices are relatively low because about one-fourth of the tillers were purchased before Indonesia devalued the Rupiah from 1 US$ = 425 to 1 US$ = 625 in November 1978. By contrast, in January 1981 a new two-wheel Honda 6.5 hp. gasoline tiller cost US$ 2,400 and a new Kubota 7.5 hp. diesel unit cost US$ 4,800.

Fixed costs. Fixed costs/season are calculated as the sum of depreciation and interest (Table 12). A use life of five years is assumed since when provided good maintenance the normal operating life of these hand tillers is about 3,000 hours and the data showed that each

---

1) Deflated by price index of nine essential commodities in rural markets in Java and Madura, W.S. 1977-78 equals approximately 320 and W.S. 1980-81 equals approximately 500 (BPS, 1980).

tiller operated for an average of slightly less than 550 hours/year. Although the gasoline tillers were purchased for cash, and the diesel tillers on credit (10.5/year), interest of 10.5%/year was charged for each type of tiller in order to standardize the comparison. It should be noted that this subsidized interest rate is at least 50% below the opportunity cost of capital. Based on these assumptions, fixed costs averaged US$ 212.88 and US$ 479.10/season for gasoline and diesel tillers, respectively (Tables 11 and 12).

Variable costs. For the gasoline tillers, variable costs/ha averaged US$ 25.41 in the wet and US$ 22.32 in the dry season (Table 10). For the diesel tiller, variable costs averaged US$ 18.16 in the wet and US$ 17.21 in the dry season. Hence, diesel tillers are 40% less expensive to operate in the wet and 30% less expensive to operate in the dry season.

Gross revenue. Gross revenue/ha is equal to the contract plowing rate/ha. While most owners did not actually earn this income because they largely plowed their own land, the existing rate is used as the opportunity cost of tiller services. This assumption may over value the opportunity cost of the units in the dry season. Since very few farmers were willing to hire the tiller in the dry season, the traditional method of land preparation is probably less expensive and considered to be equally effective. For gasoline and diesel units, gross revenue/ha averaged US$ 44.27 and 43.00/ha in both seasons (Table 11).

Net revenue. Net revenue (excluding fixed costs)/ha is calculated as gross revenue/ha minus total variable costs/ha. Because variable cost/ha were lower for diesel tiller, net revenue/ha was 32% (wet season) and 18% (dry season) higher than for gasoline units (Table 11).

Investment Analysis.

Several alternative ways of evaluating the tiller investment are presented below.

Breakeven analysis. Breakeven analysis is used to calculate the number of hectares that must be prepared each season to cover total costs. For the gasoline tiller, it would be necessary to prepare 11.3 and 9.7 ha in the wet and dry season, respectively, to cover fixed and variable costs (Table 11). Judged by this criterion, the gasoline units performed well in the wet season when they plowed 15.8 ha but were below the breakeven hectarage in the dry season when only 8.4 ha were prepared. In sharp contrast, the diesel tillers required 19.3 and 18.6 ha in the wet and dry season to cover costs, compared to a utilized capacity of only 16.5 and 9.4 ha, respectively.

Benefit cost ratio. The benefit cost ratio (B/C) is calculated as the present worth of net benefits divided by the present worth of

investment plus operating costs. In order to estimate the B/C ratio for each season, this was approximated as gross revenue divided by total costs. Table 12 shows that the B/C ratio was greater than 1.0 (i.e., 1.14) only for the gasoline tiller in the wet season and <1% in both seasons for the diesel tractor.

Internal rate of return. The internal financial rate of return is the discount (interest) rate at which the net present value of the cash flow equals zero. Based on the results presented in Tables 11 and 12, the gasoline tillers gave an internal rate of return of 7.2% slightly below the subsidized interest rate of 10.5%/year. On the other hand, the diesel units gave an internal rate of return of <1% in both seasons (Table 12).

Sensitivity Analysis.

The analysis presented was based on data collected from a sample of tiller owners in Mariuk. In order to interpret these results in terms of land preparation mechanization policy, certain parameters must be revised to take into consideration existing tiller prices and alternative interest rates.

The tractor prices used in computing Table 11 were US$ 1,752 for gasoline and US$ 3,943 for diesel units. These prices are substantially lower than the current price since these tillers were purchased over the past three years and some owners bought used units. Consequently, in order to estimate the economic returns that can be expected by farmers who purchase new tillers plus implements today, it is necessary to substitute into our model the current price — US$ 2,566 for gasoline and US$ 5,006 for diesel units (including implements).

In addition, the gasoline tillers in the sample were bought for cash and the diesel on credit. In future schemes, a decision will have to be made as to whether or not subsidized credit should be provided and if so, at what interest rate. Consequently, by introducing alternative interest rates of 10.5% and 20%, it is possible to observe the impact of credit on profitability.

Sample tiller prices, non-subsidized interest. If the current owners had purchased their tillers with non-subsidized credit, both gasoline and diesel owners would have had to plow 23% more hectares (Table 13). At the same time, the B/C ratio would have been 8-9% lower and the internal rate of return <1% for both diesel and gasoline units.

New tiller prices, subsidized interest. At current tiller prices and subsidized credit, the breakeven hectarage increases to 46% and 27% above existing capacity utilization for gasoline and diesel units (Table 13). In addition, the B/C ratio falls to 0.80 and 0.59 for gasoline and diesel tillers, both of which give internal rates of return < 1%.

New tiller prices, non-subsidized interest. At current tiller prices and non-subsidized credit, the breakeven hectarages increase to 81% and 57% above the existing capacity utilization (Table 13). At the same time, the B/C ratio drops to 0.72 and 0.51 for gasoline and diesel and the internal rate of return is <1%.

Fuel prices. Gasoline and diesel are heavily subsidized in Indonesia. Local consumers currently pay approximately 75% (US$ 0.24/1) and 26% (US$0.08/1) of the world market price for gasoline and diesel fuel, respectively. Using these world market fuel prices, variable costs (wet season) would have increased to US$28.86/ha for gasoline and for US$25.88 for diesel units. At these fuel prices, the gasoline tillers would have to prepare about 40 and the diesel units 70 ha/year in order to breakeven -- assuming new (current) tiller prices and subsidiezed credit.

Conclusion

It is generally accepted that capital investment should generate enough income to cover both fixed and variable costs and give a return on capital (profit). Economic analysis showed that at the actual tiller prices paid by the sample of owners, with subsidized credit, prevailing contract plowing rates, existing capacity utilization and assuming a five year useful life — both gasoline and diesel tillers gave negative returns (profit) to the owners. This conclusion is based in the analysis which showed a B/C ratio <1 and an internal rate of return less than the subsidized interest rate. If farmers were to purchase tillers at current prices, the economic viability of both gasoline and diesel units would be substantially below the level estimated for the sample of respondents because of recently increases in tiller purchase prices.

Part of the rationale for introducing power tillers rests on the belief of a shortage of labor units. Yet, the contract plowing rate has declined since 1978 in both nominal and real term costs. Theoretically, there should be a close relationship between the cost of tiller and human land preparation — since these are substitutable techniques. The fact that the tiller plowing rate has declined in real terms implies that the human wage rate has probably declined in real terms. This casts considerable doubt as to the applicability of the labor shortage hypothesis in Mariuk since the plowing rate should have increased if labor had been in short supply. In fact, the fall in the plowing rate may have been partially the result of the introduction of too many tillers.

A variant of the labor shortage hypothesis is that turnaround time between the first and second crop is delayed by a shortage of labor for land preparation. The validity of this argument for Mariuk is brought into question by the fact that in the dry season there is almost no demand for custom hire land preparation services.

The Government could subsidize tiller prices and credit, thereby increasing the profitability of power tiller ownership. Yet, the data indicate that tiller owners are the wealthiest farmers, owning an average

of about nine hectares each. This implies that the 46 tiller owners in the village cultivate over 400 of the 1000 hectares in Mariuk. To subsidize this group of farmers would seem inconsistent with the Government's goal of reducing inequality in income distribution.

The data shows that neither gasoline or diesel tillers are economically viable. On the other hand, in terms of all criteria considered, diesel owners in Mariuk incur substantially greater losses than gasoline tiller owners. This is because the diesel units were almost twice as expensive (gasoline = US$ 244/hp and diesel = US$ 467/hp) as gasoline tillers, but the utilized field capacity was almost the same.

It is often argued that power tillers are necessary to achieve the Government's goal of synchronized planting of rice which is believed to reduce pest problems. Yet, at new tiller prices, subsidized credit, the existing distribution of demand between wet (65%) and dry season (35%), the gasoline tiller must plow about 19 ha in the wet season to breakeven. At the reported work rate of 22.4 hours/ha for complete land preparation (plowing plus harrowing), this implies each unit must operate 426 hours or 43 ten hour days. If time is added for repairs/maintenance and idle days, 50 or more calendar days must be available to accomplish the work load required to breakeven, but a maximum of 45 days is allocated for land preparation in each irrigation area (golongan). Consequently, synchronized planting is inconsistent with the profitable operation of tillers unless we assume the owners will transport their units between villages which have sequential water (land preparation) schedules. While this may be possible, the data showed that the sample of owners travelled a maximum of only 7 kilometers in search of land to plow and were primarily interested in using the tiller to prepare their own land. In other words, the more successful the Government is in achieving synchronized planting of rice in a large area the more difficult it will be to operate tillers profitably. This is because as land preparation becomes increasingly synchronized owners will have to search for land to plow farther and farther from their village in order to cover enough hectares to breakeven.

In evaluating the scope for tillers in Mariuk and similar areas, several points should be considered. First, at existing capacity utilization and contract plowing rates, the price of the tiller should not exceed US$ 1,600. Second, presently owners must seek out contract work in order to plow enough land to breakeven. Less expensive tillers that breakeven cultivating a smaller number of hectares would reduce the need for owners to seek out contract work and make it possible for owners to breakeven by mainly cultivating their own land. Third, the tiller is more likely to breakeven in areas where complete land preparation is employed for the second crop — reducing the problem of under-utilization in the dry season. Finally, the higher the local wage rate for land preparation, the higher will be the contract plowing rate. Changes in the real cost of human and power tiller land preparation should be used to indicate the existence of a labor bottleneck. In areas where real costs of land preparation are declining like Mariuk, it is unlikely that power tillers will be economically viable.

The results reported in this paper are based on recall data. In order to obtain more accurate information on capacity utilization, costs and repair problems, each owner should be trained to keep a simple set of business records. These records could be used by the owner to evaluate the profitability tiller ownership and provide guidance as to how he could increase the profitability of his business. At the same time, these records would provide accurate data that could be used by the Government to plan future mechanization policies and corrective action that might be required to improve tiller profitability such as improving driver training and spare part availability.

REFERENCES

Consequences Research Team. 1981. Consequences of Land Preparation on Mechanization in Indonesia; South Sulawesi and West Java, paper presented at the Regional Seminar on appropriate Mechanization for Rural Development, January 26-30, Jakarta, Indonesia.

Gifford, R.C., 1980. Guidelines for Agricultural Mechanization Strategy in Development, Regional Network for Agricultural Machinery Project, under the auspices of The Economic and Social Commission for Asia and The Pacific (ESCAP).

Gittinger, J.P., 1972, Economic Analysis of Agricultural Projects, Johns Hopkins University Press, Baltimore.

Maranan, C., J.A. Wicks, and Bart Duff, 1981. The Profitability of Two and Four-Wheel Tractor Ownership in Nueva Ecija, Philippines, 1980. IRRI Saturday Seminar, Agricultural Engineering Dept., May 16, Los Banos, Philippines.

Simatupang, Pancar, 1980. Kemungkinan Mekanisasi Pertanian di Kabupaten Karawang dan Pengaruhnya terhadap Kesempatan Kerja dan Pendapatan Petani. M.Sc. Thesis pada Sekolah Pasca Sarjana, Institut Pertanian Bogor.

Sinaga, R.S., 1978. Implications of Agricultural Mechanization for Employment and Income Distribution: A Case Study from Indramayu, West Java. Rural Dynamics Series No.2. Agro-Economic Survey, Bogor, Indonesia, April.

Sinaga, R.S., 1977. Economic Viability of Hand Tractor Leasing Project and Potential Employment Impact in Kabupaten Badung, Gianyar and Tabanan, Bali. Team Survey Studi Dinamika Pedesaan, Survey Agro Ekonomi, Bogor.

Table 1. General information about 34 tiller owners, Mariuk, Subang, West Java, Indonesia, 1980.

Item	Tiller type	
	Gasoline (N=24)	Diesel (N=10)
Age	39.7	40.8
Education (%)		
No education	4.2	10.0
Primary school (1-6)	70.8	70.0
Secondary school (7- 9)	16.7	10.0
High school (10-12)	8.3	10.0
Years farming	20.4	20.6
Area cultivated (ha)		
Before purchasing tiller	8.9	9.1
After purchasing tiller	9.0	8.3
Number of parcels		
Before purchasing tiller	6.0	6.0
After purchasing tiller	6.0	6.2

Table 2. Owner's reason for purchasing a tiller Mariuk, Subang, West Java, Indonesia, 1980.

Reasons	Tiller type	
	Gasoline (N=24)	Diesel (N=10)
	(%)	(%)
Difficult to find labor for land preparation	58	30
Reduce labor cost	8	10
Easier and faster land preparation	13	10
Want to have as price is low	21	20
Difficult to care for carabou	0	10
Carabao is sold	0	10
Old tiller is broken down	0	10
	100	100

Table 3. Characteristics of tiller population and sample, Mariuk Village, Subang, West Java, Indonesia, 1980.

	Gasoline (N=40)			Diesel (N=14)		
Brand	Total	Sample	Percent	No.	Sample	Percent
Honda	39	23	(96)	0	0	
JLO	1	1	(4)	0	0	
Kubota	0	0		7	6	(60)
Satoh	0	0		7	4	(40)
	40	24		14	10	
Status when purchased						
new	14	14	(58)	12	8	(80)
used	16	10	(42)	2[a]	2	(20)
unknown	10	0		0	0	
	40	24		14	10	
Horsepower						
5.5	1	1	(4)	0	0	
6.5	36	21	(88)	0	0	
7.0	3	2	(8)	1	1	(10)
7.5	0	0		6	5	(50)
8.5	0	0		7	4	(40)
	40	24		14	10	
Year purchased (acquired)						
1975 or earlier	4[a]	0		0	0	
1976	1	0		0	0	
1977	1	0		1	0	
1978	7	7	(29)	3	2	(20)
1979	15	15	(63)	5	4	(20)
1980	2	2	(8)	5	4	(40)
unknown	10	0		0	0	
	40	24		14	10	
Purchase price (US$)						
1,600	17	10	(42)	1	0	
1,600 - 2,400	13	14	(58)	3	2	(20)
2,400 - 3,200	0	0		0	0	
3,200 - 4,000	0	0		5	3	(30)
4,000	0	0		5	5	(50)
unknown	10	0		0	0	
	40	24		14	10	
Average (US$)		1,586			3,737	

[a]Honda body with new Kubota engine.

Table 4. Area cultivated (ha) by tiller type, Wet and dry Season 1980, Mariuk, Subang, West Java, Indonesia, 1980.

Season/ Type of work	Gasoline (N = 24)		Diesel (N =10)	
	(Ha)	(%)	(Ha)	(%)
Wet				
Own farm	9.73	(40.17)	8.64	(33.28)
Custom	6.04	(24.94)	7.90	(30.43)
Sub total	15.77	(65.11)	16.54	(63.71)
Dry				
Own farm	7.03	(29.03)	6.32	(24.35)
Custom	1.42	(5.86)	3.10	(11.94)
Sub total	8.45	(34.89)	9.42	(36.29)
TOTAL	24.22	(100.0)	25.96	(100.0)

Table 5. Tiller utilization by tiller type, wet and dry seasons, Mariuk, Subang, West Java, Indonesia, 1980.[a]

Operation	Tiller type (hrs/ha)			
	Gasoline (N=24)		Diesel (N=10)	
	wet	dry	wet	dry
Plowing	11.9	N.A.	N.A.	N.A.
Harrowing	10.5	N.A.	N.A.	N.A.
Rotovating	N.A.	N.A.	21.6	21.6
Puddling	N.A.	21.0	N.A.	N.A.
	Working hours/season			
	353	177	357	203

[a]Based on owners estimate.

Table 6. Performance test[a] results of gasoline and diesel tillers, Mariuk Village, Subang, West Java, Indonesia, Wet season 1980-81.

Item	Plowing/rotary			Harrowing/rotary		
	l/hr	hrs/ha	l/ha	l/ha	hrs/ha	l/ha
Gasoline[b]						
Fuel	1.5	6.9	10.4	1.3	7.2	9.[illegible]
Diesel[c]						
Fuel	0.8	9.5	7.6	1.1	6.1	6.7

[a]Performance measurements made by Consequences staff and Aten Hurun

[b]Three two-wheel Honda tillers plowing a total of 0.3 ha and four units harrowing 0.4 ha.

[c]Seven two-wheel Kubota tillers rotovating a total of 0.7 ha (first rotovating) and four units rotovating 0.5 ha (second rotovating).

Table 7. Characteristics of tiller operators, Mariuk, Subang, West Java, Indonesia, 1980.

I t e m	Type of tiller	
	Gasoline (N=24)	Diesel (N=10)
Operator easily obtained (%)	92	100
Prior experience (%)	75	70
Operator training (%)	0	0
Operator changed since purchasing (%)	33	40

Table 8. Characteristics of tiller custom service , Mariuk, Subang, West Java, Indonesia, 1980.

I t e m	Type of tiller	
	Gasoline (N=24)	Diesel (N=10)
Transport		
Average distance - travelled for work (Km)	3.8	5.1
Maximum distance - serviced (Km)	7.3	7.4
Type of payment (%)		
Cash	100	90
Kind	0	10
Delayed payment - until next season (%)	29	30

Table 9. Contract rates for custom land preparation (US$/ha)[a] Mariuk, Subang, West Java, Indonesia, 1975-1981.

Year	Type of tiller		
	gasoline		diesel
	plow plus harrow	puddle	rotovate
	US$/ha	US$/ha	US$/ha
1975	48	40	48
1976	48	40	48
1977	48	40	48
1978	48	40	48
1979	40	32	40
1980	40	32	40
1981	40	32	40

Using current exchange rate of 1 US$ = Rp. 625,- even though the rate before October 1978 was 1 US$ = Rp. 425,-.

Table 10. Variable cost, by tiller type, wet and dry season, Mariuk, Subang, West Java, Indonesia, 1980.

	Wet season			Dry season		
	Amount l/hr or kg/hr	US$/unit	US$/ha	Amount l/hr or kg/hr	US$/unit	US$/ha
Gasoline[a]						
Fuel	1.720	0.27	10.35	1.720	0.27	9.71
Engine oil	0.023	1.30	0.67	0.023	1.30	0.63
Gear oil	0.007	1.35	0.21	0.007	1.35	0.20
Grease	0.001	0.88	0.02	0.001	0.88	0.02
			11.25			10.56
Maintenance			3.75			2.01
Operator's wage			10.41			9.75
Total variable cost			25.41			22.32
Diesel						
Fuel	1.20	0.10	2.71	1.20	0.10	2.71
Engine oil	0.03	1.42	0.92	0.03	1.42	0.92
Gear oil	0.02	1.26	0.54	0.02	1.26	0.54
Rotary oil	0.002	1.20	0.02	0.002	1.20	0.02
Grease	0.001	3.07	0.07	0.001	3.07	0.07
			4.26			4.26
Maintenance			2.21			1.26
Operator's wage			11.70			11.70
Total variable cost			18.16			17.21

[a]Based on owners estimate.

Table 11. Break even point analysis by tiller type and season, Mariuk, Subang, West Java, Indonesia, 1980.

I t e m	Tiller type			
	Gasoline		Diesel	
	W.S.	D.S.	W.S.	D.S.
Gross revenue (US$/ha)	44.27	44.27	43.00	43.00
Fixed costs (US$/season)[a]	212.88	212.88	479.10	479.10
Variable costs (US$/ha)	25.41	22.32	18.16	17.21
Net revenue (US$/ha)[b]	18.86	21.95	24.84	25.79
Break even point (ha)[c]	11.29	9.70	19.29	18.58
Capacity utilization (ha)	15.77	8.45	16.54	9.42

a) Assuming five year depreciation period (ten seasons)

b) Excluding fixed costs

c) Fixed costs/season divided by net revenue/ha

Table 12. Economic analysis of tillers by type and season, Mariuk, Subang, West Java, Indonesia, 1980.

Item	Tiller type			
	Gasoline		Diesel	
	W.S.	D.S.	W.S.	D.S.
Capital investment (US$)[a]	1,752	1,752	3,943	3,943
Total fixed costs (US$)				
Depreciation[b]	157.69	157.69	354.89	354.89
Interest[c]	55.19	55.19	124.21	124.21
	212.88	212.88	479.10	479.10
Variable costs (US$)	400.72	188.60	300.37	162.12
Total costs (US$)	613.60	401.48	779.47	641.22
Gross revenue (US$)[d]	698.14	374.08	711.22	405.06
Net revenue (US$)[e]	84.54	- 27.40	- 68.25	-236.16
Economic Parameters				
Benefit cost (ratio)[f]	1.14	0.93	0.91	0.63
Internal rate of return[g] (%)	7.15		<1	

a) Tiller plus implement typically purchased in second year

b) Five years with 10% salvage value assumed, i.e.,

$$\text{Depreciation} = \frac{0.9\ (\text{capital investment})}{\text{ten seasons}}$$

c) Calculated as 10.5% on declining balance averaged over ten seasons

d) Actual capacity for gasoline tiller was 15.77 and 8.45 ha plowed in W.S. and D.S., respectively. For diesel tiller, actual capacity was 16.54 and 9.42 ha plowed in W.S. and D.S., respectively.

e) Gross revenue minus total costs

f) Approximated as gross revenue divided by total costs

g) Discount rate at which $\sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t} = 0$ where B_t = benefits in each year
C_t = costs in each year
$t = 1 \ldots n$
i = interest (discount) rate

Table 13. Sensitivity analysis of tiller profitability assuming various capital and credit costs, Mariuk. Subang, West Java, Indonesia, 1980.

Parameter	Gasoline			
	Sample prices[a]		New prices[b]	
	10.5%[c]	20%[d]	10.5%[c]	20%[d]
Break even (ha)	20.99	25.92	30.74	37.95
Benefit cost (ratio)[e]	0.98	0.90	0.80	0.72
Internal rate of return (%)	7.2	<1	<1	<1
	Diesel			
Break even (ha)	37.87	46.75	48.08	59.36
Benefit cost (ratio)	0.70	0.61	0.59	0.51
Internal of return (%)	<1	<1	<1	<1

a) Sample tiller prices, including implement: gasoline, US$1,752; diesel, US$3,943.

b) New tiller prices, including implement: gasoline, US$2,566 and diesel, US$5,006.

c) Subsidized interest rate

d) Conservative estimate of non-subsidized interest rate

e) Benefit cost ratio =

$$\frac{\sum_{t=1}^{n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+i)^t}}$$

where: B_t = benefit in each year
C_t = costs in each year
t = time
i = interest rate

CONSEQUENCES OF SMALL RICE FARM MECHANIZATION PROJECT

Working Papers

1. Juarez, F. and B. Duff. The Economic and Institutional Impact of Mechanical Threshing in Iloilo and Laguna. October 1979.

2. Pathnopas, R. The Economics of Rice Threshing Machines in Thailand: A Case Study of Chachoengsao and Supanburi Provinces. October 1979.

3. Gardezi, J., A. Rauf, M. Munir, K. Altaf, Q. Mohd-ud-Din, and B. Lockwood. A Study of Mechanical and Traditional Wheat Threshing in Multan District, Punjab, Pakistan: Some Preliminary Results. October 1979.

4. Habito, C. and B. Duff. A Simulation Model to Evaluate Mechanization of Rice Postharvest Operations in the Philippines. October 1979.

5. Chapman, J. The Potential of Mechanization for Crop Intensification in a Rainfed Area - Iloilo, Philippines. October 1979.

6. Thapa, G. The Economics of Tractor Owernship and Use in the Nepal, Terai. October 1979.

7. Jongsuwat, N. Productivity Growth and Farm Machinery Adoption in Thai Agriculture. April 1980.

8. Bernsten, R.H. and R. Sinaga. A Methodology for Identifying Lowland Rice Farms that Would Benefit from the Mechanization of Land Preparation. October 1979.

9. Bernsten, R. H. and A. Rochim. Labor Shortage as a Constraint to Increasing Cropping Intensity. Revised March 1980.

10. Ayob, A.M. The Economics and Adoption of the Combine Harvester in the Muda Region of Malaysia. October 1979.

11. Lubis, R. Impact of Cropping Pattern Technology on Income, Employment and Production: A Case Study on Expanded Crop Production in Lampung. October 1979.

12. Wicks, J. A. Modelling the Consequences of Future Mechanization: An Outline of Possible Procedures. October 1979.

13. Khoju, M.R. and J. A. Wicks. Economics of Pump-Irrigation in Eastern Nepal. August 1980.

14. Tan, Y. L., J.P.G. Webster and J. A. Wicks. The Decomposition of Differences in Output Between Two Groups of Farms. Revised 1981.

15. Herdt, R. W. Mechanization of Rice Production in Developing Asian Countries: Perspective, Evidence, and Issues. September 1981.

16. Lanzona, R. M. Mechanization Policy and the National Agricultural Mechanization Council - Philippines. September 1981.

17. Lockwood, B. Farm Mechanization in Pakistan: Policy and Practice September 1981.

18. Wiboonchutikula, P. The Total Factor Productivity Growth of the Three Digit Manufacturing Industries in Thailand. September 1981.

19. Ahammed, C. S. and R. W. Herdt. A General Equilibrium Analysis of the Effects of Rice Farm Mechanization in the Philippines. September 1981.

20. Mikkelsen, K. and N. Langam. Technology Change in the Philippine Agricultural Machinery Industry. September 1981.

21. Boughton, D. Energy Use in Alternative Rice Production Systems in Nueva Ecija, Central Luzon, Philippines. September 1981.

22. Hurun, A. Financial Analysis of Power Tiller Ownership in Mariuk Village, West Java, Indonesia. September 1981.

23. Hafsah, J. The Economics of Tractor Operation and Use in South Sulawesi, Indonesia. September 1981.

24. Maranan, C. L. A Comparative Analysis of Tractor Contract Operations in Nueva Ecija, Philippines, 1972 and 1980. September 1981.

25. Monge, V. S. and B. Duff. Analysis of the Demand for Farm Power for Small Rice Farm Agriculture in Nueva Ecija, Philippines. September 1981.

26. Munir, M. An Evaluation of the Farmers' Decision-Making for Investment in Farm Machinery. September 1981.

27. Jabbar, M. A., Md.S. R. Bhuiyan and A. K. Maksudul Bari. Causes and Consequences of Power Tiller Utilization in Two Areas of Bangladesh. September 1981.

28. Juarez, F. and R. Pathnopas. A Comparative Analysis of Thresher Adoption and Use in Thailand and the Philippines. September 1981.

29. Ahmed, J. U. Labour Use Pattern & Mechanization of Paddy Postharvest Processing in Bangladesh. September 1981.

30. Colter, J. M. The Impact of Handtractors on Income and Employment Opportunities of Migrant Laborers in Java. September 1981.

31. Santoso, K. The Potential for Agricultural Mechanization and Labor Markets in East Java. September 1981.

32. Bernsten, R. H. Effects of Mini-Tractor Mechanization on Employment and Labour Use Intensity, Sidrap and Pinrang, South Sulawesi, Indonesia. September 1981.

33. Collier, W. Improved Cropping Patterns, Labor Absorption and Small Farm Mechanization in Indonesia. September 1981.

34. Moran, P. B. and E. Camacho. Consequences of Farm Mechanization Project Site Description: Philippines. September 1981.

35. Generalla, A. C. and A. Aguilar. Effects of Mechanization on Intensity of Land Use. September 1981.

36. Tan, Y. and J. A. Wicks. Production Effects of Mechanization. September 1981.

37. Sison, J. F. and P. B. Moran. Farm Labor Utilization and Employment in Two Selected Municipalities in Nueva Ecija - A Preliminary Analysis. September 1981.

38. Saefuddin, Y. Site Description: Mechanization Consequences Project in West Java, Indonesia. September 1981.

39. Handaka, S. Effects of Mechanization on Intensity of Land Use, West Java, Indonesia. September 1981.

40. Handaka, S. A Technical and Economic Evaluation of Rice Mills in West Java, Indonesia. September 1981.

41. Sinaga, R. Effects of Mechanization on Productivity: West Java, Indonesia. September 1981.

42. Sinaga, R. Effects of Mechanization on Productivity: South Sulawesi, Indonesia. September 1981.

43. Sri-Bagyo, A. The Impact of Mechanization on Production and Employment in Rice Areas of West Java, Indonesia. September 1981.

44 Maamun, Y. Site Description: Mechanization Consequences Project in South Sulawesi. September 1981.

45. Sarasutha, I. G. P. and R. Bernsten. Effect of Mechanization on Intensity of Land Use, South Sulawesi, Indonesia. September 1981.

46. Bockhop, C. W. and M. Nafziger. The Impact of Economics upon the Design of Machinery at IRRI. September 1981.

47. Wattanutchariya, S. Economic Analysis of Farm Machinery Industry and Tractor Contractor Business in Thailand. September 1981.

48. Hussain, K. A. An Assessment of Capacity of Workshops and Farmers To Repair and Maintain Farm Machinery in District Faisalabad: Summary of Major Findings and Policy Recommendations. September 1981.

49. Gonzales, L. A. and R. W. Herdt. Evaluating the Sectoral Impact of Mechanization on Employment and Rice Production in the Philippines: A Simulation Analysis. September 1981.

50. Khoju, M. R. The Economics of Pump Irrigation in Eastern Nepal. September 1981.

51. Sudaryanto, T. The Effect of Tubewell on Income and Employment: A Case Study in Three Villages in Kediri, East Java, Indonesia. September 1981.

52. Santoso, K. Economics of Pumpsets in East Java. September 1981.

53. Wicks, J. A. and M. A. Sumiran. Data Management for Analyzing the Consequences of Mechanization. September 1981.

54. Webster, J. P. G. An Evaluation of Mechanization Data Using the FAO's Management Data Collection and Analysis System (FMDCAS). September 1981.

55. Lingard, J. Measuring the Impact of Mechanization on Output. September 1981.

JW/hhr