PN-AAN-553
ISN: 31734

THE CONSEQUENCES OF SMALL RICE FARM MECHANIZATION PROJECT

Working Paper No. 23

THE ECONOMICS OF TRACTOR OPERATION AND USE IN SOUTH SULAWESI, INDONESIA

By

J. Hafsah
LPPM, Ujung Pandang, 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.

Economic, Technical and Social Aspects of Tractor Operation and Use in South Sulawesi, Indonesia*

J. Hafsah and R.H. Bernsten**

ABSTRACT

Mini-tractors have been introduced into South Sulawesi in order to provide additional land preparation power in this relatively sparsely populated Province. In order to better understand the impact of this program, ten individuals in Sidrap and Pinrang Districts who bought mini-tractors in each of the past five years (1975-1979) were interviewed. Information was collected about their socio-economic characteristics and various aspects of their tractor operations. These data showed that tractor ownership was not economically viable, due to breakdowns and a shorter than expected useful life. Also, utilized capacity of new tractors during their first year of use has declined each year since 1975. This suggests that annual increases in the tractor population has made it more difficult for owners to achieve the capacity utilization level required to cover variable and fixed costs.

I. INTRODUCTION

As rice is the staple food in Indonesia, Government policy has focused on increasing production in order to achieve self-sufficiency. During the first two development plans (Pelita I, 1969-74 and Pelita II, 1974-79), rice output increased 4.7 and 3.8%/year, respectively. Yet, with population growing at 2.5%/year and higher incomes, demand still exceeds domestic supply (B.P.S., 1980).

In an effort to increase production, mini-tractors have been introduced into several locations in the less densely popylated outer-islands. These programs have been initiated in an attempt to redress apparent shortages of human and animal labor that are believed to constrain area expansion, crop intensification and synchronized rice planting.

---

* Paper prepared for the Consequences of Small Rice Farm Mechanization Workshop at IRRI, Los Banos, the Philippines, on September 14-18, 1981.

** Agricultural Economist, South Sulawesi Extension Service and Associate Economist, CRIFC/IRRI Cooperative Program, Bogor, Indonesia.

The first tractor feasibility study in South Sulawesi was conducted in 1972 and concluded there was a need for small tractors, due to a shortage of labor (Parussengi, 1972). Subsequent follow up studies by Gadjah Mada University and the Agricultural Equipment Office evaluated tractor needs in 18 of the 23 districts in South Sulawesi (Gadjah Mada University, 1976; Dir. of Food Crops, 1975; Ag. Ext. Service, 1979; Directorate for Technical Agriculture, 1979). Based on these studies, four wheel mini-tractors were introduced in several districts beginning in the mid 1970's. By 1980, almost 1300 mini-tractors had been sold throughout the province (Agricultural Extension Service, 1980).

II. OBJECTIVES

Mini-tractors were first introduced by the Government into Sidrap-Pinrang in 1975. This program is a major Government sponsored effort to increase agricultural productivity. Consequently, there exists a need to better understand the successes and weaknesses of the effort in order to provide guidance for planning and implementing future tractorization programs. Specifically, this study focuses on identifying:

1) the characteristics of mini-tractor owners and their reasons for purchasing tractors;
2) mini-tractor capacity utilization;
3) problems encountered in ownership, operations and maintenance;
4) financial arrangement and credit characteristics;
5) the characteristics of tractor operators;
6) the profitability of tractor ownership.

III. METHODOLOGY

Study area. Sidrap and Pinrang Districts are in South Sulawesi and lie about 180 km north of the provincial capital, Ujung Pandang. This is a high productivity agricultural area with a population density of 93 persons/km^2 (BPS, 1980). Seventy percent of the 92,581 ha of lowland is irrigated, mostly by a modern technical system receiving water from the Saddang diversion dam (Agricultural Extension, 1980). Typically two irrigated crops are grown with farmers using the newest modern varieties and fertilizer and insecticide.

Mini-tractors were first purchased by farmers in Sidrap and Pinrang in 1969 and reached 508 units in 1979. Of this total, 149 (29%) were bought by residents of the study villages. While five different brands are found in the study area, the most popular ones are Kubota (61%), Satoh (18%) and Iseki (15%) as shown in Table 1. While a few early adopters bought units

prior to 1976, the largest number of purchases (40%) were made in 1979 when Presidental Aid (BANPRES) was extended through the small investment credit system (KIK). Interestingly, before the BANPRES program,almost all purchases were Kubota, but in 1979 Iseki and Satoh captured 64% of the market.

Sampling. Sidrap-Pinrang Districts were chosen as the study area because these districts have the largest number of mini-tractors in South Sulawesi. In each district, the four villages with the largest number of units were selected.[1] Then, ten tractor owners who purchased units in each of the previous five years were randomly chosen from the population of owners in these eight villages.

Survey. A questionnaire was developed and administered to each respondent. Since Sidrap-Pinrang was the site of the "Consequences of Mechanization Survey research project, these trained enumerators interviewed the tractor owners once during the 1979 wet and 1979/80 dry seasons.

IV. RESULTS

Charactieristics of mini-trantor owners. Tractor owners were mainly middle aged (30-50), had attended primary school (46%), farmed as their principal occupation (56%), and owned 7.2 ha of rice land valued at US$ 17,120 (Table 2). All had owned a tractor for one to five years, but none had ever owned other major pieces of machinery such as a rice mill.

By comparison, the sample of non-mechanized farmer respondents the "Consequences Survey" conducted in the same Districts were similar in age (mean, 40 years) and education (mean, 3.8 years). On the other hand, the tractor owners land assets were significantly greater than the non-mechanized farmers who owned and/or operated on average of only 1.34 ha (Consequences Team, 1981).

Reasons for purchasing mini-tractor. Respondents gave several reasons for purchasing a tractor. Since most owners were also large land owners, it is consistant that the most common reason was "to cultivate their own land" (45%). At the same time 25% expected to earn money renting the tractor to neighboring farmers (especially when pressed to meet repayments) and 16% were encouraged to purchase the unit because credit was available. (Table 3). Only 6% admitted they purchased a tractor because it enhanced their prestige.

---

[1] These were the same villages selected for study in the "Consequences of Small Farm Mechanization in Asia" project, implemented by Maros Research Institute for Food Crop, South Sulawesi Extension Service, Hassanuddin University, Rural Dynamics and IRRI.

On the other hand, the respondents noted several perceived benefits from owning a mini-tractor. Most important was the potential for timely planting (30%), followed by better land preparation (25%) and a reduced need to hire labor (26%) as shown in Table 4. Interestingly, only 10% believed the tractor increased yields and 8% replied that it reduced the drudgery of work. Among farmers hiring custom services (Table 4) similar responses were given although greater emphasis was placed on a better land preparation (45%) and less emphasis on both reducing need to hire labor (13%) and to reduce drudgery (0%).

Characteristics of mini-tractors. Among the sample of 50 respondents, Kubota was the most popular unit (66%), followed by Iseki (14%) Satoh (16%) and Yanmar (4%) as shown in Table 5. All of these mini-tractors were rated at 12-15 hp. and operated on diesel fuel. The average cash purchase price was US$ 5,513. Yet, the cash price increased significantly over the period. Because of the devaluation of the rupiah from 1 US$ = Rp.425 to 1 US$ = Rp.625 (November 1978), the dollar price undervalues this impact. As shown in Table 5, the rupiah price increased by 32% from 1978 to 1979.

Mini-tractor utilization[2]. In both wet and dry seasons, complete land preparation involves rotovating the field two times. Alternatively, some farmers hired the mini-tractor for only one rotovating and harrowed the field using animal or human power.

Each tractor owner was asked how many hectares he prepared each season since purchasing the unit (Table 6). These data show that for tractors of each vintage (purchase year), the utilized capacity was highest in the first year used and declined in each successive year. For example, 1975 vintage units prepared an average of 102 ha in 1975 but only 14 ha in 1979.

At the same time, it is clear that mini-tractor owners who boutht units later in the period considered were unable to achieve the same level of utilized capacity as early adapters. For example, while 1975 and 1976 vintage tractors plowed over 100 ha in their first year of use, 1978 and 1979 vintage tractors plowed only 81 and 57 ha during the initial year. This suggests that the tractor population may be becoming so large that new owners are no longer able to utilize the tractors at the same level that was achieved in earlier years.

The total hectares prepared each season for tractors at all vintages is distributed relatively evenly between seasons. Although roughly 55-60% of the hectares plowed are done in the wet season, this is to be expected since the tractors are used on both rainfed (one rice crop) and irrigated (two rice crops) land.

Problems in ownership, operations and maintenance. Since the mini-tractor sample included units purchased in each of the past five years, it is possible to observe the relationship between age and breakdowns. As shown in Table 7, mini-tractors bought in 1975 were able to operate in 80% of the 91 available seasons since being purchased[3]. This means that during

---

[2]Sometimes the mini-tractor is used for only one rotovating and in other instances for two rotovating. Consequently, data on utilization has been converted to two rotovating equivalents.

[3]Owners reported they did not use the tractor in these seasons because spare parts were not available, they could not afford repairing the unit, or the cost of repairs were almost equal to the cost of a new unit.

the past five years (ten seasons) these units did not operate in 20% of the seasons due to breakdowns. In the last season (1979/80 D.S.) for which data was collected, only three of the ten units were still operating, plowing average of only 14.2 ha in 1979 (W.S. plus D.S.). As shown in Table 8, the percent of seasons broken declines, the number of units operating in 1979/80 D.S. increases and average ha plowed in 1979 increases as we move from units bought in 1975 to those bought in 1979. These data suggests that for the first two years, the mini-tractors are relatively free of major problems, but after this time breakdowns significantly affect utilized capacity. Given that after five years only three years were operating, we can conclude that the useful life of the mini-tractors is a maximum of five years.

A wide variety of parts have required replacement over the life of these mini-tractor (Table 9). Breakdowns were most frequently associated with the transmission (43%), engine (29%) and implements (21%) - especially the rotor blade. On the other hand, the single part most frequently requiring replacement was the piston (23%) and associated components (rings, piston and seger).

Transmission damage is probably aggravate by irratic stopping and starting and engine damage from late oil changes and continuously operating beyond the recommended hours/day. These explanations are consistent with the owners observations. The respondents attributed breakdown to poor maintenance by the driver (36%), the drivers carelessness/inexperience (22%), frequent turnover of drivers (20%), poor service/distance to the workshop (14%) and low quality equipment (8%) as shown in Table 10. Consequently, it would appear that breakdowns could be greatly reduced through better driver training and supervision.

All of the respondents felt that spare parts were expensive and 56% reported they were not always available when needed (Table 11). Owners complained of long delays in getting their unit repaired due to shortages of spare parts at workshops, dealers and stores (43%), distance to the workshop (24%), no time to bring the unit to the workshop (20%) and a shortage of cash to pay for repairs (13%).

Financial arrangements and credit characteristics. Almost all (94%) of the mini-tractors have been purchased on credit (Table 12). The source of credit has been largely the Bank (74%) and dealers (20%). As a result of the BANPRES program started in 1979 credit purchase was made easier with the extension of the payback period to 72 months, low interest of 10.5%/year, and a reduction in the land required for collateral to 2.5 to 5 ha (Team of selective Agricultural Mechanization, 1979). While some purchases were made by partners/groups, most (81%) of the tractor owners purchased the units by themselves.

Arrears on mini-tractor loans varied with year of purchase. At the end of the 1979 dry season, none of the owners purchasing tractors in 1975 had arrears, but defaults as a percent of loans extended averaged 12% for 1976, 5.4% for 1977, 15% for 1978 and 4% for 1979 vintage purchases. Owners gave several specific reasons for having difficulties in meeting loan payments. The most important was that their mini-tractor was damaged and could not be used (45%), followed by inability to plow enough area to generate a great enough cash flow (35%), crop failure (12%) and custom renters are late in paying for tractor services (Table 13).

Mini-tractor operators. The service life of a tractor is affected by the way it is operated and maintained. Consequently, the driver - responsible for operation and maintenance - is a key element in the success of a tractor scheme. Seventy operators of the 50 units were interviewed to learn about the background of these technicians.

Generally, the operators were young with 33% between 21-25 years and 86% between 15-30 years old (Table 14). On the other hand, they were more educated than the owners as only 11% were illiterate, 69% with 1-6 years of schooling and 20% with 7 years or more, including two former university students. About half of the operators are sons of the owner, 37% relatives and only 14% from outside the family. Most of the operators (64%) had just 1-2 years of driving experience and only 2 (3%) had five years or more service. Slightly more than half of the operators had no other occupation. Of these with second jobs, almost all (88%) operated their own farm.

Training opportunities for drivers appear to be inadequate. Eighty-three percent of the drivers had never attended a training course (Table 14). Of the training courses that have been organized, they had been mainly sponsored by the dealers (63%), followed by Government (25%) and jointly (12%). Most of the 12 operators who had attended a course studied only driving (42%) or maintenance (25%), although some (33%) were taught both. While dealers agree to provide training to new owners, few owners actually operate their units. Since drivers are often not identified before the owner purchases the tractor, it is impossible for new owners to send the driver. Yet, because the owners receives only minimal training, he is not capable of adequately transferring his knowledge to his driver.

Individuals choose to take up tractor driving as an occupation for a variety of reasons. The most frequent responses were that driving increases their prestige (24%), provides supplemental income (24%), gives job satisfaction (22%), provides a higher income than other alternatives (13%) no other jobs are available (11%) and was influenced by friends (6%) as shown in Table 15. The importance of prestige is sympathetically expressed by Mr. Sjamsuddin Abbass, Director of Extension for South Sulawesi (Sjamsuddin, 1977):

> Youth who drop out of school are very interested in mini-tractors because it is driver like a car. This means their social standing or prestige will not decline by operating. Moreover, they can listen to the radio while driving. It gives them style -- like a show-off.

The income earned by the operator is quite high. They are generally paid 15-20% of the plowing rate/ha. In addition, the operator is served meals by the land owner (farmer), snacks and cigarettes in order to encourage the operator to cultivate the field properly. If 30 ha are cultivated/season at US$ 40/ha, his income would be US$ 180-240 for the 60 day land preparation season. This is equal to a daily wage of US$ 3-4 compared to a bricklayer or carpenter who earns US$ 1.20-2.40/day without meals.

Custom activities. The rate/ha charged for land preparation is established jointly by mini-tractor owners and the Extension Service each year, although some owners reported charging less than the agreed upon rates in order to increase the demand for their contract services. From 1975 to 1979, the charge/ha has increased steadily at an average of 33%/year in terms of rupiah (Table 16). About 86% of the hectares prepared were done under contract for local farmers (Table 7). In order to find land to plow, some owners travelled as far as 50 km from their residence.

V. ECONOMIC EVALUATION

Data was collected on the costs and returns for each season from each mini-tractor owner operated his unit. This data makes it possible to evaluate the impact of changes in prices and tractor density on the profitability of mini-tractor ownership.

In November 1978 Indonesia devalued the rupiah from 1 US$ = Rp.425 to 1 US$ = Rp.625. If we convert all values to US$, the results are difficult to interpret. Consequently, Tables 17-20 are presented in terms of Indonesian currency.

Capital investment. The cost of mini-tractors increased by 95% over the period studied, from Rp.1.9 million in 1975 to Rp.3.7 million in 1979.

Fixed costs. Total fixed costs/year are calculated as the sum of depreciation plus interest. While tractor loans have been extended for 72 months since 1979, a five year depreciation period is assumed since the data indicates that after five years most of the mini-tractors were inoperable. Annual depreciation is calculated as initial cost minus salvage value divided by useful life (straight line). Salvage value was assumed to be 10% of the initial cash price. Credit cost (interest) was calculated as 12%/year on the declining unpaid balance. Since the price of mini-tractors increased each year, total fixed costs have also risen for tractors bought in each successive year.

Variable costs. Variable costs include all expenditures on fuel, oil, repair and maintenance and the driver's salary. These costs/ha increased every year for tractors of all vintages — partly due to increases in the price of variable inputs. At the same time, in 1979 variable costs/ha were highest for units bought in 1975 and 30% lower for units purchased in 1975. This suggests that as the mini-tractors age, the repair component of variable costs increases steadily.

Gross revenue. Gross revenue/season is the product of the land preparation charges/ha times the number of hectare contract plowed, plus land the owner plowed for himself. Although gross revenue/ha increased each year as the contract rate rose, gross revenue/season generally declined as the tractor aged due to falling utilized capacity. This relationship held for tractors of each vintage.

Net revenue. Net revenue/year is calculated as gross revenue/year minus annual fixed costs (depreciation plus interest). For units bought in 1975, 1977, and 1979, net revenue was negative every year and for units purchased in 1979, negative in one of two years. In contrast, net revenue was positive three out of four years for tractors purchased in 1976, due to these owners' ability to achieve a higher capacity utilization.

Net returns. Net returns/ha were computed without considering fixed costs. In each year for all vintages, net returns/ha increased. While this shows that gross revenue/ha has increased more rapidly than variable costs/ha, since capacity utilization declined rapidly over time owners were still generally unable to cover fixed costs.

Breakeven analysis. Net returns/ha represents the amount of income available to cover fixed costs. By dividing total fixed costs/season by net returns/ha, the number of hectares required to cover total fixed costs is calculated. Utilized capacity exceeds breakeven hectares in only one of the five years for 1975 vintage, three of four years for 1976 vintage, and one of two years for 1978 vintage tractors.

These data show that the gap between actual and breakeven capacity generally increases with the age of the tractor. At the same time, we must keep in mind that each year an increasing number of tractors operated in these villages. This suggests that as the total tractor population increased, it became increasingly difficult for owners to find hectares for contract plowing. This conclusion is further supported by the fact that in 1979 the shortfall between breakeven and actual hectares plowed was greatest — regardless of vintage.

Benefit cost. Since data was not available to estimate the benefit cost ratio as the quotient of the present value of all benefits divided by the present value of all costs over the life of tractors of all vintages, this measure was approximated as gross revenue/season divided by total costs/season. Benefit cost ratios greater than one are only observed for 1976 (three of four years) and 1978 (one of two years) vintage mini-tractors.

Further considerations. As noted previously, values of these economic measures were computed based on costs and return data for all tractors of each vintage operating during the respective years. Yet, Table 8 shows that 1978 vintage tractors did not operate in 3%, 1977 vintage models in 7%, 1976 vintage models in 10% and 1975 vintage models in 20% of the seasons after they were purchased. Consequently, these estimates are conservative and if seasons not operable were taken into consideration, the benefit cost ratios would be lower than those observed in Tables 17-20.

VI. CONCLUSION

Mini-tractors have been used in Sidrap and Pinrang Districts for several years. Evaluation of data collected from ten owners who purchased mini-tractors in 1975 through 1979 showed that even when purchased with subsidized credit, these tractors were not economically viable. Two problems appear responsible for this situation. First, breakdowns are a major problem -- reducing both the available working time during the season and reducing the useful life to less than the six years assumed in the loan repayment schedule. Second, as the number of tractors introduced has increased, the utilized capacity has declined. In other words, there does not appear to be enough land available for land preparation to enable the owners to utilize their mini-tractors to the level required to cover fixed and variable costs.

The low man land ratio suggests there is a shortage of labor (human and animal) for land prepration in Sidrap and Pinrang Districts. Also, since mini-tractors do not displace hired labor (Bernsten, 1981), there are no negative labor displacement impacts that arise from introducing tractors. Yet, unless the useful life of the units can be extended to five full years of operation, and the number of units introduced held at a level that enables each mini-tractor to achieve a high enough capacity utilization to cover fixed costs, tractors will not be an economically feasible alternative to existing techniques.

ACKNOWLEDGEMENT

The authors would like to express their appreciation to Aten Hurun who assisted in interpreting the data reported in this paper.

REFERENCES

Abbas, Sjamsuddin, 1977. Perspective of Agricultural Mechanization in Indonesia and South Sulawesi, Ujung Pandang.

Agricultural Extension Service, South Sulawesi, 1980. Internal data on tractor sales in the Province, Ujung Pandang.

Agricultural Extension Service and Association of Devotees of Agricultural Mechanization in Indonesia, 1976. Feasibility Study of Tractor Development in Barru, Enrekang and Tona Toraja Districts, South Sulawesi, Ujung Pandang.

Bernsten, R.H., 1981. Effects of Mini-Tractor Mechanization on Employment and Labor Use Intensity, Sidrap and Pinrang Districts, South Sulawesi, Indonesia. Paper presented at the Consequences of Small Farm Mechanization Workshop at IRRI, Los Banos, the Philippines, September 14-18, 1981.

B.P.S., 1980. Statistical Handbook of Indonesia, Jakarta.

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

Directorate for Technical Agriculture, 1979. Survey for the Possibility of Using Small Tractors in Sidrap and Pinrang Districts, South Sulawesi, Jakarta.

Directorate of Food Crops, 1975. Tractor Development Study in Gowa, Maros, Pangkep, Polmas, and Soppeng Districts, South Sulawesi, Jakarta.

Gadjah Mada University, 1976. Survey for Agricultural Tractor Development at Bantaeng, Bulukumba, Sinjai, Wajo, Bone-Bone, Tekalar, Luwu Districts, South Sulawesi, Faculty of Agriculture, Yogyakarta.

Parusengi, Djafar, 1977. Possibility of Using small tractor for People's Farming in South Sulawesi, Fatometa IPB.

Team of Selective Mechanization, 1979. "Owning and Operating a Tractor in South Sulawesi (manual), Ujung Pandang.

Table 1. Mini-tractor sales in Sidrap and Pinrang District, eight study villages, South Sulawesi, Indonesia. 1969-79.

Year of purchase	Brand					Total	Percent
	Kubota	Iseki	Yanmar	Satoh	Sibaura		
1969	1	0	0	0	0	1	1
1972	1	0	0	0	0	1	1
1974	2	0	0	0	0	2	1
1975	15	0	0	0	0	15	10
1976	37	2	0	0	0	39	26
1977	15	4	0	0	1	20	13
1978	5	1	0	6	0	12	8
1979	15	16	6	22	0	59	40
Total	91	23	6	28	1	149	100
Percent	61	15	4	18	1	100	

Table 2. Social and economic characteristics of 50 mini-tractor owner respondents in Sidrap-Pinrang Districts, South Sulawesi, Indonesia. 1980.

Characteristic	
Age (years)	Percent
< 30	10
31-40	30
41-50	32
> 50	28
Education (years)	
illiterate	28
primary school	46
junior/senior high school	14
university	12
Occupation	
farmer	56
government	14
trader	20
merit/service	10
Assets (average)	Number
rice fields (ha)[a]	7.2
cows	3.1
buffalo	0.7
	US$ value
rice land	17,120
animals	520
total properties[b]	22,080

[a]Range in area from 0.7 to 16.7 ha

[b]Excluding house and tractor

Table 3. Reasons given by fifty mini-tractor owners for purchasing a tractor, Sidrap and Pinrang District, South Sulawesi, Indonesia, 1980.

Reason	Number of responses[a]	Percent
To cultivate own land	71	45
To rent to neighbors	40	25
To experiment	12	8
Social prestiege	9	6
Credit available	26	16
	158	100

[a]Responsents were permitted to give more than one answer.

Table 4. Mini-tractor owners and custom users perceptions of benefits associated with tractor ownership, Sidrap and Pinrang Districts, South Sulawesi, Indonesia, 1980.

Reason	Owners		Custom users	
	No.	Percent	No.	Percent
Timely planting	45	30	28	31
Better land preparation	39	26	40	45
Reduce need to hire labor	39	26	12	13
Increase yields	15	26	20	22
Reduce drudgery	12	8	0	0

Table 5. Characteristics of fifty mini-tractors owned by respondents in Sidrap and Pinrang Districts, South Sulawesi, Indonesia, 1980.

Characteristic		
Brand[a]	Number	Percent
Kubota	33	(66)
Isehi	7	(14)
Satoh	8	(16)
Janmar	2	(4)
	50	(100)

Purchase year[b]	Rupiah price		Dollar price	
	Rp (million)	Percent increase[c]	US$	Percent increase[c]
1975	1.90	-	4471	-
1976	2.10	(11)	4941	(11)
1977	2.40	(14)	5647	(14)
1978	2.80	(17)	6588	(17)
1979	3.70	(32)	5920	(-10)
mean	2.58		5513	

[a]All units rated at 12-15 Hp

[b]Cash price of units purchased each year.
From 1975-78, 1 US$ = Rp 425; In 1979, US$ = Rp 625

[c]Percent increase over previous year's price.

Table 6. Hectares plowed each season, by year of tractor purchase, Sidrap and Pinrang Districts, South Sulawesi, Indonesia, 1980.[a]

Year/season	Purchase year				
	1975	1976	1977	1978	1979
1975					
W.S.	55.5				
D.S.	46.6	N.A.	N.A.	N.A.	NA.
	102.1				
1976					
W.S.	36.8	58.0			
D.S.	28.9	42.1	N.A.	N.A.	N.A.
	65.7	100.1			
1977					
W.S.	30.5	34.9	43.6		
D.S.	25.7	34.3	29.8	N.A.	N.A.
	56.2	69.2	73.4		
1978					
W.S.	25.4	35.3	39.6	43.6	
D.S.	15.8	22.0	16.2	37.7	N.A.
	41.2	57.3	55.8	81.3	
1979					
W.S.	10.3	20.8	20.5	24.6	33.9
D.S.	3.9	7.8	10.8	16.5	23.3
	14.2	28.6	31.3	41.1	57.2
Average	55.9	63.8	53.5	61.2	57.2

N.A. = not applicable.

[a]Average of hectares plowed by all units operating in respective seasons.

Table 7. Area cultivated/season[a] over mini-tractors life, by year of purchase, Sidrap and Pinrang Districts, South Sulawesi, Indonesia, 1980.

Purchase year	Own		Custom		Total area plowed	
	Ha[a]	%	Ha[a]	%	Actual units[a] operating	Including seasons[b] not operating
1975	4.4	(16)	23.9	(85)	28.3	22.6
1976	3.7	(12)	27.7	(88)	31.4	28.3
1977	4.9	(15)	26.8	(85)	31.7	29.5
1978	4.4	(14)	26.1	(86)	30.5	296
1979	4.6	(13)	31.0	(87)	35.6	35.6
Mean	4.4	(14)	27.1	(86)	31.5	29.1

[a]Total area plowed by all mini-tractors, divided by the total number of units operable in each season.

[b]Total area plowed by all mini-tractors divided by total number of seasons available since purchase.

Table 8. Number of seasons during which mini-tractors operated, Sidrap and Pinrang District, South Sulawesi, Indonesia. 1975-80.

Purchased year	Season operating			No. of tractors operating in 1979/80 D.S.[d]	Average Ha.plowed in 1979[e]
	Maximum[a]	Actual[b]	Percent[c] of seasons broken		
1975	91	73	20	3	14.2
1976	73	66	10	5	28.6
1977	59	55	7	7	31.3
1978	30	29	3	10	41.1
1979	19	19	0	10	57.2

[a]While ten mini-tractors were purchased in each year, some were acquired after the beginning of the wet and/or dry season and not used that season. The maximum number of seasons the tractor could be used takes this into consideration.

[b]Total seasons all tractors were used after being purchased.

[c]Total seasons broken divided by total seasons after being purchased.

[d]Owners felt tractors not operating in 1979/80 would be too costly to repair.

[e]Average number of hectares plowed by units still operating in 1979 (wet and dry seasons).

Table 9. Reported damage requiring spare parts, 50 tractor owners in Sidrap and Pinrang Districts, South Sulawesi, Indonesia. 1980.

Part repaired/replaced	No. of units experiencing problem	Percent
Engine		
injector	1	1
piston[a]	19	23
dynamo	4	5
	24	29
Transmission		
brake	5	6
joint	7	9
chain	7	9
gears	10	12
clutch	6	7
	35	43
Hydrolic		
ring	1	1
pump	2	3
oil cylinder	2	3
	5	7
Implement		
joint[a]	3	4
rotory blade	11	14
floating wheel	2	3
	16	21

[a]Between power-take-off and implement.
[b]Including seger, stand and rings

Table 10. Perceptions as to causes of damage to their units, fifty mini-tractor owners, Sidrap and Pinrang Districts, South Sulawesi, Indonesia. 1980.

Reason	No.[a]	Percent
Poor maintenance	32	(36)
Improper driving	19	(22)
Driver Turnover	18	(20)
Distance to workshop	8	(9)
Low quality equipment	7	(8)
Poor quality workshop service	4	(5)
	88	(100)

[a]Respondent were permitted to give more than one answer.

Table 11. Reasons for delays in repairing broken units, 50 mini-tractor owners, Sidrap and Pinrang Districts, South Sulawesi, Indonesia, 1980.

Reason	Percent
Spare parts not available	(43)
Distance to workshop is great	(24)
No time to bring mini- tractor to workshop	(20)
No money to pay for repairs	(13)
	(100)

Table 12. Sources of credit for purchasing tractors, 50 mini-tractor owner in Sidrap and Pinrang Districts, South Sulawesi, Indonesia, 1980.

Year	System		
	Cash	Bank	Dealer
1975	0	7	3
1976	0	9	1
1977	1	5	4
1978	2	6	2
1979	0	10	0
Total	3	37	10
Percent	(6)	(74)	(20)

Table 13. Reasons given by 50 mini-tractor owners for having difficulties in repaying their tractor loans, Sidrap and Pinrang District, South Sulawesi, 1980.

Reason	Number[a]	Percent
Mini-tractor damaged	45	(44)
Cannot plow enough area	30	(29)
Crop failure	12	(12)
Renters do not pay	9	(9)
Used for other purposes	6	(6)
	102	(100)

[a]Owners were permitted to give more than one reason.

Table 14. Characteristics of seventy mini-tractor operators, Sidrap and Pinrang, South Sulawesi, Indonesia, 1980.

Characteristic	Number	Percent
Age (years)		
15 - 30	-	(86)
21 - 25	-	(33)
Formal education (years)		
None	8	(11)
1 - 6	48	(69)
> 6	14	(20)
	70	(100)
Driving experience (years)		
1 - 2	45	(66)
3 - 4	21	(31)
> 4	2	(3)
	68	(100)
Training courses		
None	58	(83)
One	11	(16)
Two	1	(1)
	70	(100)

Table 15. Reasons given by 70 mini-tractor drivers for choosing driving as an occupation, Sidrap and Pinrang Districts, South Sulawesi, Indonesia, 1979.

Reason	Number[a]	Percent
Supplemental income	44	(24)
Prestige	44	(24)
Comfortable/interesting job	40	(22)
Higher income	24	(13)
No other jobs available	19	(11)
Influenced by friends	11	(6)
	182	100

[a]Respondents were permitted to give more than one response.

Table 16. Contract rates for custom land preparation (US$/ha), by year, Sidrap and Pinrang Districts, South Sulawesi, Indonesia, 1980.[a]

Year		Rupiah	US$	
			Current exchange rate[b]	Existing exchange rate[c]
1975	WS	8,000	12.80	18.82
	DS	8,000	12.80	18.82
1976	WS	10,500	16.80	24.71
	DS	12,500	20.00	29.41
1977	WS	13,700	21.92	32.23
	DS	13,700	21.92	32.23
1978	WS	15,375	24.60	36.18
	DS	19,000	30.40	44.70
1979	WS	23,250	37.20	37.20
	DS	25,000	40.00	25.00
1980				

[a]Two rotovatings
[b]Rupiah cost divided by exchange rate prevailing in 1980 (1 US$ = Rp 625).

[c]Rupiah cost divided by exchange rate prevailing during 1975-1978 (1 US$ = Rp 425) and after devaluation in November 1978 (1 US$ = Rp 625).

Table 17. Economic analysis of mini-tractors purchased in 1975, Sidrap and Pinrang Districts, South Sulawesi, Indonesia, 1980.

Item	1975	1976	1977	1978	1979
Hectares plowed/year[a]	102.1	65.7	56.2	41.2	14.2
Capital investment (million Rp)	1.9	-	-	-	-
	Rp/year				
Total fixed costs					
depreciation[b]	342,000	342,000	342,000	342,000	342,000
interest[c]	228,000	182,400	136,800	91,200	45,600
	570,000	524,400	478,800	433,200	387,600
Variable costs[d]	280,067	264,704	299,731	318,817	156,397
Total costs	850,067	789,104	778,531	752,017	543,997
Gross revenue	817,283	738,521	775,354	690,735	338,000
Net revenue	- 32,784	- 50,583	- 3,177	- 61,282	- 205,997
	Rp/hectare				
Gross revenue[e]	8,000	11,500	13,700	17,188	24,125
Variable costs[d]	2,743	4,028	5,333	7,738	11,014
Net returns[f]	5,257	7,472	8,367	9,450	13,111
Economic parameters					
Breakeven hectares[g]	108.4	70.2	57.2	45.8	29.6
Benefit cost (ratio)	0.96	0.94	1.00	0.92	0.62

[a]Average of all tractors operating in respective seasons.
[b]Five year depreciation; salvage value equals 10% of capital investment.
[c]Twelve percent/year on declining balance.
[d]Oil, diesel fuel, repairs and maintenance and driver's pay.
[e]Custom plowing rate.
[f]Net returns/ha calculated as gross revenue/ha minus variable costs/ha.
[g]Fixed costs/year divided by net revenue/ha.

Table 18. Economic analysis of mini-tractor purchased in 1976, Sidrap and Pinrang Districts, South Sulawesi, Indonesia, 1980.

Item	1976	1977	1978	1979
Hectares plowed/year[a]	100.1	69.2	57.3	28.6
Capital investment (million Rp)	2.1	-	-	-
	Rp/year			
Total fixed costs				
depreciation[b]	378,000	378,000	378,000	378,000
interest[c]	252,000	201,600	151,000	100,800
	630,000	579,600	529,000	478,800
Variable costs[d]	315,441	294,298	358,672	301,510
Total costs	945,441	873,898	887,642	780,310
Gross revenue	1,121,083	951,035	959,450	680,390
Net revenue	175,642	77,137	71,778	- 99,920
	Rp/ha			
Gross revenue[e]	11,500	13,700	17,188	24,125
Variable costs[d]	3,151	4,253	6,260	10,542
Net returns[f]	8,349	9,447	10,928	13,582
Economic parameters				
Breakeven hectares[g]	75.5	61.4	48.4	35.3
Benefit cost (ratio)	1.19	1.09	1.08	0.87

[a]Average of all tractors operating in respective seasons.
[b]Five year depreciation; salvage value equals 10% of capital investment.
[c]Twelve percent/year on declining balance.
[d]Oil, diesel fuel, repairs and maintenance and driver's pay.
[e]Custom plowing rate.
[f]Net returns/ha calculated as gross revenue/ha minus variable costs/ha.
[g]Fixed costs/year divided by net revenue/ha.

Table 19. Economic analysis of mini-tractors purchased in 1977, Sidrap and Pinrang Districts, South Sulawesi, Indonesia, 1980.

Item	1977	1978	1979
Hectares plowed/year[a]	73.4	55.8	31.3
Capital investment (million Rp)	2.4	-	-
		Rp/year	
Total fixed costs			
depreciation[b]	432,000	432,000	432,000
interest[c]	288,000	230,400	172,800
	720,000	662,400	604,800
Variable costs[d]	324,183	331,122	336,615
Total costs	1,044,183	993,522	941,415
Gross revenue	1,009,803	916,026	748,367
Net revenue	- 34,380	- 77,496	-193,048
		Rp/ha	
Gross revenue[e]	13,700	17,188	24,125
Variable costs[d]	4,416	5,934	10,754
Net returns[f]	9,383	11,254	13,370
Economic parameters			
Breakeven hectares[g]	76.7	58.9	45.2
Benefit cost (ratio)	0.97	0.92	0.79

[a]Average of all tractors operating in respective seasons.
[b]Five year depreciation; salvage value equals 10% of capital investment.
[c]Twelve percent/year on declining balance.
[d]Oil, diesel fuel, repairs and maintenance and driver's pay.
[e]Custom plowing rate.
[f]Net returns/ha calculated as gross revenue/ha minus variable costs/ha.
[g]Fixed costs/year divided by net revenue/ha.

Table 20. Economic analysis of mini-tractors purchased in 1978 and 1979, Sidrap and Pinrang Districts, South Sulawesi, Indonesia, 1980.

Item	Purchased in: 1978		1979
	1978	1979	1979
Hectares plowed/year[a]	81.3	41.1	57.2
Capital investment (million Rp)	2.9	-	3.7
	Rp/year		
Total fixed costs			
depreciation[b]	517,500	517,000	666,000
interest[c]	345,000	276,000	444,000
	862,500	793,000	1,110,000
Variable costs[d]	472,446	347,997	413,538
Total costs	1,334,946	1,140,997	1,523,538
Gross revenue	1,386,936	986,146	1,370 900
Net revenue	51,990	- 154,851	- 152,638
	Rp/ha		
Gross revenue[e]	17,188	24,125	24,125
Variable costs[d]	5,811	8,467	7,730
Net returns[f]	11,377	15,658	16,895
Economic parameters			
Breakeven hectares[g]	75.8	50.6	66.32
Benefit cost (ratio)	1.03	0.86	0.90

[a]Average of all tractors operating in respective seasons.
[b]Five year depreciation; salvage value equals 10% of capital investment.
[c]Twelve percent/year on declining balance.
[d]Oil, diesel fuel, repairs and maintenance and driver's pay.
[e]Custom plowing rate.
[f]Net returns/ha calculated as gross revenue/ha minus variable costs/ha.
[g]Fixed costs/year divided by net revenue/ha.

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. Lantin, 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