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THE CONSEQUENCES OF SMALL RICE FARM MECHANIZATION PROJECT

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THE ECONOMICS OF MECHANICAL LAND PREPARATION: AN EVALUATION OF EVIDENCE FROM SUPHANBURI PROVINCE

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The Economics of Mechanical Land Preparation: An Evaluation of Evidence from Suphanburi Province

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INTRODUCTION

Estimates up to 1980 indicate there were over 60,000 four-wheel tractors and over 200,000 two-wheel tractors operating on farms in Thailand. The annual growth rate in the stock of these machines ranged from 16 to over 20% per year for the 1975-80 period. The composition of the tractor fleet centers on locally built two- and small four-wheel machines. An appreciable number of larger four wheel machines have been imported and, in recent years, there has been an emerging market for small, second hand imported tractors which are reconditioned and sold in the country.

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Small two wheel walking tractors are almost exclusively employed in wetland paddy production, primarily in the Central Plain. The small four-wheel units are used for land preparation in paddy producing areas, although not normally under flooded or wetland conditions. Larger tractors are used primarily for contract plowing, powering corn shellers and provision of transportation.

As part of the Consequences of Small Farm Mechanization project in Thailand, an extensive body of information was gathered to provide details on the operation of two- and four-wheel tractors owned or hired by survey respondents in Suphanburi Province. The objectives in gathering data describing use of tractors in the area were:

1. to compare the financial viability of alternative mechanical land preparation techniques.
2. to evaluate tractor use patterns.
3. to assess problems of repair, maintenance and sustainability.
4. to examine factors which affect the profitability of machine investments, e.g. fuel costs and contract rates.

The Farmer

Table 1 shows the general characteristics of the three groups of respondents, namely: two-wheel tractor owners, four-wheel tractor owners and a draft animal owning group. The respondents did not vary so much in average age (47 to 54 years), with draft animal owners being the oldest among the three groups. Likewise, they all had the same level of educational attainment of around 4 years and came from households of

similar size. The draft animal owning group reported the longest farming experience at 25 years on the average, and two-wheel tractor owners had the least number of years in farming at 20 years. A majority of the parcels being cultivated by the respondents from each group are owned, 56% and 59%, for two- and four-wheel tractor owners. Twenty-two and seventeen percent of the households respectively, rented-in land which involved different rental arrangements such as: fixed rental fees; varied rental fee and several parcels which were used free of cost. A very small percentage of the parcels were rented out using similar arrangements.

Farm Description

Among the three farmer groups, the four-wheel tractor owners owned the largest farms with 4.57 ha on the average, followed by the two-wheel tractor owners at 3.77 ha (Table 2a & b). Draft animal owners had the smallest average farm size at 2.12 ha. The total cultivated area of each farm were however slightly smaller. Soils on more than one-third of the total farm parcels owned by both two- and four-wheel tractor owners contained a high percentage of clay and the rest were either clay-loam, loam, sandy, sandy loam or others. Draft animal owner farms were either sandy or sandy loam. Most farms had flat or sloping topography.

The most common problems reported by respondents regarding land conditions were general infertility and water logging for two- and four-wheel tractor owners and general infertility, erosion and sandiness on draft animal owning farmers.

Diversion structures in secondary canals was the source of irrigation for all three groups. The only land improvements noted were levelling and clearing.

Farming Practices

Seventy-three percent of the two-wheel, sixty percent of the four-wheel tractor owners and seventy-eight percent of the draft animal owners reported that paddy was generally transplanted (Table 3). Similar practices were used during the dry season. The transplanting method was also used on relatively larger parcels than those planted using the broadcast method. An exception was the animal owning group.

Improved varieties were planted by the majority of the respondents and the average parcel area planted to these varieties was also larger.

Tractor Ownership and Use

Tractor purchase decision. The decision to purchase a tractor is one of the important decisions of the farm household. The farmer needs to consider the different advantages and disadvantages of such decision and also the size of the capital investment involved. The tractor owners interviewed indicated that there were usually several people involved in their decision to buy the tractor (Table 4). Other family members were cited by 78% of the two-wheel tractor owners and 64% of the four-wheel tractor owners. Another major influence in the purchase

decision mentioned was other farmers. Others acknowledged to have affected their decision were extension workers, machine dealers, farmer's organization and the village leader.

There were perceived advantages in owning a machine. Examples were more timely operations, time saving, cheaper land preparation, better quality land preparation; better control of weeds, increased yields and expanded farm size, easier operation, and less drudgery.

Tractor operator. Generally, a prospective tractor owner had not operated a tractor before he purchased one. Table 5 shows that only 7% of the two-wheel tractor and 2% of the four-wheel tractor owners had previous training or experience in machine operation. Those with training had experience with two-wheel tractors, four-wheel tractor and an irrigation pump. These people were trained either by the machine dealer, extension worker or a farmer's organization member. More than half of the respondents were members of a government organization in the area.

Tractor use pattern. Both two- and four-wheel tractors were utilized principally on the farmer's own farm (Table 6). Ninety-one percent of the two-wheel and ninety-two percent of the four-wheel tractor units were utilized on the owner's farm during the wet season. The same was true during the dry season, although off-farm use increased to 18% and 14%, respectively.

The total area serviced by the two-wheel tractors during the dry season was lower than the area in the wet season on the average. Four-wheel tractor units, however, increased from 33.2 rai during the wet season to 36.25 rai during the dry season.

Farm tasks performed by both tractor types included land preparation, irrigation pumping, threshing and transportation.

Tractor breakdowns. Out of the 97 two-wheel units and 52 four-wheel units, 43 and 28 units, respectively, reported breakdowns during the wet season and 23 and 8 units, respectively, during the dry season in the same crop year (Table 7).

The mean horsepower of the two-wheel tractor units was around 9 hp while it was 11 to 11.5 hp for the four-wheel tractors. The two-wheel units which broke down during the wet season were relatively older (8 years) than those reported during the dry season (5 years on the average), while the mean age of four-wheel tractor units which broke down were 7.5 years during the wet and 9.5 years during the dry season. Most units were diesel powered.

Tractor owners reported most frequent breakdowns of the engine component for both types and seasons, followed by the transmission system and implements.

When breakdowns occur, machines were not usually operable until repairs were completed as reported by half the respondents during the wet season. Forty-six percent of two-wheel tractor units were reported to be running but were dangerous to the operator. Seven and twenty-nine

percent of the two- and four-wheel tractor units reported their machine to be no longer usable during the wet season, while about a third of both types were out of order during the dry season.

Tractor repairs. Repairs on 30% of the two-wheel and 25% of the four-wheel tractors were delayed during the wet season, and 25% and 12%, respectively, during the dry season (Table 8). Some reasons cited were lack of money for repairs and spare parts, or that there was no time available during the period of the breakdown. Some mentioned spare parts were not readily available although many indicated they had to either wait for the spare part, find substitute parts, or order the parts through direct contact with the supplier.

Spare parts for four-wheel tractors were generally more expensive than for the two-wheel tractors. A majority of the tractors of both types were repaired at local shops or on the farm. Some 5% of the two-wheel tractor owners reported having repairs performed at the local dealer's shop.

Minor repairs were usually carried out by family members or the tractor operator. About 3 hours of family labor were used for repair. If hired labor was used a mean value of 3.4-3.7 hours was required for two-wheel tractor units during wet season and the dry seasons. Four-wheel tractor units required a greater number of hours for repairs for both seasons, 21 and 18 hours, respectively.

Hired labor for repairing tractors were paid an average fee of 79 baht for two-wheel units and 98 baht for four-wheel units. It was relatively higher during the dry season for both types, i.e. 206 baht and 185 baht, respectively.

Two-wheel tractor owners were generally satisfied with the repairs done on their machines while one-fourth of the four-wheel owners indicated dissatisfaction.

The distance to the repair site from the field ranged from about 3 to 4.25 km on the average for both types and both seasons. Cost to transport of the machines to the repair site averaged to 24 baht and 36 baht for two- and four-wheel units, respectively, during the wet season and 10 baht and 1 baht for dry season, respectively.

Tractor cost analysis. The two- and four-wheel tractors in the study were almost all the same age, 5.0 to 9.5 years, mean horsepower of two-wheel units was 9 hp and four-wheel tractors was 11.5 hp (Table 9). There were 95 two-wheel tractor units reported during the wet season with a mean acquisition cost of 19,724 baht. The 50 four-wheel tractors on the other hand, were acquired at an average cost of 29,512 baht each.

From the sets of data taken from the survey plus other information, a cost and returns analysis was developed for both tractor types.

Fixed cost components included depreciation and interest on average capital investment. Depreciation was computed using the straight-line method over the life of the machine. It was estimated that the useful

life of the tractor was 10 years and salvage value was charged at 10% of initial cost. The formula used was:

$$\text{Depreciation} = \frac{\text{Initial Cost less Salvage Value}}{\text{Estimated Useful Life}}$$

Interest on average capital investment was calculated using a 13% interest rate per annum, based on the average prevailing rate, computed as follows:

$$\text{Interest} = \frac{\text{Initial Cost plus Salvage Value}}{2} \times \text{Interest Rate}$$

Total annual fixed cost is the sum of depreciation and interest. Since the analysis is seasonal, total annual fixed cost was divided by 2, i.e., assuming 2 cropping season a year. Variable costs include fuel, oil, repairs and maintenance, and driver's fee. The first three items were taken from the survey data and the last was 6.25 baht per rai, the prevailing rate in the area.

Average machine capacity was 5.28 hours per rai per operation. For purposes of computation, total tractor utilization was assumed to be for land preparation activities only. Total cost is the sum of total fixed cost per season plus total variable cost per ha multiplied by seasonal utilization in hectares.

Total benefits were imputed by multiplying the prevailing contract rate/ha by total use in hectares. The contract rate per hectare was 200 baht per rai or 1250 baht per hectare. The prevailing rate was used because of insufficient data to measure benefits directly. Nearly all tractor owners used their tractors only on their own farms.

The undiscounted benefit-cost ratio, break-even point and payback period were estimated and the results were at the bottom of Table 9.

Two-wheel tractors showed a profitable investment with an average BCR of 1.20. This finding illustrates that at present utilization levels and at the existing contract rate/ha, two-wheel tractors need to cover 18.54 rai (2.97 ha) per season, or be used for only 10 seasons to recover the capital invested.

For four-wheel tractors, however, the estimated BCR was only 0.99 which meant its total cost was slightly greater than the benefits derived. This was due to the lower utilization levels during the wet season. The dry season analysis, however, indicated improved results for both tractor types.

Financial Characteristics

To assess their financial position, tractor and animal owners were interviewed to determine the financial assistance used to purchase the tractor. Thirty-four percent of the two-wheel, 37% of the four-wheel and 50% of draft animal owners used outside financial assistance.

Different types of financial resources were tapped by respondents during both seasons. There were credits, loans and mortgages.

In this case credit was in kind whereas loans were in cash. A majority of those using financial assistance obtained cash. Some, however, took financing in kind while a number of two-wheel and four-wheel tractor owners mortgaged their properties.

The most common sources of financing were the Bank of Agriculture and Cooperatives, cooperatives, friends and relatives, middlemen, commercial banks, landlords, input dealers and others. Collaterals used to obtain loans were land titles, personal notes, crops/buildings and agricultural products.

When asked the purpose for incurring the liabilities, respondents mentioned: long term agricultural investment, seasonal farm expenses, family expenses/consumption, and machine purchase.

Of all financing sources, commercial bank were the source giving the longest maturity for two-wheel tractors with an average of 16.8 months to repay, followed by the Bank of Agriculture and Cooperatives. For four-wheel tractor owners, however, the Bank of Agriculture and Cooperative provided the longest debt maturity.

Sensitivity Analysis

To examine the impact of changes in cost components such as the price of fuel and oil on the profitability of investing in a machine, three fuel and oil cost increase levels were projected, i.e., 10%, 25%, and 50%. Similarly, contract rates were also assumed to rise by 10%, 20% and 30% . Tables 10 to 15 show the results of these changes. These values have not been discounted. Thus, the changes in costs and benefits do not reflect value changes over time.

The benefit/cost ratios for both tractor types and both seasons declined as fuel and oil prices increased and the contract rate remained constant. The reverse was true when prices were held constant and the contract rate per hectare was increased. To maintain a set level of viability an increase in any cost component would be accompanied by a proportional increase in the contract rate.

The break-even point increased as the fuel and oil prices increased with no change in the contract rate. The opposite occurred as the as contract rate increased with fuel and oil prices unchanged. These changes in fuel and oil prices and contract rate produced similar effects on the payback period.

CONCLUSION

Two-wheel and four-wheel tractors in the Suphanburi Province seem to be a good investment although use of the machines was restricted almost exclusively to the owners. Examining profitability using the prevailing contract rate and prices showed utilization at an acceptable level. Additional use would mean higher benefit-cost ratios for the owners.

The number of samples for the draft animal owning group prevented a more conclusive comparison among other types of technology.

While frequent breakdowns appeared to plague most machine owners, the length of time breakdowns kept machines out of order was not highly detrimental. Because most machines are of local manufacture, spare

parts and technicians to affect repairs appeared to be readily available. It is probably true that a higher cost machine produced using better quality standards would have fewer breakdowns. It is uncertain, however, whether accessability to spare parts and the experitse to maintain more sophisticated equipment could keep these machines operating at the high level of availability noted in current machines used in Thai agriculture.

Increased costs of petroleum products will increase the operational expense of mechanized land preparation. There are, however, effectively no short run alternatives available to replace the tractors used in Suphanburi. These farmer-owned machines do not appear to be earning excess profits and are operating in equilibrium at or near the cost of contractors operating in the same area. They are employed at or above their breakeven levels and, as has been noted in the paper by Saitan, do not appear to be the cause for maldistribution in income amongst farm groups. Without this technology it is likely rice production in the Suphanburi area would suffer serious declines.

Table 1. General profile of two- and four-wheel tractor and draft animal owning farmers in selected irrigated villages of Suphanburi Province, Thailand, wet and dry seasons 1980-81.

Item	Farm Type		
	2 WT Owners	4 WT Owners	Draft Animal Owners
Farmer characteristics			
Average age of farmers	48	47	54
Average educational attainment, years	4.0	3.7	3.5
Years of farming experience	20	24	25
Average household size	6.5	6.4	6.1

	Wet Season 1980-81			Dry Season 1981		
	2 WT	4 WT	Animal	2 WT	4 WT	Animal
	% Reporting					
Number of farmers reporting	97	52	5	88	50	2
Tenure status by parcel						
Owned	56	59	100	59	64	100
Rented-out						
Fixed rental fee	2	6	-	2	7	-
Varied rental fee	1	5	-	1	4	-
Free	3	2	-	4	2	-
Rented-in						
Fixed rental fee	22	17	-	25.0	14	-
Varied rental fee	8	5	-	6.0	3	-
Free	8	6	-	3.0	6	-

Table 2a. Farm characteristics, two- and four-wheel tractor and draft animal owning farmers in selected irrigated villages of Suphanburi Province, Thailand, wet and dry seasons, 1980-81.

Item	Wet Season 1980-81			Dry Season 1981		
	2 WT	4 WT	Animal	2 WT	4 WT	Animal
No. of respondents	97	52	5	88	50	2
Average farm size, ha	3.77	4.57	2.12	3.92	4.88	2.08
Total cultivated area, ha	3.58	4.39	2.12	3.44	4.15	2.08
Total number of parcels	202	129	9	196	126	3
			% Reporting			
Soil texture, by parcel						
Clay	35	38	-	36	38	-
Clay-loam	14	12	-	14	12	-
Loam	3	1	-	3	1	-
Sandy	14	19	33	13	20	-
Sandy loam	18	15	22	18	11	33
Others	16	16	45	16	18	67
Soil color						
Red	18	11	22	19	13	33
Brown	18	15	22	17	12	-
Black	42	47	22	43	47	67
Grey	13	5	11	12	8	-
Others	9	22	23	9	20	-
Topography						
Flat	69	70	56	69	67	67
Sloping	23	26	33	23	29	33
Steep	2	-	11	2	-	-
Very steep	1	-	-	1	-	-
Terraced	2	3	-	3	3	-
Others	3	1	-	2	1	-

Table 2b. Farm characteristics, two- and four-wheel tractor and draft animal owning farmers in selected irrigated villages of Suphanburi Province, Thailand, wet and dry seasons, 1980-81 (continued).

Item	Wet Season 1980-81			Dry Season 1981		
	2 WT	4 WT	Animal	2 WT	4 WT	Animal
	% Reporting					
Restricting factors						
None	54	57	22	56	59	-
Water logging	11	6	-	10	6	-
General infertility	27	27	22	25	25	33
Errosion	0.5	-	22	1	-	-
Sandiness	1.5	1	11	1	1	33
Marshiness	1	4	-	1	4	-
Salinity	1	-	-	1	-	-
Others	4	5	22	5	5	34
Source of irrigation						
None	-	3	-	-	2	-
Technical system	1	-	-	1	-	-
Brush diversion	90	83	100	91	82	100
Pumped from surface	9	14	-	8	16	-
Others	-	-	-	-	-	-
Improvements done on land						
None	76	76	33	73	75	33
Land clearing	7	9	-	7	10	-
Levelling	16	14	67	19	14	67
Land consolidation	1	-	-	1	-	-
Others	-	1	-	-	1	-

Table 3. Farming practices, two- and four-wheel tractors in selected irrigated villages of Suphanburi Province, Thailand, wet and dry seasons, 1980-81.

Items	Wet Season 1980-81			Dry Season 1981		
	2 WT	4 WT	Animal	2 WT	4 WT	Animal
	% Reporting					
Farming practices						
Planting method						
Broadcasting	23	40	22	32	29	25
Transplanting	73	60	78	66	69	75
Transplanting/ broadcasting	4	-	-	2	2	-
Variety planted						
Improved variety	87	89	100	94	95	4
Local variety	13	11	-	6	5	-
Area planted (rai)						
Improved variety	10.25	12.31	6.5	10.80	11.92	6.75
Local variety	7.75	5.8	5	12.15	13.11	-
Area planted by method (rai)						
Broadcast	8.67	10.14	10.5	9.59	10.63	6.67
Transplant	10.15	13.31	5.1	11.44	12.70	7.12
Transplant/broadcast	14.03	-	-	12.65	-	-
Others	-	-	-	8.00	-	-

Table 4. Factors affecting farmer's decision to purchase farm machine, two- and four-wheel tractor owners in selected irrigated villages of Suphanburi Province, Thailand by season, 1980-81.

Item	Wet Season		Dry Season	
	2 WT	4 WT	2 WT	4 WT
	% Values			
Person influencing decision on machine purchase:				
Family member	78	64	60	40
Fellow farmer	10	21	40	40
Extension worker	1	3	-	20
Machine dealer	2	3	-	-
Farmer's organization	1	1	-	-
Village head	2	-	-	-
Others	6	8	-	-
Perceived advantage of machine ownership:				
Timeliness	34	21	43	20
Save time	21	22	14	20
Cheaper	2	-	14	40
Better quality land preparation	11	15	29	-
Easier operation/less drudgery	10	23	-	20
Increase yield + farm size	5	2	-	-
Increase income	2	-	-	-
Others	15	18	-	-

Table 5. Characteristics of tractor operators for two- and four-wheel tractors in selected irrigated villages of Suphanburi Province, Thailand, 1980-81.

Item	Tractor Type	
	2 WT	4 WT
	% Reporting	
1. Had previous training or experience in machine operation:		
Yes	7	2
No	93	98
2. Machine type operator was trained to operate:		
None	93	97
Two-wheel tractor	4	1
Four-wheel tractor	2	2
Irrigation pump	1	-
3. Who trained the operator:		
None	93	98
Extension worker	1	-
Machine dealer	4	1
Farmer's organization	1	-
Others	1	1
4. Membership in any organization:		
None	40	35
Private organization	9	6
Government sponsored organization	51	59

Table 6. Tractor use pattern, two- and four-wheel tractors in selected irrigated villages of Suphanburi Province, Thailand, wet and dry seasons, 1980-81.

Items	Wet Season 1980-81		Dry Season 1981	
	2 WT	4 WT	2 WT	4 WT
Number of tractor units reported	97	52	88	50
Average horsepower	9	11.5	9	11.5
Average area serviced by location, rai:				
a. Own farm	22.4	27.4	21.5	25.9
b. Off-farm	7.8	5.8	3.6	10.3
TOTAL	30.2	33.2	25.1	36.25
Location of tractor service:		% Reporting		
a. Own farm	91	92	82	86
b. Off-farm	9	8	18	14

Table 7. Tractor breakdown by type and season in selected irrigated villages of Suphanburi Province, Thailand, crop year 1980-81.

Item	Wet Season 1980-81		Dry Season 1981	
	2 WT	4 WT	2 WT	4 WT
No. of tractors reported	43	28	23	8
Tractor characteristics				
Average horsepower	9.0	11.3	9.4	11.5
Average tractor age, years	8	7.5	5.0	9.5
Fuel type used:		% Reporting		
gasoline	16	-	17	-
diesel	84	100	83	100
Tractor breakdown by component:				
Engine	57	57	74	39
Transmission system	17	29	12	32
Implements	13	-	10	25
Hydraulic system	9	-	2	4
Irrigation	-	-	2	-
No answer	4	14	-	-
No. of same breakdown since machine was acquired	2	2	2	2
Seriousness of breakdown:				
Machine not operable	47	46	29	50
Machine runs but dangerous	46	25	38	12
Machine no longer usable	7	29	33	38
Average no. of days field activity was delayed	2.2	2.0	2.0	2.2

Table 8. Tractor repairs by type and season in selected irrigated villages of Suphanburi Province, Thailand, 1980-81.

Item	Wet Season 1980-81		Dry Season 1981	
	2 WT	4 WT	2 WT	4 WT
No. of tractors reported	43	28	23	8
Tractor repair:				
Whether machine was repaired		% Reporting		
Yes	100	100	96	100
No	-	-	4	-
Whether machine repair was delayed				
Yes	30	25	25	12
No	70	75	75	88
Action taken if spare part availability caused delay in the repair:				
- Substitute parts	2	14	-	-
- Ordered spare parts	2	-	-	-
- Wait for spare part's availability	12	18	21	-
- No answer	84	68	79	100
Average value of spare parts, Baht	1180	1301	1158	2270
Location of repair site				
- On farm	30	57	33	25
- Local repair shop	60	39	63	63
- Local dealer	5	-	-	-
- Others	5	4	4	12
Labor used for tractor repair, hours:				
Family labor	2.4	2.9	3.2	3.1
Hired labor	3.4	21.0	3.7	17.5
Payment for hired labor for repairs, Baht	79	98	206	185
Satisfaction with the repair:				
Yes	98	75	92	75
No	2	25	8	25
Distance from repair site, km (average)	4.25	3.9	3.3	2.9
Transport cost to repair site, Baht	24	36	10	1

Table 9. Cost analysis for two- and four-wheel tractors in selected irrigated villages of Suphanburi Province, Thailand, wet and dry seasons, 1980-81.

Item	Wet Season 1980-81		Dry Season 1981	
	2 WT	4 WT	2 WT	4 WT
Number of tractors reported	95	50	88	50
Average age of tractors, years	5.3	5.0	5.4	5.4
Initial cost of tractor, Baht	19,724	29,512	19,822	30,297
Fixed cost per season				
Depreciation	888	1,328	892	1,363
Interest	705	1,055	708	1,083
TOTAL FIXED COST	1,593	2,383	1,600	2,446
Variable cost/rai[a]				
Fuel	44.63	47.49	49.58	53.04
Oil	7.84	8.42	10.00	10.02
Repairs and maintenance	28.59	41.71	16.71	8.00
Driver's fee	33.00	33.00	33.00	33.00
TOTAL VARIABLE COST	114.06	130.63	109.29	103.95
Seasonal use (rai)	30.16	33.18	25.06	36.25
Average contract rate/rai, Baht	200	200	200	200
Machine capacity, hrs/rai	5.28	5.28	5.28	5.28
Total Cost Per Season	5,033	6,717	4,339	6,214
Total Benefits Per Season	6,032	6,636	5,012	7,250
Benefit-cost ratio, undiscounted	1.20	0.99	1.16	1.17
Break-even point, rai	18.54	34.35	17.64	25.46
Payback period, seasons	10.45	23.67	12.66	12.63

[a]6.25 rai = 1 ha.

Table 10. Effect of changes in fuel and oil price and contract rate per rai on the benefit-cost ratios of two- and four-wheel tractors in selected irrigated villages of Suphanburi Province, Thailand, wet season 1980-81.

Machine Type	Changes in Price of Oil and Fuel			
	Prevailing Price[a]	10% Increase	25% Increase	50% Increase
1. Two-wheel Tractor				
Contract rate				
a. Prevailing rate[b]	1.20	1.17	1.12	1.04
b. 10% increase	1.32	1.28	1.23	1.14
c. 20% increase	1.44	1.40	1.34	1.25
d. 30% increase	1.56	1.51	1.45	1.35
2. Four-wheel Tractor				
Contract rate				
a. Prevailing rate[b]	0.98	0.96	0.92	0.87
b. 10% increase	1.09	1.06	1.02	0.95
c. 20% increase	1.19	1.15	1.11	1.04
d. 30% increase	1.28	1.25	1.20	1.13

[a]Prevailing market price during the survey as reported by the respondents.

[b]Prevailing contract rate at 200 baht per rai or 1250 baht per hectare.

Table 11. Effect of changes in fuel and oil price and contract rate per rai on the benefit-cost ratios of two- and four-wheel tractors in selected irrigated villages of Suphanburi Province, Thailand, dry season 1981.

Machine Type	Changes in Price of Oil and Fuel			
	Prevailing Price[a]	10% Increase	25% Increase	50% Increase
1. Two-wheel Tractor				
Contract rate				
a. Prevailing rate[b]	1.16	1.12	1.06	0.99
b. 10% increase	1.27	1.23	1.17	1.08
c. 20% increase	1.39	1.34	1.28	1.18
d. 30% increase	1.50	1.45	1.38	1.28
2. Four-wheel Tractor				
Contract rate				
a. Prevailing rate[b]	1.17	1.12	1.07	0.98
b. 10% increase	1.28	1.23	1.17	1.08
c. 20% increase	1.40	1.35	1.28	1.18
d. 30% increase	1.52	1.46	1.39	1.28

[a]Prevailing market price during the survey as reported by the respondents.

[b]Prevailing contract rate at 200 baht per rai or 1250 baht per hectare.

Table 12. Effect of changes in fuel and oil cost and contract rate/ha on the break-even point of two- and four-wheel tractors in selected irrigated villages of Suphanburi Province, Thailand, wet season 1980-81.

Machine Type	Changes in Fuel and Oil Price			
	Prevailing Price[a]	10% Increase	25% Increase	50% Increase
	Hectare			
1. Two-wheel Tractor				
Contract rate				
a. Prevailing rate[b]	2.97	3.16	3.50	4.27
b. 10% increase	2.41	2.53	2.75	3.20
c. 20% increase	2.02	2.11	2.26	2.56
d. 30% increase	1.75	1.81	1.92	2.13
2. Four-wheel Tractor				
Contract rate				
a. Prevailing rate[b]	5.50	5.98	6.88	9.20
b. 10% increase	4.26	4.55	5.06	6.21
c. 20% increase	3.49	3.67	4.00	4.68
d. 30% increase	2.95	3.08	3.30	3.76

[a]Prevailing market price during the survey as reported by the respondents.

[b]Prevailing contract rate at 200 baht per rai or 1250 baht per hectare.

Table 13. Effect of changes in fuel and oil price and contract rate/ha on the break-even point of two- and four-wheel tractors in selected irrigated villages of Suphanburi Province, Thailand, dry season 1981.

Machine Type	Changes in Fuel and Oil Price			
	Prevailing Price[a]	10% Increase	25% Increase	50% Increase
	Hectare			
1. Two-wheel Tractor				
Contract rate				
a. Prevailing rate[b]	2.82	3.02	3.38	4.20
b. 10% increase	2.31	2.44	2.67	3.16
c. 20% increase	1.96	2.05	2.21	2.54
d. 30% increase	1.70	1.77	1.88	2.12
2. Four-wheel Tractor				
Contract rate				
a. Prevailing rate[b]	4.17	4.37	4.88	6.08
b. 10% increase	3.44	3.57	3.91	4.64
c. 20% increase	2.92	3.02	3.26	3.75
d. 30% increase	2.54	2.62	2.79	3.14

[a]Prevailing market price during the survey as reported by the respondents.

[b]Prevailing contract rate at 200 baht per rai or 1250 baht per hectare.

Table 14. Effect of changes in fuel and oil price and contract rate per rai on the payback period of two- and four-wheel tractors in selected irrigated villages of Suphanburi Province, Thailand, wet season 1980-81.

Machine Type	Changes in Price of Fuel and Oil			
	Prevailing Price[a]	10% Increase	25% Increase	50% Increase
	Seasons			
1. Two-wheel Tractor				
Contract rate				
a. Prevailing rate[b]	10.5	11.4	13.2	18.0
b. 10% increase	7.9	8.5	9.4	11.6
c. 20% increase	6.4	6.7	7.3	8.6
d. 30% increase	5.3	5.6	6.0	6.8
2. Four-wheel Tractor				
Contract rate				
a. Prevailing rate[b]	23.7	27.8	37.7	92.4
b. 10% increase	15.4	17.1	20.4	30.0
c. 20% increase	11.5	12.4	14.0	17.9
d. 30% increase	9.1	9.7	10.6	12.8

[a]Prevailing market price during the survey as reported by the respondents.

[b]Prevailing contract rate at 200 baht per rai or 1250 baht per hectare.

Table 15. Effect of changes in fuel and oil price and contract rate per rai on the payback period of two- and four-wheel tractors in selected irrigated villages of Suphanburi Province, Thailand, dry season 1981.

Machine Type	Changes in Price of Oil and Fuel			
	Prevailing Price[a]	10% Increase	25% Increase	50% Increase
	Seasons			
1. Two-wheel Tractor				
Contract rate				
a. Prevailing rate[b]	12.7	14.0	16.6	24.2
b. 10% increase	9.6	10.3	11.7	15.0
c. 20% increase	7.7	8.2	9.0	10.9
d. 30% increase	6.5	6.8	7.4	8.5
2. Four-wheel Tractor				
Contract rate				
a. Prevailing rate[b]	12.6	14.0	16.7	24.2
b. 10% increase	9.7	10.5	11.9	15.3
c. 20% increase	7.9	8.4	9.3	11.2
d. 30% increase	6.6	7.0	7.6	8.8

[a]Prevailing market price during the survey as reported by the respondents.

[b]Prevailing contract rate at 200 baht per rai or 1250 baht per hectare.