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THE CONSEQUENCES OF SMALL RICE FARM MECHANIZATION PROJECT

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PERSPECTIVES ON ASPECTS OF SMALL FARM MECHANIZATION IN INDONESIA

by

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PERSPECTIVES ON ASPECTS OF SMALL FARM MECHANIZATION IN INDONESIA

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Introduction

The role of mechanization in modernizing the small farm sector in Indonesia is an important policy issue.

In this paper several related questions are presented that have been raised by participants in the ongoing mechanization discussion. An attempt is made to provide a perspective on these questions, based on economic theory and data reported in recent research studies.

Will the synchronized mechanization of land preparation have an impact on subsequent operations?

The synchronized planting of rice is a major objective in the integrated pest control program. Some researchers argue that available labor cannot prepare the land on time and labor shortages are a constraint to the realization of synchronized land preparation and planting. Consequently, tractors must be introduced to facilitate the preparation of large contiguous areas in 3-4 weeks or less.

If synchronized land preparation is achieved, it will have a significant impact on the distribution of labor demand for subsequent operations. Since almost all the farmers in a contiguous area plant the same duration varieties, all major labor absorbing activities (transplanting, harvesting and threshing) occur at fixed intervals after the seed is planted in the seedbeds. Consequently, synchronization of land preparation will induce relative (i.e. compared to the non-synchronized situation) and possibly absolute labor shortages. This situation is likely to result in land owners purchasing recently developed labor saving equipment such as the mechanical transplanter, weeder, reaper (harvester) and thresher. Considering that on manual farms, land preparation absorbs about 30%, transplanting 16%, weeding 18% and harvesting 25% of the 175 MD/ha required for non-mechanized lowland rice production (Consequences Team, 1981), the synchronized planting of the crop is likely to lead to substantial displacement of labor.

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Do economists and engineers speak the same language?

Often it seems that in exchanging ideas about mechanization, economists and engineers focus on different aspects of related issues.

First, engineers emphasize the potential impact on yields, cropping intensity and timeliness that can be realized. Economists, using survey data, focus on the realized impact under farmers' conditions.

Second, engineers emphasize the potential labor savings gains that can be achieved, thereby reducing drudgery and freeing labor for alternative uses. Economists accept the potential for saving labor but focus on the distribution of these labor savings gains between owners/suppliers of labor and capital. Where suppliers of labor are also the new owners of capital (owner-operators using family labor who buy a tractor), the labor reducing benefit of mechanization is accepted as "good". On the other hand, if the new technology redistributes benefits from laborers to owners of capital, economists question the appropriateness of mechanization.

Reflecting on these two perspectives, it seems that economic analysis would make a greater contribution if it focused more on understanding why potential positive impacts are not realized instead of continually attempting to document that these benefits are not achieved. At the same time, engineers need to be more sensitive to the distribution of benefits issue in mechanization extension efforts. Yet, until mechanization researchers develop procedures that can be utilized ex ante to evaluate the impact of technology on factor shares, it will remain difficult to make concrete recommendations regarding mechanization policy.

Can the non-agricultural sector absorb the increase in population and labor displaced from agriculture?

It is sometimes suggested that the agricultural sector should not be burdened with redundant labor. Agriculture must be modernized thru the introduction of machinery and this labor must be absorbed by the non-agricultural sectors.

While this is a provocative point of view, it is enlightening to evaluate the capacity of the non-agricultural sector to absorb labor. Currently, population growth in Indonesia averages over two percent/year with about 65% of the population employed in the agricultural sector. This implies that in order to absorb the annual population increase, non-agricultural employment must expand at a rate of 6%/year. Mechanization can be expected to displace labor if tractors, transplanters, reapers and threshers are widely introduced. Each 1% annual reduction in agricultural employment will require approximately a 2% increase in non-agricultural employment to maintain current employment levels. Hence in the short run, an 8% annual increase in non-agricultural employment will be required to absorb the current population increase and reduce agricultural employment by 1%/year.

Available time series employment data is generally considered to be only indicative due to changes in definitions and the importance of seasonal employment. Yet, available data suggests that between 1971 and 1976, agricultural employment increased at an annual rate of 1.6-3.4%/year and non-agricultural employment at 5.2-7.0%/year (World Bank, 1979). While these numbers are encouraging, it is not clear whether they indicate an increase in welfare. First, the agricultural sector figures do not consider whether the person is fully employed and probably hides considerable seasonal disguised unemployment. Second, real wages appear to be stagnant. For example, from 1972-1977 real wages for unskilled construction workers in 7 of the 10 largest cities declined from 100 (1972) to 81 (1977) and for rubber workers in Java real wages have been relatively constant from 1969 to 1975 (World Bank, 1979). While there is no general rural wage index prepared by the Government for rural agricultural wages paid to laborers, the general impression is that real wages have not declined over the past ten years, but any increase has been very small (World Bank, 1979).

Consequently, it would appear it will be very difficult for the non-agricultural sector to absorb both the increase in agricultural and non-agricultural labor plus an exodus of agricultural labor displaced by mechanization at a rate rapid enough to produce an increase in real wages.

Farm size is small in Japan and these farms are mechanized, so shouldn't it be possible to mechanized Indonesian farms?

The economic viability of mechanizing land preparation is dependent on the cost of inputs and the value of the output (paddy). Since these values differ between countries, we can expect to observe different combinations of capital and labor used to complete the same job. A simple example illustrates this concept. As shown in Table 1, at Japanese wage rates land preparation in Java would cost about US$1,026/ha compared to the present cost in Indonesia of US$43/ha. Alternatively, land preparation costs in Java are equivalent to 250 kg of paddy. If Javanese farmers received the same subsidized price for paddy as Japanese farmers, the cost of land preparation would be $313/ha compared to the actual cost of US$43/ha. In other words, at Japanese wage rates the Indonesian tiller owner could charge up to US$1026/ha for mechanized land preparation or at Japanese rice prices he could charge up to US$300/ha-compared to the existing custom rate of US$43/ha. Consequently, at Japanese prices a power tiller would be an economically viable technique (compared to manual land preparation) if only 3-4 ha were plowed/year.

While these comparisons are crude measures, they are indicative of why hand tractors are widely adopted in a country with high wage rates and paddy prices - but unprofitable in a country with low wage rates and low paddy prices.

Does tiller mechanization reduce labor bottlenecks?

Much of the recent discussion on the need to introduce power tillers into Java focuses around the perceived need to synchronize rice planting as a necessary and integral component of the integrated control of rice pests. Because the brown planthopper multiplies only when rice is available as a food source, farmers are encouraged to plant large blocks of irrigated rice land within 3-4 weeks. Even if human labor were previously available to prepare fields when staggered planting over two months was the common practice, the push for sychronized planting induces a relative (i.e. with respect to the pre-synchronized situation) labor shortage during the land preparation period.

The potential of power tillers to break the labor bottleneck is constrained by the economics of tractor use. At current tiller prices bought with subsidized credit, each diesel unit must operate eight weeks/wet season and plow 24 hectares (Hurun, 1981). At an estimated work rate of 22 hours/ha for complete land preparation, assuming an equal demand for custom services in the wet and dry season and assuming ten working hours/day, three hectares can be plowed each week - taking into consideration breakdowns, travel time and searching for custom jobs.

In Table 2, the custom rates required to give breakeven returns are noted. From this data it is clear that if synchronized planting in 3-4 weeks is achieved, tiller owners will have to find custom opportunities outside his home village in areas on a different water schedule. Otherwise, only half of the hectares required to breakeven will be completed within the required 3-4 weeks. Hence, the tillers can only break the labor bottleneck and achieve the breakeven hectarage if the mobility of machines is increased beyond the owner's village. At the same time, the farther the tiller owner must travel to find additional work, the greater will be the search time required.

What factors determine tiller/tractor custom rates?

To be economically variable, the total tiller cost/ha must be equal to or less than gross revenue/ha (i.e. custom rate). Total costs/ha are dependent on the initial price of the unit and useful life which determines the level of fixed costs/ha; and variable cost/ha such as fuel, repairs and maintenance, and operators' wage. Recent studies have shown that tractor owners are unable to cover all costs and suffer losses (Hurun, 1981; Javar, 1981). It has been suggested that if the plowing rate was increased above the existing level, profits could also be increased.

Logically, tractor owners will charge the highest possible rate/ha in order to maximize profits. Yet, they are constrained by the cost of alternative techniques - the cost of human land preparation. As labor is a factor sold in a competitive market, wages are determined by the interaction of supply and demand. If demand increases relative to supply, wages rise and vice versa. The interaction of supply and demand factors are illustrated by

observing changes in custom rates in Mariuk, West Java. In 1975 the contract plowing rate was Rp. 30,000/ha (two plowings), but had fallen to Rp. 29,000/ha in 1980 (Hurun, 1981). Considering the fact that there was considerable inflation over this period, the real value of the Rp. 25,000 paid in 1980 - in terms of 1975 rupiah is only Rp. 16,250/ha - compared to Rp. 30,000/ha in 1975.[1] These changes suggest that either the initial contract rate was established at an artificially high rate and/or real wages have declined over the period. Regardless of the reason for the fall in the custom rate, it is clear that it is impossible to maintain custom plowing charges above the cost of alternative techniques.

Do power tillers increase timeliness of land preparation?

By comparing the time required to prepare one hectare of land with a power tiller of 22 hours (Hurun, 1981) to the manday requirements for human land preparation of 50 8 hour MDs (Consequences Team, 1981); it would appear that mechanized land preparation can speed the rate at which land is prepared. Yet, an additional factor must be considered. Assuming a diesel tiller must plow 25 ha/season to cover fixed costs, it must operate over 50 days/season (Hurun, 1981). Consequently, a queuing problem arises. While farmers whose land is prepared first may achieve more timely (earlier) land preparation than those using manual techniques, land owners at the end of the queue will necessarily have their land prepared over 50 days later. If the objective of introducing tillers is to achieve more rapid and timely land preparation, this can only be achieved if excess capacity exists (making tiller use unprofitable) or tillerowners are willing and able to travel from areas with one irrigation schedule to areas with a subsequent water schedule.

Who are the beneficiaries of mechanization?

Machines are adopted by farmers for non-economic and economic reasons. Non-economic incentives may include a desire to reduce drudgery, reduce labor management problems, increase the owner's prestige, and increase leisure. Economic incentives for adoption may include the desire to increase time for non-farm employment, increase yield/crops, increase cropping intensity, and reduce production costs.

The beneficiaries of mechanization are the individuals affected by these changes. The primary beneficiaries of mechanization may include consumers, if the machines increases output or reduces labor costs and these benefits are passed to consumers in terms of lower food costs; farmers, if adoption increases profit; and machine owners if custom work is profitable. Secondary beneficiaries may include importers of machinery, suppliers of credit and equipment dealers. If machinery is domestically produced, backward linkages may increase incomes of manufacturers, employees in manufacturing and the skill level of manufacturing sector. Forward

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[1] 1980 custom rate deflated by the change in the rural price index for twelve essential commodities.

linkages may benefit the service sector (repairs), marketing sector and custom operators.

The primary group disadvantaged will be those individuals displaced by the labor reducing contribution of machines. This impact on labor displacement must consider who will be displaced and who will be hired for newly created jobs, what are the employment alternatives for the displaced, and how many mandays of labor will be eliminated/created by the introduced technology.

From this discussion we see that it is difficult to empirically resolve whether the benefits from mechanization are greater than the social costs. On the other hand, it is clear that where labor is provided by landless laborers with little education and few skills, mechanization of such operations as land preparation, transplanting, harvesting and threshing will have a substantial labor displacing impact. Since these disadvantaged groups are relatively invisible and powerless, unless the impact of mechanization on their welfare is given high priority by researchers and policy makers, it is likely their position in society will deteriorate.

When are labor substituting techniques appropriate?

One of the important characteristics of machines is that they increase the productivity of labor. Hence, the same amount of work can be done with a smaller labor force or more work could be done with the same labor force.

Mechanization may be needed under three situations:

- To complete tasks that are currently not done, but will indirectly or directly increase output.
- To complete tasks that currently appear to be delayed resulting in output and profit losses associated with this delay.
- To complete tasks that are being done on time, but at an increasingly higher wage rate, thereby reducing owner's profits.

The first condition may exist in areas where population densities are extremely low, relative to the potential agricultural area such as transmigration sites in the outer islands of Indonesia. In this instance, analysis must focus on the most profitable technologies to introduce which will enable more land to be farmed.

In the second case, farmers would offer higher wages to induce additional laborers to sell their services or adopt machines to capture the unrealized potential output gains. This would not occur if

- the potential output gains are not real, but illusionary;
- the potential output gains are real, but farmers lack knowledge about these opportunities;

- the potential output gains are real, but the cost of capturing this benefit is greater than its value; and

- the potential output gains are real and profitable to capture, but other constraints make it impossible to capture these gains simply by increasing the labor/power supply.

The third situation may have resulted as a consequence of changes in the labor supply-demand situation. Consider the situation where previously the supply of labor was adequate to maintain a constant real wage level, but recent changes in the supply and/or demand for labor have created shortages. In order to evaluate the current situation vis-a-vis the past, time series data can provide insights.

Changes in the labor supply should be reflected in changes in man-land ratios, population, rural-urban migration patterns, inter-regional rural migration patterns, landless laborer numbers, and livestock numbers (re land preparation).

Changes in the demand for labor should be reflected in changes in cropping intensity, irrigation schedules, crop calendars, new technologies introduced, non-farm rural employment, and urban employment.

From an economic point of view, the wage rate reflects the integration of supply and demand factors. If a shortage of labor exists relative to some previous time period, this will be reflected as an increase in real wages paid. These changes should be reflected in changes in wage rates paid for given operations over time, relative the wage rate between operations over time (i.e. weeding to land preparation), wages between seasons for the same operations, and urban-rural wage differentials. If there is no increase in real wages, it cannot be argued that mechanization is required to restore a supply-demand balance. On the other hand, if labor demand appears to be increasing but no real wage rate change are observed, the labor force must be underemployed.

Rising wages are not <u>prima facie</u> evidence that a task should be mechanized. First, new technology increases the productivity of resources employed in agriculture. The increased output must be distributed between resource owners. The equitable allocation of these gains is not an empirical but a philosophical question. Yet, rising real wages are required if the labor is to benefit from the adoption of new technology.

Furthermore, in evaluating the need to mechanize a task, a broad perspective is required. In some instances alternatives may exist. For example, assume we want to increase cropping intensity and the period between planting the first and harvesting the second crop must be reduced by 20 days to achieve this goal. One possible way to achieve this goal is by reducing turnaround time through mechanizing land preparation of the second crop. At the same time, the same objective (i.e. saving 20 days) could be achieved

with a shorter duration variety, planting the seedbed earlier and/or planting older seedlings. There are little doubt that labor markets in the Third World are extremely fragmented and the cost of searching for a job is high. Hence, frictional employment is probably significant. Consequently, by increasing the mobility of labor by providing job location information to laborers, shortages that may exist could be reduced.

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Table 1. Comparison between factor and output prices in Indonesia and Japan, 1980.

	Indonesia	Japan
Capital cost ($US)[a]	4,800	<4,800
Fixed costs in first year ($US)[b]	1,200	1,200
Labor cost ($US/day)	.80	19.00
Labor/ha (8 hr MD)[c]	54	54
Custom rate ($US/ha)[d]	44	?
Paddy price ($US/ha)	0.18	1.25
Land preparation cost ($US/ha)		
Equivalent wage rate	43[e]	1,026[f]
Equivalent paddy price	43	300[g]

[a]Current price of two wheel diesel hand tractor. The price in Japan is assumed to be equal to the Indonesian price, less transportation.

[b]Capital cost minus salvage value (10%), assuming five year depreciation period and 12%/year interest.

[c]Assuming the same number of mandays would be required in Japan as in Indonesia to prepare the land manually.

[d]Custom rate in Subang District, West Java, W. S. 1980.

[e]Human land preparation cost/ha in Subang, assuming a wage rate of $US0.80/day and a labor input of 54 MD/ha.

[f]Cost of human land preparation in Subang at Japanese wage rates.

[g]Cost/ha in Subang District, West Java, assuming some relationship between paddy price and custom rate as in Subang, but at Japanese paddy price.

Data on wage rate and paddy price from Palacpac, 1980; land preparation human labor requirements and custom rate from Hurun, 1981.

Table 2. Custom rate required to breakeven at various time durations available for wet season land preparation, West Java, Indonesia 1980.

Weeks operating	Hectares plowed[a]	Breakeven custom rate[b] ($/ha)
1	3	218
2	6	118
3	9	85
4	12	68
5	15	58
6	18	51
7	21	47
8	24	43

[a]Assuming a power tiller operates 10 hours/day, 22 hrs/ha and one day/week is lost to downtime and searching for land for custom work, a tiller can prepare about 3 ha/week.

[b]Breakeven custom rate calculated as:

$$\frac{\text{Fixed costs + (hectares prepared (variable costs/ha x hectares prepared))}}{\text{hectares prepared}}$$

Depreciation and interest (12%/year) on the diesel power tiller selling for US$ 4,800 is $600/season when the hand tractor is depreciated over five years.

Source: Data on wages and paddy price from Palacpac, 1980 and average fixed costs/season from Hurun, 1981.