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By

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THE IMPACT OF MECHANIZED LAND PREPARATION ON EMPLOYMENT AND INCOME DISTRIBUTION IN WEST JAVA, INDONESIA*

Yusuf Saefudin and Bart Duff**

INTRODUCTION

Development of the Jatilukur irrigation project permits the spread of double cropping, and, to ensure the efficient use of water deliveries are very tightly scheduled. Additional water together with adoption of high yielding varieties (HYV), which require more precision in the timing of transplanting and harvesting over a large area, means land preparation must be undertaken within a very limited period. The result is that labor demand is concentrated in a short period. The problem is exacerbated by a decrease in the seasonal migration of labor and draft animals into the area.

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* For the more complete analysis on which this is based, see: Yusuf Saefudin, "The Domestic Resource Cost of Mechanization in West Java, Indonesia", Unpublished M.S. thesis, University of the Philippines at Los Banos, 1983.

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Some officials are convinced that a labor shortage exists in the area and have welcomed introduction of tractors to mitigate this peak labor demand - supply inbalance. However, there has been no detailed and systematic study conducted to examine the issue. The number of tractor has increased very rapidly during the 1974-1980 period (500 to 600% in West Java province and in the sample districts). There are, however, many factors which influence the increase in tractor population. Among them are: (1) the accumulated wealth of large farmers resulting from rapid increases in real income (due to higher yield and subsidized input prices), (2) massive introduction and demonstration of tractor use in recent years, and (3) the availability of subsidized credit.

As in other labor surplus developing countries, the introduction of tractors in West Java has been the center of a continuing controversy attracting high level government attention in recent years. Criticism of agricultural mechanization has focused on its possible negative impact on rural employment and income distribution.

There have been many studies conducted on the mechanization issue (Binswanger, 1978; Duff, 1978; Gemmill and Eicher, 1973; Herdt, 1981; McInerney and Donaldson, 1975; Sinaga, 1978). The arguments cited are: (1) most studies fail to provide convincing evidence that machines are responsible for substantial increases in yield and cropping intensity, (2) faster rates of machine adoption by larger farmers, (3) capital is substituted for labor and the degree of replacement depends on the degree of mechanization, (4) a tendency

toward negative income distribution and (5) government policies affecting the impact of mechanical equipment vary but often include making availability credit at subsidized interest rates causing significant increases in the rate of mechanization.

The objectives of the study are: (1) to compare labor use and yield between mechanized and non-mechanized farms, and (2) to examine the impact of land preparation mechanization on income distribution among factors and earners in the production process.

SAMPLING PROCEDURE

The research sites in West Java were selected using a combination of random and purposeful sampling procedures. Secondary data on farm area, production and the number of tractors in each of 20 districts in West Java were collected and assessed to determine tractor distribution in the province.

Subang and Indramayu districts were chosen because of a high degree of rice production and also because 34 percent of all tractors in West Java are found in these two districts.

A stratified two stage sampling procedure was applied to draw village and farm samples.

Selection of villages. A random sample of the six sub-districts (within the two districts) with the greatest number of hand tractors was first selected. Next, four villages with four or more tractors each were randomly selected from each district.

Selection of the farmers. First a block census was conducted of the eight villages covering 1600 households. Next, a stratified random sample was obtained for the survey. Census respondents were stratified according to the power used for land preparation in the wet season 1978/79. The six groups taken for sample stratification were: (1) tractor owners, (2) tractor hirers, (3) animal users (4) animal-manual combined, (5) manual and, (6) landless labor. A total of sixty farmers was selected from each group so there were 300 sample farmers (excluding landless labor) in the study. Since some of the samples gave incomplete information for the purpose of the study, only 254 farmers were eventually included.

Data were collected during the following seasons: 1979 dry season (second crop), 1979 dry season (third crop), 1979/80 wet season, 1980 dry season (second crop) and the 1980 dry season (third crop).

During the period of the study, however, many farmers changed power source from season to season. Therefore, for the present analysis sample farms were reclassified into mechanized and non-mechanized farmers. The data from the 1979-80 wet season and the 1980 dry season (I) were used in this study.

During the wet season, there were 126 mechanized farms (consisting of 114 wholly mechanized farms, 12 respondents who used

combinations of tractors and manual methods)[1], and 126 non-mechanized farms (consisting of 60, 47, and 21 respondents who used animal, manual and combination of animal and manual, respectively).

In the dry season, there were 106 mechanized farms (consisting of 91 respondents who used only tractors and 15 who used combinations of tractors and manual methods), and 148 non-mechanized farms (all used manual/hoe in land preparation).

METHODOLOGY

Costs and returns analysis is a common tool of agricultural economists, but the definitions are not standardized. Therefore, there are a number of alternative methods for measuring factors and earner's shares.

Paris (1982) indicated that in functional income distribution (factor share), the total value of output can be distributed among the following factors: (1) land, (2) fixed capital, (3) management, (4) labor, and (5) current inputs. In personal income distribution (earner's share), total output can be distributed among: (1) landlords,

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[1] The farmers usually prepare the land in two operations. A combination of tractor and manual methods means the farmer used the tractor for the first operation and manual/hoe in the second. A similar aggregation of techniques is found for other combinations.

(2) operators, (3) hired laborers, (4) current input earners, and (5) other earners (recipients of rents on tractors and other machines).

Herdt (1978) divided the total value of output into payments made to each factor of production: labor, land, capital, current inputs and a residual. For the earner's share, total output is distributed among various individuals involved in production such as: hired labor, landlord, current inputs, and the operator. If long run-perfect competition does not prevail, there may be a residual, and this residual accrues to the operator in the earner's share analysis.

An examination of the distribution of production components indicates that farm operators may receive or own not only the management factor but also land, labor, and other capital. Therefore hired laborers and landlords do not have exclusive claim on the labor and land shares, respectively. Thus, income distribution among factors may have little coincidence among earners. An increased labor share does not necessarily imply that hired and landless workers are the only ones benefited because owner-operators and their family members sometimes contribute on their own farm, or hire out their own labor (Paris, 1982).

In this study, the total income from rice production was equated to the sum of output going to each production factor: (1) land, (2) labor, (3) capital, (4) current inputs, and (5) a residual. It was also equated to the sum of the payments to the earners in the

production process such as: (1) current inputs, (2) hired laborers, (3) landlords, (4) capital earners, and (5) farmers/operators.

The definition of the various payments (or income) are as follows:

a) Payment to the landlord is the value of output given as rent on land minus those production costs paid by the landlord.

b) Payment to land is the payment to the landlord plus imputed rent for owned land.

c) Payment to hired labor are wage payments (including meals) to hired labor (including the tractor driver) plus the value of output given to harvesters.

d) Payment to labor is the payment to hired labor plus the imputed value of family labor.

e) Payment to current inputs is the sum of expenses on seed, fertilizer, insecticides, pesticides, and irrigation.

f) Payment to hired capital is the rental paid on tractor/animal services (excluding the payment to the drivers).

g) Payment to capital as the payment to hired capital plus the imputed value of owned tractor/animal services plus imputed interest on pre-harvest paid out costs.

h) Payment to the residual is the value of output minus the sum of payment to current inputs, land, labor and capital.

i) Payment to the operator/farmer is the value of output minus the sum of payments to the landlord, current inputs, hired labor and the hired capital owner.

The computational diagrams are presented in Table 1.

RESULT

The main objective of the study was to determine which among alternative methods of land preparation is more profitable. The analysis therefore required costs and returns to be identified. Input use and yield comparisons between mechanized and non-mechanized farms are important factors which determine costs and returns.

Labor use. On the whole, the wet season labor requirements were considerably higher than those for the dry season (Table 2 and 3). This was mainly due to easier land preparation during the dry season. Farmers usually prepare land immediately after the wet season harvest when the soil is still wet and soft and rainfall is still relatively high. Conversely, during the wet season, farmers cultivate the land about three months after the dry season harvest. For three months the land has been fallow and the wet season rainfall will have just begun. The soil is often very hard and dry sometimes cracking the soil surface. Hence, land preparation during the wet season is more difficult than in the dry season. Similarly, harvesting is more difficult in wet fields than in dry fields.

Labor utilized on mechanized farms in the wet season was higher than the dry season by about 30, 53 and 84 hours for family, hired and total labor respectively. On non-mechanized farms, labor contributed by the above mentioned sources was higher by about 17, 159, and 177 hours respectively.

During the wet season, labor use on non-mechanized farms was higher than on mechanized farms (Table 1). These differences were about 27 and 23 per cent for pre-harvest and total labor use. The difference was mainly due to greater labor use in land preparation on non-mechanized farms. Based on the source of labor, more than one-half the total labor input was contributed by hired labors. The share of family labor was higher on non-mechanized farms (20.5%) than on mechanized farms (7.8%). Similarly in the dry season, labor use on non-mechanized farms was higher than on mechanized farms (Table 3). These differences were about 22 and 15 per cent for pre-harvest and total labor use. The source of labor use also indicates that the share of family labor on non-mechanized farms was higher than on mechanized farms. On mechanized farms, the shares were 6.2 and 5.5 per cent for pre-harvest and total labor. For non-mechanized farms, the shares were 25 and 22 per cent, respectively.

The high rate of dependency on hired labor results partially from use of high yielding varieties (HYV) which require planting and harvesting operations to be completed in a very short period of time, which is difficult using family labor alone. A second reason results

from a common labor use system in the study area. Farmers always want to complete every operation within one or two days, so they employed each other in their farm operations. Under this system, even if family labor income from their own farm is reduced by the amount paid to neighbors, the reduction can be offset by the family's wage earning working for neighbors. This system, which is a form of labor exchange with wage payment, is very popular, especially among small farmers.

In the distribution of labor input by tasks, harvesting, land preparation and weeding required the major share on non-mechanized farms. These three major tasks accounted for about 72 and 70 per cent of total labor in the wet and dry seasons. For mechanized farms, the three major tasks were harvesting, weeding and transplanting, which required 72 per cent of total labor in both seasons.

Harvesting had the largest share of total labor input for both groups and seasons. It has traditionally been carried out as a kind of community activity called "bawon". Any villager can participare in harvesting and the harvesters are entitled to one-sixth to one-tenth of the output.

The effect of mechanization on labor use was consistent with the results of several previous studies which found that machines replace animal power and labor. However, in this study only family labor was significantly replaced by mechanization. Although mechanized farms used 20 and 13 mandays less labor for land preparation in the wet and dry season, the differences in hired labor use were only 11 and 6

mandays, respectively. Lower hired labor use for land preparation was almost offset by higher labor use for non land preparation activities so total hired labor use was not significantly different.

Other inputs used. Table 4 shows the quantity of fertilizer use, value of pesticides and yield in the wet and dry seasons. In general, mechanized farms used more fertilizer per hectare in the wet season but almost the same in the dry season. On the average, the differences in fertilizer use were about 12 and 1 per cent in the wet and dry seasons, respectively.

Conversely, mechanized farms generally spent less on pesticides than non-mechanized farms in both seasons.

Higher levels of fertilizer use on mechanized farms supported the findings of previous studies which reported that mechanization increased input utilization. Lower pesticide costs on mechanized farms does not mean mechanized farms used less pesticide since there are many different pesticides with different prices.

Yield per hectare. The yield per hectare was higher on mechanized than on non-mechanized farms in both the wet and dry seasons. The resulting yield per hectare seems closely associated with fertilizer use. Mechanized farms used more fertilizer than non-mechanized farms. Yield per hectare was significantly lower in the dry season for both mechanized and non-mechanized farms. For each

season, however, there were not significant yield differences between mechanized and non-mechanized farms (Table 4).

We should note that the 1980 dry season was a poor crop since 2.6 percent of the area of mechanized farms and about 24 percent of the area of non-mechanized farms harvested only about one-half the expected yield. This was due to extensive rat and stemborer damage. Crop loss was highest on non-mechanized farms.

Using adjusted yield figures[2], which are estimated based on crop losses reported by the farmers, mechanized farms had a higher yield per hectare than non-mechanized farms. This difference, however, was not significant at the 5% confidence level. These adjusted yield figures are very rough estimates based on the responses of farmers who could estimate their expected yield.

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[2] Adjusted yield is estimated as follows:

- for mechanized farms, $Ad = \frac{Ac}{0.97 + 0.03\ (0.50)} = \frac{Ac}{0.99}$

- for non-mechanized farms, $Ad = \frac{Ac}{0.76 + 0.24\ (0.50)} = \frac{Ac}{0.88}$

where Ad and Ac are Adjusted and Actual yield per hectare, respectively.

Factor share analysis. Estimated total costs, including the imputed cost of unpaid family labor, owned land and capital are shown in Table 5. The imputation of family labor cost was calculated by multiplying hours of family labor by the average wage paid per hour to hired labor for each activity. For owned land, we multiplied the owned land area by the market rental rate. Similarly, imputed capital was estimated by multiplying owned land by the market rate for tractor or animal services plus interest on pre-harvest paid out costs.

Labor and land costs represent the largest portion of total cost. Those two major costs summed to about 79 and 85 per cent for mechanized and non-mechanized farms in both the wet and dry seasons. The imputed family labor cost on non-mechanized farms was much higher than on mechanized farms. Conversely, the imputed owned land cost was lower on non-mechanized farms because the proportion of owned land was lower on non-mechanized farms. The data shows, however, that owned land was a major portion of cultivated land for both mechanized and non-mechanized farms.

There were minor differences in terms of total cost and total paid-out cost between mechanized and non-mechanized farms. In the wet season, higher capital costs on mechanized farms was more than offset by lower labor cost so that total cost on mechanized farms was slightly lower than on non-mechanized farms. Similarly, although the imputed family labor cost was much higher on non-mechanized farms, it was more than offset by lower total labor cost on mechanized farms. This

together with the cost of rented land, which was two times higher on non-mechanized farms, meant total paid-out costs on non-mechanized farms was still slightly higher than on mechanized farms.

Total value of output, value added, gross family factor income and residual (income) were higher in the wet than in the dry season for all groups. This was mainly due to higher yields in the wet season. They were also higher on mechanized than non-mechanized farms (due to higher yield on mechanized farms).

Factor share analysis shows that the relative share of labor was 7 and 4 per cent lower on mechanized farms in the wet and dry seasons (Table 6 and 7). Conversely, the relative share of capital was 3 and 5 percent higher on mechanized farms. The share of both current inputs and land were almost the same. As a result, the share of operators' surplus (residual) in the wet season was 6 per cent lower on non-mechanized farms but it was the same in the dry season.

Tables 6 and 7 also show how income (value added) was distributed between farmers and hired laborers. Farmers' income consists of a residual and return to family labor, land and capital. Laborers' income consists of wage earnings on farms.

Hired laborers' income was only 2 percent lower on mechanized farms in the wet season, and it was offset by higher hired laborers' income on mechanized farms in the dry season. In the meantime, farmers' income was 5 and 2 percent lower on non-mechanized farms in the wet and dry seasons. Thus, land preparation mechanization resulted

in a very minor effect on income distribution. Although mechanized farms used less labor input, only family labor was significantly reduced. In the wet season, although mechanized farms used 21 less mandays for land preparation, the difference in hired labor use was only 11 mandays, and lower hired labor use in land preparation was almost offset by higher hired labor use in the other operations. In the dry season, non-mechanized farms used much less labor for land preparation by practicing minimum tillage. The difference in total labor use (for land preparation) between mechanized and non-mechanized farms was only 13 mandays, or only 5 mandays in terms of hired labor use. Again, lower hired labor use in land preparation was more than offset by higher hired labor use in other operations.

CONCLUSION

This study indicates that only family labor use was significantly affected by tractors. Mechanization resulted a very minor effect on income distribution. Mechanization in this study was, however, limited only to the land preparation operation, and introduction of tractors in the study area is relatively new. As a consequence, even farmers using tractors still use much labor in land preparation because of the lower efficiency and low level of drivers' skill in using the tractor. Also, some farmers still use combinations of tractors and animal/manual techniques in land preparation. Observation of tractor user over the three seasons shows that farmers who use tractors continuously used less labor than those who used

tractor in the last two seasons. These farmers also used less labor than those who used the tractor only in the wet season. This finding indicates that when tractor use has been established, there is a possibility that sustained use will replace more labor than is measured in the current study. This would be most likely if mechanization is expanded in the form of transplanters, weeders, harvesters and threshers. Further introduction of tractors, therefore, must be preceded by a careful study about the demand for and supply of labor in land preparation. Such a study should cover a small unit area so that labor mobility within a subdistrict can be taken into consideration. Of course, there may be some areas where a labor shortage exists, but there are also some areas where labor surplus exists, even at peak times. Therefore, open labor market operation, by mobilizing the labor force from a surplus area, should first be examined to solve the labor shortage in deficit areas. At the same time, it may improve income distribution in rural areas. Mechanized land preparation should be the final solution when labor mobilization fails to solve the problem. The appropriate number of tractors introduced should be equivalent to the labor deficit to minimize the unemployment effect.

Table 1. Derivation of factors and earner shares.

1a. Rice production cost and return (Rp/ha)

Variable	Variable code	
A. Production cost		
1. Total current input	T_c	
2. Total labor	T_l	
a. family		S_l
b. hired		P_l
3. Total land rent	T_a	
a. owned-land		S_a
b. rental-land		P_a
4. Capital interest and rental paid	T_k	
a. owned capital		S_k
b. hired capital		P_k
5. Total costs	T	
6. Total paid-out costs	P	
B. Total output	O	
C. Gross value added	$V = O - Tc$	
D. Gross family factor Income (GFFI)	$Y = V - (P_l + P_a + P_k)$	
E. Residual	$R = O - T$	

Table 1b. Output and income shares (in %).

Variable	Output share	Value added share	Family income share
Factor shares			
1. Current input	T_c/O	-	-
2. Labor	T_e/O	T_e/V	S_l/Y
3. Land	T_a/O	T_a/V	S_a/Y
4. Capital	T_k/O	T_k/V	S_k/Y
5. Residual	R/O	R/V	R/T
Total	100	100	100
Earner shares			
1. Current input	T_c/O	-	
2. Hired labor	P_e/O	P_e/V	
3. Landlord	P_a/O	P_a/V	
4. Capital earner	P_k/O	P_k/V	
5. Operator	Y/O	Y/V	
	100	100	

Table 2. Labor use per hectare by activity and source of labor, wet season 1979-80, West Java (hrs/ha).

Activity	Mechanized			Non-mechanized		
	Family	Hired	Total	Family	Hired	Total
1. Land preparation[a]	19	172	191[b]	95	261	356
2. Transplanting[c]	5	196	201	17	196	213
3. Weeding	11	238	249	49	207	256
4. Fertilizer appl.	7	27	34	21	18	39
5. Pesticide appl.	9	23	32	22	19	41
Total pre-harvest	50	661	711	203	703	906
6. Harvesting	2	335	337	4	358	362
7. Drying	34	17	51	70	9	79
Total	86	1013	1099	277	1070	1347
(%)	(8)	(92)	(100)	(21)	(79)	(100)

[a] Including seedbed preparation.

[b] Including tractor driver hours.

[c] Including pulling seedling.

Table 3. Labor use per hectare by activity and source of labor, dry season, 1980, West Java (hrs/ha).

Activity	Mechanized			Non-mechanized		
	Family	Hired	Total	Family	Hired	Total
1. Land preparation[a]	13	166	179[b]	77	205	282
2. Transplanting[c]	4	188	192	19	188	207
3. Weeding	9	224	233	62	195	257
4. Fertilizer appl.	7	25	32	19	15	34
5. Pesticide appl.	6	22	28	11	12	33
Total pre-harvest	42	646	688	214	629	843
6. Harvesting	1	299	300	5	275	280
7. Drying	27	14	41	51	7	58
Total	70	959	1029	270	911	1181
(%)	(7)	(93)	(100)	(23)	(77)	(100)

[a] Including seedbed preparation.

[b] Including tractor driver hours.

[c] Including pulling seedling.

Table 4. Material input and yield per hectare by season, West Java.

	Wet season 1979-80		Dry season 1980	
	Mecha-nized	Non-mechanized	Mecha-nized	Non-mechanized
Seed (kg/ha)	30	30	30	30
Fertilizer (kg/ha)				
Urea	233	213	219	222
TSP	80	66	78	70
Total	313	279	297	292
Pesticides (Rp/ha)	4,013	5,028	4,861	5,057
Actual yield	4,915	4,702	3,512	3,057
Adjusted yield[a]	-	-	3,548	3,473

[a] Adjusted yield was estimated based on the crop loss reported by the farmers.

Table 5. Rice production costs and returns per hectare, West Java (Rp/ha).

Item	Code	Wet season 1979/80		Dry season 1980	
		Mechanized	Non-mechanized	Mechanized	Non-mechanized
A. Production cost					
1. Current input	Tc	33,815	32,482	32,832	32,455
2. Total labor cost	Tl	119,368	139,601	118,417	128,793
a. Family	Sl	7,353	26,413	6,963	25,010
b. Hired	Pl	112,015	113,188	111,454	103,783
3. Total land rent	Ta	104,174	106,489	106,533	108,146
a. Owned land	Sa	88,032	75,324	91,336	77,197
b. Hired	Pa	16,142	31,165	15,197	30,949
4. Capital	Tk	26,172	11,933	22,848	6,480
a. Owned	Sk	17,576	8,940	16,874	6,480
b. Hired	Pk	8,596	2,993	5,974	-
5. Total cost	T	283,529	290,505	280,630	275,874
6. Total paid-out cost	P	170,568	179,828	165,457	167,187
B. Total output	O	401,534	380,686	303,582	298,494
C. Gross value added	V	367,719	348,203	270,750	266,034
D. Gross family factor income	Y	230,966	200,857	138,125	131,307
E. Residual	R	118,005	90,180	22,952	22,620

Table 6. Output and income shares, wet season 1979-80, West Java (%).

Item	Output share		Value added share		Family income share	
	Mecha-nized	Non-mecha-nized	Mecha-nized	Non-mecha-nized	Mecha-nized	Non-mecha-nized
A. Factor shares:						
1. Current input	8.4	8.5	-	-	-	-
2. Labor	29.7	36.7	32.5	40.1	3.2	13.2
3. Land	25.9	28.0	28.3	30.6	38.1	37.5
4. Capital	6.5	3.1	7.1	3.5	7.6	4.4
5. Residual	29.5	23.7	32.1	25.8	51.1	44.9
Total	100	100	100	100	100	100
B. Earner shares:						
1. Current input	8.4	8.5	-	-		
2. Hired labor	27.9	29.7	30.5	32.5		
3. Landlord	4.0	8.2	4.4	9.0		
4. Hired capital	2.1	0.8	2.3	0.9		
5. Operator	57.6	52.8	62.8	57.7		
Total	100	100	100	100		

[a] Data rearranged from Table 4.

Table 7. Output and income shares, dry season 1980, West Java (%)[a].

Item	Output shares		Value added shares		Family income share	
	Mecha-nized	Non-mechanized	Mecha-nized	Non-mechanized	Mecha-nized	Non-mechanized
A. Factor shares						
1. Current input	10.8	10.9	-	-	-	-
2. Labor	39.0	43.1	43.8	48.8	5.0	19.0
3. Land	35.1	36.2	39.3	40.6	66.1	58.8
4. Capital	7.5	2.2	8.4	2.4	12.2	4.9
5. Residual	7.6	7.6	8.5	8.5	16.7	17.3
Total	100	100	100	100	100	100
B. Earner shares						
1. Current input	10.8	10.9	-	-		
2. Hired labor	36.7	34.8	41.2	39.0		
3. Landlord	5.0	10.4	5.6	11.6		
4. Hired capital	2.0	-	2.2	-		
5. Operator	45.5	43.9	51.0	49.4		
Total	100	100	100	100		

[a] Data rearranged from Table 4.