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The Mechanization of Rice Threshing in the Philippines

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ABSTRACT

Mechanized rice threshing has increased rapidly in the Philippines since 1975. The impact of mechanical innovations on small farmers and landless workers who derive a substantial portion of their income from this task is examined. The study indicates threshing machines are both privately and socially profitable. The machines produce a redistribution of income from laborers to machine owners and users.

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EFFICIENCY OR EQUITY:

THE MECHANIZATION OF RICE THRESHING IN THE PHILIPPINES

Concern with the rural poor, particularly landless laborers and small holders has focused attention on their situation and on developments which impact directly on their source of livelihood. In recent years, improvements in rice varieties, which increase yields and the value of the harvest share apportioned to farm labor, clearly had a positive impact on income. Expanded irrigation facilities, which increase cropping intensity and yields, also improve the welfare of the rural poor, assuming labor inputs remain constant or the real wage rises.

Certain innovations, such as herbicides, increase the productivity of labor without concomittantly raising cropping intensity or yields. These reduce the demand for labor. Others, such as irrigation pumps, increase both yields and cropping intensity and thereby increase labor demand. In recent years, the Philippines has witnessed the rapid adoption of machines for rice threshing. Traditionally, threshing is one of the most labor intensive activities and is normally carried out by hired laborers. The implications for labor utilization therefore require careful examination, particularly in circumstances when few non-farm employment opportunities are available to absorb displaced labor.

In this paper, we are concerned primarily with the following issues: 1) the pattern and growth in adoption of mechanical threshing; 2) the profitability of mechanical compared with

traditional threshing technology; 3) the impact of machines on employment and wage earnings particularly of the landless and; 4) the implications for future policies to develop and promote mechanical technologies which enhance labor productivity.

Historical Perspective

Mechanical threshing in the Philippines had its origins in the 1920s when stationary machines were imported for use on the large haciendas which characterized the land ownership pattern at that time. Use of the machines was seen primarily as a means of controlling collection of the landlord's share of the harvest. Tenants were obliged to have their crops threshed by the machines, at which time the division of yield was made. These threshers were large, heavy and suitable only for use when the fields were dry and firm: conditions typical of the single crop agriculture practiced at that time.

Following independence, use of the stationary threshers persisted, despite the fact that many users were now leaseholders or owner/operators. Landlords continued to employ the machines to consolidate the harvest on their own holdings and also rented them on a contract basis to others. Following land reform in the early 1970s, there was a reversion to traditional methods of manual threshing in many parts of the country and the number of larger machines decreased steadily. While smaller indigenous threshing machines were available, these did not find a ready market among Filipino farmers. It was not until 1975 when the International Rice Research Institute introduced the design for the axial flow thresher that mechanized threshing began to increase among small farmers. The IRRI design was the result of

nearly 5 years of research and development. It is a power efficient, low cost, high capacity machine that can move directly into the farmers fields thus reducing the need for repetitive handling and stacking of the crop (Figure 3). It also has the technical advantage over other machines of being able to thresh very high moisture grain -- up to 30% -- without appreciable loss in performance or capacity. This feature was particularly valuable in irrigated areas where double cropping was becoming available. In these areas, the first crop must normally be harvested during the rainy season (Khan 1983).

Following release of the first axial flow design in 1974, a second, smaller model was released in 1977. The newer model differed from the initial design in being lighter, less costly and having a lower output capacity (Figures 1 and 2). Both machines were rapidly adopted by farmers. Production of threshers increased steadily up to 1979. After this period sales stabilized presumably because of the increase in oil prices (Figure 4). The larger thresher found its greatest market in Central Luzon and Laguna provinces with most machines being employed on a contract basis. The smaller portable machines were widely produced and used in Iloilo province. In the latter case, the machines were acquired by small farmers and used largely on their own farms and the farms of their neighbors. In both cases the rate of return was high and repayment on the original investment was achieved rapidly (Juarez 1983). The extension and promotion of the designs was assisted by the Institute's Industrial Extension Program (Stickney 1983).

Total investment in the design and development of the machines from 1970 to 1978 was estimated at US$600,000. This represents

approximately two percent of the value of sales by firms cooperating with IRRI in the manufacture of the designs up to the end of 1982. The actual return to R&D is difficult to calculate directly because total sales include those by firms who have copied the design but are not cooperating with the Institute and also production by firms in other countries such as Thailand which are producing the machines in large numbers. To correctly assess the return, one should examine the benefits and the costs to the machine owners, users and the labor which was replaced by the technology. Using the rate of return on total sales tells us nothing about the impact on income distribution amongst those affected by introduction of the machines.

Private Profitability of Mechanized and Manual Rice Threshing

The previous section demonstrated the rapidity with which the axial flow thresher was adopted by rice farmers. In the first part of this section we demonstrate how use of the thresher increases the profitability of rice production. For illustrative purposes we use data from Laguna province, Philippines, an irrigated area characterized by highly successful adoption of new technology.

An important benefit of using the thresher is that it enables the farmer to recover a higher proportion of grains from the harvested stalks. Theoretically manual threshing could be equally thorough. In practice, however, laborers tend to terminate the threshing operation prematurely. Grains remaining on the stalks are then appropriated by gleaners, usually elderly relatives or children of laborers. Gleaning is highly lucrative and there are claims that particularly industrious

gleaners can end up with as much as 10% of the harvest (Goodell 1979). Looked at it from this point of view the thresher is a substitute for hiring additional labor supervisors (Smith 1983).

In addition to deliberate losses caused by laborers working without adequate supervision, the thresher has certain technical superiorities over manual threshing methods. Winnowing and cleaning is carried out by the axial flow thresher. This reduces losses caused by grains being blown away by the wind and lowers the proportion of impurities left behind. The effect of these factors have been meticulously measured in on-farm experiments comparing threshing and winnowing losses from manual and mechanized methods (Toquero 1983). Grain quality under the two techniques was also compared. The only significant differences were improvements in the existence of impurities and a slight increase in the percentage of fermented grains (Table 1).

Other claims have been made on behalf of the thresher. Rapid threshing is hypothesized to reduce turnaround time and thereby increase cropping intensity. Rapid completion of the operation, it is claimed, reduces the time during which the crop is left lying in the field subject to the vagaries of weather (Habito and Duff 1979). These factors could not be incorporated as adequate documentation was not available. Our analysis therefore should be regarded as a conservative estimate of the benefits of using a thresher.

The private profitability of threshing rice by manual and mechanized methods is presented in Table 2. The analysis assumes that pre-harvest input-output coefficients are identical for thresher users and non-users, i.e. with identical levels of preharvest inputs such as

fertilizer and labor, the two groups obtain identical yields at harvest. After threshing yields are adjusted for differences in recovery rates, impurities and fermented kernels, according to figures in Table 1. This gives thresher users a yield advantage of nearly half a ton per hectare (4.4 tons/ha for users vs. 3.9 for non-users). Input-output coefficients used in the analysis were taken from a survey of 100 Laguna farmers carried out in 1981. Prices of inputs and paddy were adjusted up to levels prevailing in October 1983 (i.e. just before the latest devaluation of the Philippine Peso from $1=₱11 to $1=₱14). The cost of threshing for non-users was computed from the rate prevailing in the area (1/8 of the threshed yield plus 1 can, roughly equivalent to kg 11, per paddy field). When threshing machines are used the harvester's share falls to 1/10 of the yield.

The cost of machine threshing was computed as the user cost of the axial flow thresher (Table 3). This imputes the cost of thresher services by taking into account both fixed costs, such as depreciation and interest, incurred because of investment in the purchase of the thresher, as well as variable costs such as fuel and labor services used in operating the machine.

The cost of the machine, ₱30,380, includes the body of the thresher which is locally manufactured and an imported 16 hp gasoline engine. Figures on depreciation were calculated on a straight line basis, assuming a 10% resale value after 5 years. Threshers were mainly purchased from personal savings. However, a real interest rate of 6% (calculated as the prime rate deflated by the inflation rate in 1982) was applied to the purchase price to represent the cost of capital tied up in the machine. Of the variable costs of thresher

use, labor is the most important component accounting for 46% of the total user cost. Fuel and repairs take up another 14 and 11% respectively. The total user cost of axial flow threshers was calculated to be ₱720/ha. This is somewhat lower than the custom rate for hiring threshers, which, at 1/9 of the threshed yield, works out to ₱840/ha.

From the farmer's point of view threshers are more profitable than manual methods (Table 2). The cost of the harvesting and threshing operation is actually about ₱300/ha higher under the mechanized method. This is however offset by higher yields, due to the advantages cited in Table 1, giving profits of ₱1989/ha which is 30% higher than profits made when manual methods of threshing are used. With mechanized threshing, the cost of producing a ton of paddy falls from ₱1316 to ₱1253. Farmers who rent threshers make slightly lower profits (₱1869). However, these values are still 22% higher than profits with manual threshing (Table 4). As pointed out before, these cost and profit differences probably underestimate the thresher's advantages over manual methods. However, they do help to explain the rapid adoption of axial flow threshing in the area.

Employment Effects of Threshers

In developing countries, an important policy objective is the generation of sufficient agricultural employment to absorb the growing number of people living in rural areas. Rapid adoption of the threshing machine could critically affect employment opportunities for several reasons. Threshing is one of the most labor intensive operations. Furthermore, it is usually carried out by hired laborers

who belong to the poorest segment of rural society -- landless, and marginal farm households. Payment for threshing has traditionally been in the form of harvest shares. This enabled landless laborers to participate to some extent in yield increases accompanying the diffusion of new rice technology. The adoption of threshing machines could therefore seriously reduce employment and earnings of landless laborers. On the other hand, theoretically, threshers could have a positive effect on employment by reducing turnaround time and thereby increasing cropping intensity. Unfortunately very few researchers have documented this effect. From the limited evidence available, Herdt (1981) concludes that threshers have little impact on intensity, timeliness or turnaround time. The analysis in this section therefore ignores the possible employment generation effect of these factors while recognizing that further research in this area is required.

Manual harvesting and threshing requires 30 labor days/ha. The axial flow thresher carries out threshing and winnowing and although about 4 labor days/ha are required for operating the machine, total labor requirements fall to 20 days/ha, which is a decline of 33% (Toquero 1983).

These figures are supported by results of a survey in Nueva Ecija, Philippines, in which post production labor on mechanized farms were 25% lower than on farms in which the paddy was manually threshed (Table 5). Broken down into family and hired labor the data revealed that family labor was marginally higher on mechanized farms. Hired labor, which comes mainly from landless households, declined by 31%. This is consistent with results of multivariate regression analysis which revealed that mechanization was the most important factor

accounting for between farm differences in the use of post production labor. Output had a positive impact on labor use. Its effect, however, was small compared to the effect of mechanization (Sison et al 1983).

The data indicate that the immediate effect of threshers is a decline in employment. Threshers however, also have an output increasing effect which, over time, could induce higher levels of labor absorption. This is consistent with time series data from a sample of farms in Laguna.

Up to 1975, threshing in the area was entirely manual. By 1981, 82% of the farmers had switched to the axial flow thresher. Labor use for harvesting and threshing declined by 19% after the introduction of threshers. By 1981, however, labor use had increased to pre machanized levels (Table 6). Yields increased by 35% between 1975 and 1981 and it is possible that this increased labor requirements for harvesting. It is likely that both threshers and improved crop production practices were responsible for the increase in yields. Whatever the cause, it would appear that the yield increasing impact of technology had mitigated the labor displacing effect of threshers. Laguna province, however, has been exceptionally successful in the adoption of new technology. In other areas of the Philippines, therefore, we would expect a much larger decline in agricultural employment following the adoption of mechanized threshing.

This is consistent with economy wide estimates of the employment impact of threshers (Table 7). Ahammed and Herdt (1981) used a general equilibrium model with an input output core to estimate the nationwide employment implications of increasing rice production by

alternative methods of cultivation. If manual threshing were used to increase rice production by 1%, employment in the agricultural sector would increase by 16,000. The employment effect would be 22% lower (12,400) if portable threshers were used.

Ahammed and Herdt then go on to estimate the impact of the alternative threshing methods on non-agricultural employment, by taking account of backward and forward linkages. Domestically produced threshers would generate employment in the manufacturing sector. Increased rice output would have a positive effect on employment via consumption linkages. Taking all sectors into consideration, substitution of manual by mechanized threshing would reduce the employment generating potential of increased rice production by about 7% (Table 7).

Although Ahammed and Herdt point out that ignoring non-agricultural sectors might result in over estimation of the labor displacing effect of machines, it is important to bear in mind that the poorest segment of society lives in the rural areas.

Wages and Labor Earnings

The consequences of mechanization depend on relative endowments of capital and labor in the economy (Binswanger 1982).

In a labor surplus country, mechanization would be expected to exert downward pressure on the wage rate. In the Philippines, the agricultural labor force has been growing at about 1% per annum (David 1983). This has been accompanied by a decline in real agricultural wages which are now lower than in the mid 60s (Figure 5). This would indicate that employment opportunities in the agricultural sector have

been lagging behind growth in the labor force. Adoption of labor saving devices such as threshers would therefore be expected to further reduce the agricultural wage rate.

It might be argued that seasonality in agricultural wages cannot be ignored. Labor shortages at harvest time might co-exist with a labor surplus during the rest of the year. Inspection of the data on harvesting and threshing wages in Laguna shows that real wages increased prior to the introduction of the thresher, i.e. up to 1975, labor demand at harvest time was increasing more rapidly than supply. The widespread adoption of mechanized threshing since 1978 was accompanied, however, by a steady decline in real wages which in 1981 were in fact below the level prevailing in 1965 (Table 8). This indicates that since the introduction of threshers, employment opportunities, even at harvest time, have been unable to absorb additions to the labor force.

A survey of landless laborers was carried out in a thresher using area of Nueva Ecija. This revealed certain non-monetary benefits of threshers. Mechanized threshing considerably reduces the ardousness of post production operations. The lighter nature of the work also makes it possible for women and children to participate in post production activities. A majority of laborers stated however that labor was in excess supply during harvest time. Most expressed fears of a future decline in the harvest share paid to laborers (Ebron et al 1983).

While the evidence therefore seems to indicate a fall in real post production wages, this decline cannot be attributed to threshers

alone. Real wages have fallen in other agricultural operations as well (Table 8). Wages of unskilled laborers are declining in the industrial sector (Lal 1979). While the labor saving nature of mechanized threshing has undoubtedly contributed to the trend further analysis is necessary to isolate the effect of other changes which may have been occuring simultaneously.

Table 9 presents a breakdown of the total value of rice produced into the income shares going to each factor of production. This depicts the immediate effect on earnings and income distribution of a shift to the axial flow thresher. Compared to manual threshing, labor earnings fall by 13%, from ₱2346 to ₱2047. Earnings of gleaners are included in the computation for thresher non-users. Earnings of thresher operators are included in the figure for thresher users. Since thresher operators are relatively skilled, and therefore command higher wages, a more valid comparison might be between the earnings of unskilled workers. These fall by 27% when threshers are used. The implications could be serious as micro level data from Laguna and Iloilo show that harvest shares account for around 60% of the total income of landless agricultural laborers (Herdt 1981). Unskilled labor's share of the total value of rice production falls from 33 to 23%. Accompanying this is an increase in capital's share from 10 to 16%. Operator's profits also increase from 22 to 25%. This implies a deterioration in income distribution as capital owners, and farm operators, are generally substantially better off than unskilled laborers.

In the long run, the adverse distributional effects of thresher adoption would be mitigated to some extent. The greater profitability of threshers would, depending on the elasticity of demand for rice, induce increases in production. This would increase earnings in the agricultural sector. Urban and rural consumers would benefit because of falling rice prices, the degree of benefit being a function of the proportion of income they spend on rice (Hayami and Herdt 1977). As the poorest sectors tend to consume most rice, this would mitigate to some extent the adverse income distribution effects of a transfer of income from laborers to capital owners.

The thresher therefore seems to be a prime example of the classic conflict between the dual policy objectives of efficiency and equity. It is profitable and lowers the cost of rice production from the farmer's point of view. On the other hand, it pulls down wages and earnings of agricultural laborers, worsens income distribution and widens the disparity among the different sectors of rural society. Further work quantifying more precisely the magnitude of these opposing effects is necessary. This will enable policy makers to make better informed decisions on the desirability of government intervention in support of mechanization.

The Effect of Government Intervention on the Mechanization Decision

Earlier we showed that given the existing price structure in the economy, the thresher is more profitable than manual threshing. It is often argued that government policies artificially lower the price of

capital and therefore encourage mechanization (David 1983). In this section, we investigate whether the thresher would remain profitable if government intervention did not exist; i.e. if prices in the economy were allowed to reflect their true values or opportunity costs. The analytical technique we use calculates the domestic resource cost (DRC) of producing rice by the alternative threshing systems (Page and Stryker 1979). The DRC computes the value of domestic resources required to save or earn 1 unit of foreign exchange. As long as the DRC of an activity is lower than the shadow exchange rate, the country has a comparative advantage in the activity. When comparing DRCs between activities, the lower the DRC the more efficient is the activity in saving or earning foreign exchange and therefore in balancing the budget.

In the absence of government intervention, domestic prices of tradeable inputs would be equal to their world prices. We use the concept of the implicit tariff to measure the extent of divergence between the two sets of prices. The implicit tariff is calculated as

$$T = \frac{P_d}{P_b} - 1$$

(David 1983)

where T = implicit tariff

P_d = domestic price of the input

P_b = border price of the input.

A positive T implies that government policies tax or increase the cost of the input. A negative T represents a government subsidy on the input.

Implicit tariffs on the user cost of threshing are given in Table 10. The rate of depreciation is a technical characteristic of the machine over which the government has no control. Government policies can however affect the price of the thresher and therefore the value of depreciation. In the case of an imported machine domestic prices diverge from world prices because of tariffs and taxes. The axial flow thresher is domestically produced but incorporates an imported engine. In the last few years domestic manufacturers have been exporting a few units of these threshers to countries such as Brunei, Burma, Peru, Egypt, Cameroon and Malaysia. Since the numbers are still very small, it is doubtful whether these can be regarded as commercial exports.

The correct procedure in this case would be to treat the thresher as a non-tradable good and move one step backwards in the input output chain to break down the intermediate goods used in production into imported and domestic components. As the number of components is extremely large this would involve adopting arbitrary rules of thumb.

It was felt that a more valid procedure would be to treat the thresher as an exportable item, particularly as recent devaluations of the peso would be expected to stimulate exports.

Export prices charged by manufacturers are about 15% higher than domestic prices. It is possible that this difference represents monopoly profits which might not be sustainable as the number of manufacturers increases. As a conservative estimate it was decided therefore to value exports at the domestic price. Since export taxes are not levied, this gives an implicit tariff equal to zero.

Government policy can lower the cost of purchasing threshers by providing credit at subsidized rates. IBRD funded credit programs have been extended to include rice threshers since 1977. Most of the funds have, however, been used to purchase tractors and power tillers (Agabin 1983). This is confirmed by micro level data from Iloilo and Laguna which shows that most purchases of threshers were self financed (Juarez 1983). The impact of these programs on the cost of purchasing threshers has therefore been small.

Government policy has however, subsidized the user cost of threshers by maintaining interest rates at levels which do not represent the returns which capital could earn in alternative uses. In 1982, for instance, the real interest rate, when adjusted for inflation was only 6%. On the other hand, the National Economic Development Authority (NEDA) estimates that the real shadow interest rate is 15%. This gives an implicit tariff of -60% on the user cost of threshers and represents a government subsidy to the use of machinery. Fuel on the other hand is heavily taxed by the government, implicit tariffs being particularly high on gasoline which has a higher imported component than oil and grease (Appendix Table 1). The weighted average on the implicit tariff for fuels is 83%. The analysis assumes that government policy has no effect on the wage rate. While minimum wage laws exist, they are more applicable to plantation crops like sugar. In the case of rice which is mostly produced by small farmers, it is probably valid to assume that the market wage rate represents the shadow price of labor (David 1983).

Weighting each component of the user cost of threshers by its implicit tariff shows that the total effect of government policy is a

small implicit tariff of 7% on the cost of threshers. Although implicit tariffs on fuel are high, fuel consists of only 14% of the user cost of threshers. Its effect is therefore offset to a large extent by the subsidy on interest rates.

So far we have ignored the effect of overvalued exchange rates. If exchange rates are maintained at levels which are higher than their true value, the cost of imports is artificially low. This effect is captured by the net implicit tariff in which border prices are converted into local currency at a shadow exchange rate. The analysis in Table 10 assumes that the peso is over valued by 32% (Medalla and Power 1979). The net implicit tariff on depreciation is -24%, i.e. government policy, including the effect of over valuation subsidizes the cost of the thresher. When overvaluation is considered, the 'tax' on fuels falls to 37%, giving an overall net implicit tariff of -7%. This indicates that when all components of government policy are taken into consideration, thresher use is subsidized by about 7%.

Since threshers have a yield increasing effect, government policy could also affect the relative profitability of threshers via the price of rice.

The average ratio of domestic and world prices from 1979-1982 is 1.09 (Unnevehr and Balisacan 1983). This marginally favors the relative profitability of mechanized threshing.

The DRCs of rice production under the alternative threshing methods is given in Table 11. DRCs are calculated as follows:

$$DRC = \frac{\text{Domestic costs in shadow prices/unit of output}}{\text{Border price of output - foreign cost/unit of output in border prices}}$$

(Page and Stryker 1979)

For both threshing methods the DRCs are lower than the shadow exchange rate of $1=₱14.5. This indicates that both activities are socially profitable, i.e. they remain profitable even after the effect of government intervention is removed. The DRC of rice with mechanized threshing (11.65) is 7% lower than the figure for manual threshing (12.5). This implies that rice production with mechanized threshing is a slightly more efficient way of saving foreign exchange and balancing the budget. Mechanized threshing is therefore more efficient both from the farmers' and the government's point of view.

Intervention by International Research Institutes

Although threshing machines of various sorts had been available for some years in the Philippines mechanical threshing became widespread only after the release in 1975 of the axial flow thresher designed by the International Rice Research Institute (IRRI). Indigenous threshers were heavy and inefficient in the use of power. Imported Japanese threshers were not suited to Philippine conditions. Difficulties were encountered in threshing wet paddy. Also the machines were designed for Japonica type grains which separate from the stalk more easily than the Indica type varieties grown in South and South East Asia. The axial flow thresher was tailored to both physical and economic conditions prevailing in South East Asia. Its

rapid and enthusiastic adoption by farmers is therefore not surprising.

IRRI's provision of 'free innovation' lowers the price of machinery relative to labor (Jayasuriya and Shand 1983). If private manufacturers had shouldered the development costs, these would undoubtedly have been passed on to the consumer in the form of higher market prices for threshers. This would have reduced or even eliminated its competitive edge over manual threshing. Given the country's tariff structure, it is in any case highly unlikely that private manufacturers would have been willing to invest resources in developing the thresher. Even after the latest tariff reforms the effective protection rate (EPR) on agricultural machinery (13.7%) is low relative to EPRs on motor vehicles (27%) and consumer goods (43%) (Bautista 1981). This diverts scarce capital resources away from machinery development towards import substitution in consumer goods and automobiles.

This effect is reinforced by poor enforcement of patents in the country. In addition the design, though costly to develop, is in fact extremely simple and therefore easy to copy. This makes it difficult for private entrepreneurs to capture the gains from innovation.

At a time when the labor absorptive performance of the domestic manufacturing sector has been disappointing and labor demand from the Middle East is approaching the saturation point should IRRI be developing machineries which reduce labor demand in the agricultural sector? We believe this question cannot be answered until the efficiency and equity effects of threshers have been more accurately quantified. Furthermore, IRRI's machinery development program

is oriented globally: towards rice growing areas in general and not towards conditions prevailing in particular countries. Even within South East Asia, socio economic conditions can vary markedly from country to country. In Thailand where the percentage of landless households is negligible, the efficiency/equity conflict would be far less serious as the labor displaced would be coming from farming households which at the same time would be benefiting from the greater efficiency of mechanized threshing.

Under a laissez faire policy, the theory of induced innovation predicts that machinery development will occur, without government intervention, when relative factor price ratios are sufficiently favourable to capital (Binswanger and Ruttan 1978). Under these conditions few equity problems arise. Overall our viewpoint is that government support of machinery development and purchase is rarely warranted. If timely innovation is impeded by distortions in the incentive structure, a gradual dismantling of these distortions would be more effective than further interventionist policies in support of agricultural machinery.

Conclusions

Since the introduction of the IRRI designed axial flow thresher, mechanized threshing has spread rapidly in many parts of the Philippines. Threshers not only substitute capital for labor, they can also increase output by just under half a ton/ha because of a superior recovery rate. As a result, net revenues can be 30% higher when mechanized methods of threshing are used. In the Philippines, government policy lowers the user cost of threshers by about 7%

because of artificially low interest rates and overvalued exchange rates. The premium of domestic rice prices over world prices also marginally favours the profitability of threshers relative to manual methods. Threshers however, remain slightly more profitable than manual threshing even when the effect of government intervention is removed. Threshers therefore are more efficient from both the farmers and the government's point of view.

Preliminary evidence seems to indicate however, that threshers reduce labor requirements, depress real wages and worsen income distribution in the agricultural sector. Thus the classic efficiency-equity dilemma arises. More careful quantification of these effects is necessary before conclusive statements can be made. In particular, the cropping intensity and timeliness effects of threshers require further investigation. However, it is probably valid to state that equity efficiency conflicts will be most serious where the proportion of landless and marginal households, and their dependence on agricultural earnings, is highest. Projections show that in most South and South East Asian countries, the agricultural labor force will grow at 1 to 1.8% per annum over the next 20 years (Herdt 1981). If increases in labor demand induced by yield or acreage expansion fall short of these levels the introduction of labor saving devices like the thresher will tend to depress real wages.

Government support of machinery development and purchase is rarely necessary. In the absence of distortions in the incentive structure machinery development would be carried out by the private sector once wages were sufficiently high relative to the price of

capital. Under these conditions efficiency-equity conflicts would be rare. The most effective policy governments could follow would be the gradual dismantling of distortions which impede induced innovation.

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Table 1. Differences in recovery rate and grain quality: axial flow thresher vs. manual threshing: Central Luzon and Bicol, 1975-1977.

	Axial flow thresher	Manual threshing & winnowing
	kg/ha	
Threshing losses	626	856
Winnowing losses	640	849
Losses due to impurities	184	248
Losses due to fermentation	92	56
Total losses	1542	2009

Source: Adapted from Toquero (1983).

Table 2. Private profitability of rice production: thresher owners vs. non-users, Laguna, Philippines, 1983.

	Thresher owners	Non-users
Fertilizer	503	503
Pre-harvest labor	955	955
Tractor hire	669	669
Land rent	1288	1288
Irrigation	79	79
Other Cash Inputs (including interest)[a]	598	598
Harvesting	756 [b]	1144 [d]
Threshing	720 [c]	
Total cost/ha	5568	5236
Gross revenue[e]	7557	6763
Net revenue	1989	1527
Cost/ton	1253	1316
	tons/ha	
Yield	4.445	3.978

Source: Input-output coefficients from Herdt (forthcoming).

[a]Interest = 7% per season

[b]1/10 of yield

[c]User cost of threshers (see Table 3)

[d]1/8 of yield plus kg 11 per paddy field at 16 paddy fields/ha

[e]

Table 3. User cost of axial flow thresher at market prices (₱/ha), Laguna 1983.

	₱
Purchase price (thresher body plus 16 hp engine)	30,380
User cost/ha[a]	
Depreciation[b]	155.81
Interest on investment[c]	51.94
Gasoline[d]	93.80
Oil[e]	5.40
Grease[f]	0.53
Labor[g]	332.49
Repair and maintenance	80.00
Total	719.97

[a]Average annual use 156 tons/year. Yield/ha = 4.4 tons.

[b]Straight line depreciation with resale value = 10% of purchase price after 5 years.

[c]Real interest rate = Prime rate deflated by inflation rate (1982) = 6% of purchase price p.a.

[d]Gasoline consumption 3.83 litres/ton at ₱5.51/litre.

[e]Oil consumption 0.09 litres/ton at ₱13.5/litre.

[f]Grease consumption 0.008 lbs/ton at ₱15/lb.

[g]4.4% of yield.

Source of fuel consumption and average annual use: Juarez 1982.

Table 4. Private profitability of rice production: thresher renters, vs. non-users.

	Thresher users	Non-users
	₱/ha	
Costs excluding harvesting and threshing	4092	4092
Harvesting	756[a]	1144[c]
Threshing	840[b]	
Total cost/ha	5688	5236
Gross revenue[d]	7557	6763
Net revenue	1869	1527
Cost/ton	1280	1316
	tons/ha	
Yield	4.445	3.978

[a]1/10 of yield

[b]1/9 of yield

[c]1/8 of yield plus kg 11 per paddy field at 16 paddy fields/ha

[d]Paddy price = ₱.7/kg.

Table 5. Hired and family labor utilization in post production activities: Nueva Ecija, Philippines, 1979-1980.

	Hired labor	Family labor (labor hours/ha)	Total
Manual threshing	232	18	250
Mechanized threshing	161	23	184
Labor displaced	71	-5	66
% displaced	31	-3	26

Source: Adapted from Sison et.al. 1983.

Table 6. Thresher adoption and labor use: Laguna province, 1965-1981.

	1965	1970	1975	1978	1981
% farmers using threshers	0	0	0	67	82
Harvesting & threshing labor (days/ha)	30	32	32	26	31
Yield (tons/ha)	2.2	3.1	3.4	3.7	4.6

Source: Kikuchi et.al. (1982).

Table 7. Employment implications of a 1% increase in rice production.

	Direct increase (agricultural sector)	Indirect increase (non-agricultural sectors)	Total increase
	----------thousands----------		
Manual threshing	15.9	27.1	43
Portable thresher	12.4	27.6	40
% difference	22	2	7

Source: Adapted from Ahammed and Herdt (1981).

Table 8. Agricultural wages: Laguna, 1965-198..

	1965	1970	1975	1978	1981
Harvesting & threshing					
Nominal wage (₱/day)	4.19	5.89	17.41	18.31	19.55
Real wage[a] (₱/day)	4.19	4.50	5.86	4.75	3.30
Index of real wage	100	101	140	113	79
Transplanting					
Index of real wage	100	121	104	83	85

[a]Deflated by CPI outside Manila.

Source: Herdt (forthcoming)

Table 9. Factor shares: Laguna 1983: thresher renters vs. non-users.

	Thresher renters		Non-users	
	₱	%	₱	%
Land owner	1,288	17	1,288	18
Labor	2,047	27	2,346	33
Unskilled[b]	1,711	23	2,346	33
Skilled[c]	336	4	0	0
Capital	1,173	16	669	10
Current inputs	1,180	15	1,180	17
Operator's residual	1,869	25	1,527	22
Value of production	7,557	100[d]	7,010	100

[a]Including gleaners (₱247/ha): Source Toquero (unpublished data).

[b]Excluding thresher operators.

[c]Thresher operators.

[d]Including gleaners' earnings.

Table 10. Implicit tariffs on user cost of threshers: Laguna, Philippines 1983.

	Implicit tariff (%)	Net[a] implicit tariff (%)	% of total cost
Depreciation[b]	0	-24	22
Interest[c]	-60	-60	7
Fuel (gasoline, oil and grease)[d]	83	37	14
Repair and maintenance[e]	0	-24	11
Labor	0	0	46
Total user cost	7	-7	100

[a]Assuming 32% over valuation of exchange rate: Medalla and Power 1979.

[b]Foreign component = engine plus 30% of thresher body.

[c]Assuming real shadow interest rate of 15% p.a.

[d]Weighted average of gasoline, oil and grease. Derivation in Appendix Table 1.

[e]Assuming same breakdown as thresher.

Table 11. Domestic resource cost of rice production: mechanized vs. manual threshing, Laguna, 1983.

	Thresher owners	Non-users
Domestic cost/ton (₱)[a]	1,345.13	1,450.93
Foreign cost/ton ($)[a]	26.32	25.8
DRC	11.65	12.5
% difference	7	

[a]Allocation of social costs into domestic and foreign components in Appendix Table 2.

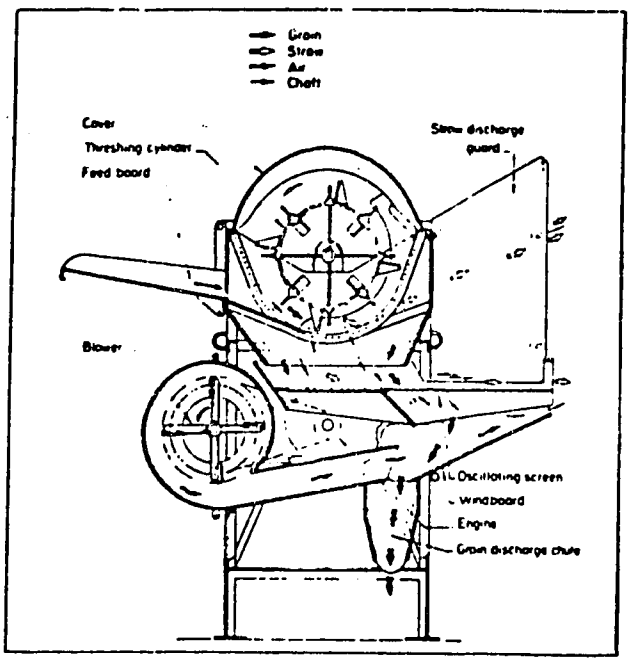
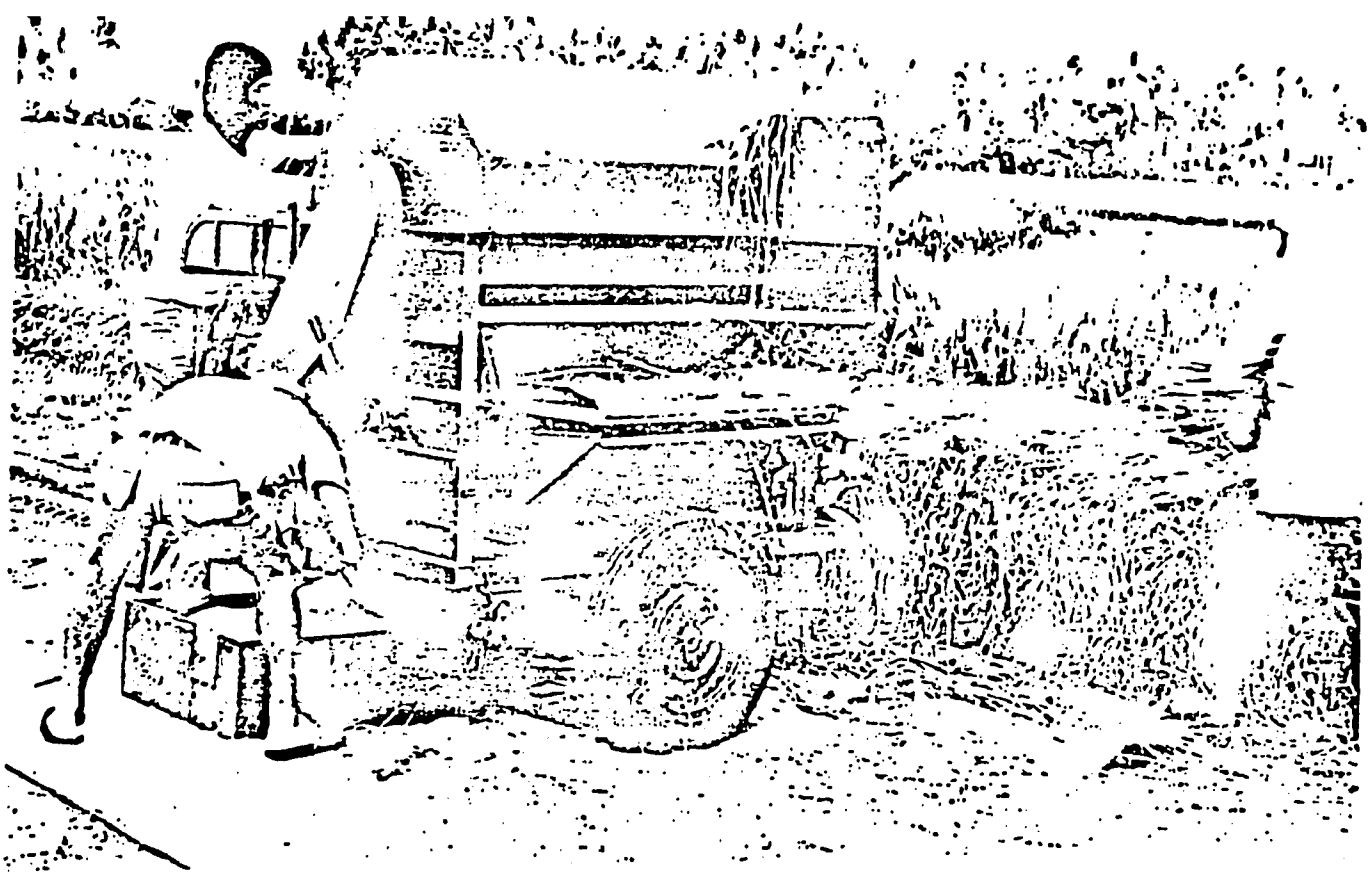


Fig. 1. Schematic of Portable Thresher

Fig. 2. Portable thresher being transpc



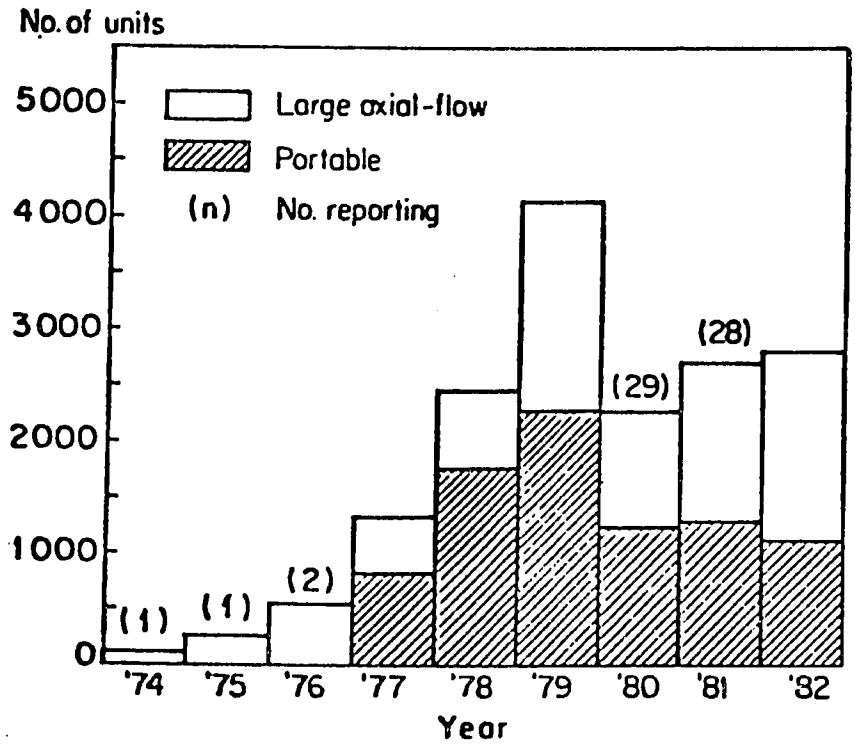


Fig. 4. Production of IRRI designed mechanical threshers in the Philippines by cooperating manufacturers, 1974-'82.

Source: Juarez, 1983.

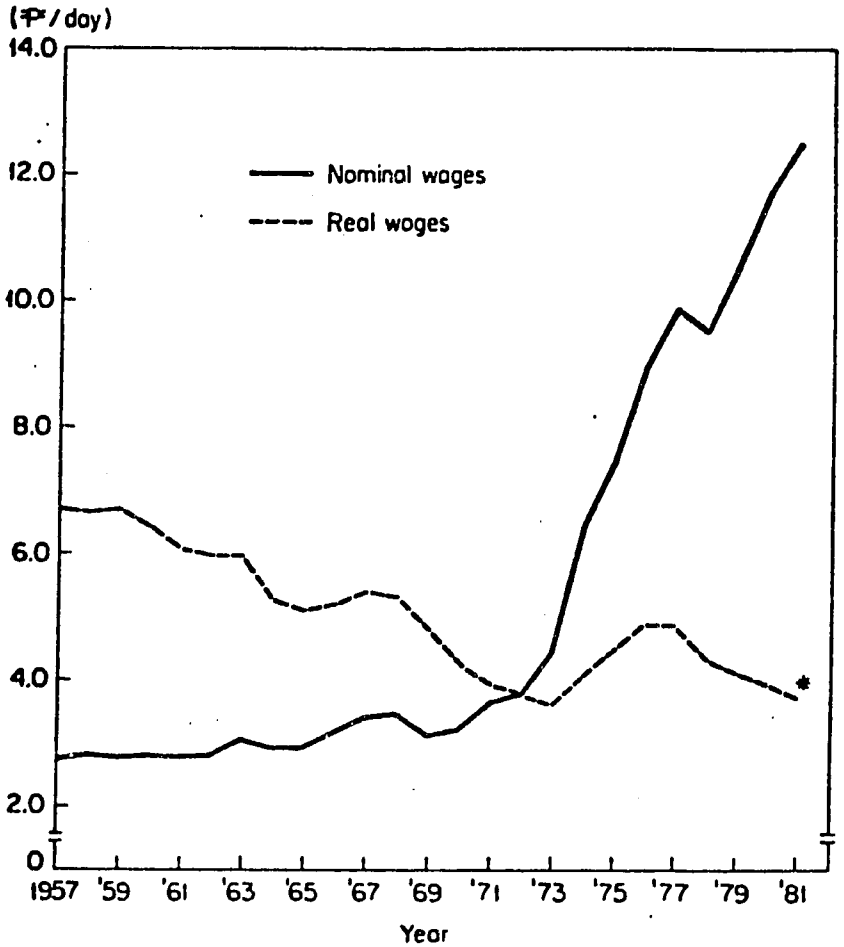


Fig. 5. Trends in nominal and real wages in Philippine Agriculture, 1957-1981.

* Deflated by consumer price index outside Manila, 1972 = 100.
Source of data. Bureau of Agricultural Economics and NCSO.
CPI = 1972 = 100

Source: C.C. David, 1983.

Appendix Table 1. Shadow prices and implicit tariffs on gasoline and oil: Laguna, 1983.

	Foreign component	Domestic component	Taxes and duties	Shadow price	Domestic price	Implicit tariff
	₱/liter[a]					%
Regular gasoline	2.19	0.78	2.54	2.97	5.51	86
Oil	6.27	4.53	2.70	10.8	13.5	25

[a]Foreign component converted at $1=₱11.

Source: Pilipinas Shell Petroleum Corporation, Manila

Appendix Table 2. Allocation of social costs of rice production into domestic and foreign components: Laguna[a], 1983.

	Domestic component	Foreign component	Total
Land preparation	294.85	390.14	685
Irrigation	378	186	564
Fertilizer	51.67	345.79	397.46
Preharvest labor	751	0	751
Land rent	2,608	0	2,608
Other cash inputs (including interest)	544.28	207.22	751.5
Total (excluding harvesting and threshing)	4,627.8	1,129.15	5,756.95
Manual harvesting & threshing	1,144		
Thresher users			
Harvesting	756		
Threshing[b]	595.29	158.17	753.46

[a]For all inputs except harvesting, threshing and fertilizer, implicit tariffs and percentage allocation into domestic and foreign components were taken from Unnevehr and Balisacan 1983.
Implicit tariff on fertilizer = 50%
(average of 1982 and first half of 1983).

[b]User cost of threshers at social prices: Appendix Table 3.

Appendix Table 3. User cost of axial flow thresher at shadow prices: Laguna, 1983.

	Domestic component	Foreign component	Total
	(t/ha)		
Depreciation	77.44	78.37	155.81
Interest on investment	129.85	0	129.85
Gasoline	13.28	37.28	50.56
Oil and grease	1.99	2.76	4.75
Labor	332.49	0	332.49
Repair and maintenance	40.24	39.76	80.00
Total	595.29	158.17	753.46