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THE CONSEQUENCES OF SMALL RICE FARM MECHANIZATION PROJECT

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A COMPARATIVE ANALYSIS OF THRESHER ADOPTION AND USE IN THAILAND AND THE PHILIPPINES

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ABSTRACT

This paper provides a cross country comparison of thresher adoption and use in Thailand and Philippines. It attempts to trace the history of thresher adoption and diffusion, determine the factors affecting adoption, and measure the private costs and benefits. It is found that factors like irrigation, high yielding rice varieties, farm size and credit facilities affect adoption. However, it is the net positive benefits that induces rapid adoption. Past and future investments were analyzed and it is found that benefits are generally positive for owners and users.

INTRODUCTION

Rice threshing in Thailand and Philippines has traditionally been carried out by methods such as animal treading, tractor treading, foot treading and hand beating. Recently, mechanical rice threshers have replaced the older methods, and have become an important component in the rice production systems of both countries. Along with the increasing use of other modern inputs such as the high yielding rice varieties, fertilizers and chemicals, irrigation, and tractors, rice threshers have significantly contributed to the shift from subsistence to commercial rice production. Portable and large axial flow threshers were introduced to the Philippines in 1974-75[1/] and to Thailand in 1975. To date a total of approximately 8,700 and 4,300 units have been produced and sold in the Philippines and Thailand, respectively. These two countries are the biggest users of the IRRI thresher in Asia (Fig. 1).

The purpose in this study is to determine how and why these machines were adopted, and to estimate the private benefits and costs of ownership. The results reported here provides some of the basic information which would be required later for social benefit-cost analysis.

REVIEW OF LITERATURE

Several studies in the past (e.g. Stout; 1966) have shown the importance of choosing the most suitable and efficient threshing method.

Locational is another factor affecting the choice of threshing method. Suitable gathering and placement of the unthreshed rice at a particular point in the field helps decrease the work load considerably. Chancellor (1963) has shown the overall rate of threshing to be highly affected by the gathering and the transporting operations.

Toquero, Maranan, Ebron and Duff (1976) revealed in their study how improvement in technology could help decrease production losses,

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1/ Large McCormick type mechanical threshers (driven by a 4-wheel tractor) were used in the country prior this period but the farmer often had to wait for months before palay could be threshed. Their use became limited when double cropping came into practice.

since grain loss is increased with time between harvesting and threshing.

Although mechanization has been accepted as a possible major factor in the improvement of farming efficiency, there are many constraints hindering the adoption of machines for harvesting and threshing. Khan (1971) pointed out that some farmers were reluctant to accept modern methods because of their poor mechanical aptitud and/or inability to raise capital to finance the purchase of a machine. Rasanond et. al. (1977) found that acceptance of the IRRI axial flow thresher was largely due to it being cheaper than other threshing methods. In addition, in areas where double cropping was widely practiced, the shorter time period available for threshing and the scarcity of labor were major factors encouraging the adoption of modern threshing methods. Sison, Sarmiento and Dacumos (1977) have attempted to measure the costs, benefits and return on investment of different rice threshers in different areas of the Philippines. The current study provides a cross-country comparison.

OBJECTIVES AND HYPOTHESES

The objectives are: 1) to trace the history of thresher adoption and diffusion; 2) to determine the factors affecting adoption and use; and 3) to determine the private benefits and costs of ownership and use. The hypothesis is that although the package of modern technology, cropping intensity, manufacturers, credit facilities and other factors affect thresher adoption, it is the positive net benefit from this investment that induces rapid adoption. However, before any firm policy implications can be drawn a social benefit analysis would be required. Research on this aspect is under way.

SCOPE AND RESEARCH DESIGN

This study provides a cross country comparison between Thailand and the Philippines. The study areas covered 5 villages in Chachoengsao and 3 in Supanburi, Thailand (Figure 2); 6 villages in Laguna and another 6 in Iloilo, Philippines (Fig. 3). These four provinces were chosen because of their high thresher utilization and high concentration of rice thresher producers. They are also predominantly rice areas, mostly with good irrigation and have widely adopted high yielding rice varieties. An exception is 3 of the villages in Iloilo which are rainfed and were purposely included for comparison with the irrigated ones. Land preparation in the survey areas is mostly mechanized.

A total of 268 respondents were interviewed in Thailand and 101 respondents in the Philippines. These were classified into three groups and randomly selected from the list provided for each village. The groups were: 1) thresher owners, 2) thresher non-owner users (or thresher renters), and 3) thresher non-users (or those who employ only traditional methods of threshing). The sample size for each group is presented in Table 1. Interviews were conducted in 1978-79.

ANALYTICAL METHODOLOGY

The methodology for estimating private costs and benefits between traditional and mechanical threshing methods in Thailand and the Philippines was as follows. The annual cash flows, defined as the difference between gross benefit from the investment and all input costs-such as fuel, labor and operating materials - were obtained for each method. The net present value (NPV) for each of these investments was then estimated using various discount rates.

The formula used for the NPV (Branson; 1975) is:

$$NPV = -C + \frac{R_1}{(1+i)} + \frac{R_2}{(1+i)^2} + \frac{R_3}{(1+i)^3} + \cdot\cdot \frac{R_n}{(1+i)^n} + \frac{S_n}{(1+i)^n} \qquad (1)$$

where:

C = the investment cost of the thresher, power engine attachment and other complements;

$R_1 \ldots R_n$ = the stream of net income in periods 1, 2, . . .,n respectively;

S_n = the resale value; and

i = the discount rate.

Analyses were made on a) investments based on different past periods and b) future investments which may be in the decision making stage. In Thailand, thresher investments covered the periods 1975-78 while in the Philippines from 1974-78. For easy understanding and comparison, all values were converted to US dollars using the official exchange rates for the different investment periods.

Benefits were assessed as: 1) gains from ownership and/or rental, and 2) gains from utilization.

The formula used for gains from ownership and/or rental is:

$$R_t = NRF_t + NROF_t - MA_t + LS_t \qquad (2)$$

where:

R_t = the total income from a thresher investment including both on-farm and off-farm uses in period t

NRF = the net income obtained from on-farm use of a rice thresher in period t

$NROF_t$ = the net income obtained from hiring out a thresher in period t

MA_t = the repair and maintenance expenses for period t

LS_t = the benefit in terms of loss incurred comparing between traditional and mechanical methods of threshing in period t

The formula used for gains to thresher user from utilization is:

$$RR_t = NRF_t + LS_t$$

where:

RR_t = the average gains in period t to the thresher renter by switching from traditional to mechanical methods

and NRF_t and LS_t are as defined above.

Gains per hectare are compared between small, medium and large farms.[2/] The maximum, minimum and average gains of thresher use by renters are also examined.

The following variables were included in the estimation of benefits.

1. Capital investment in a rice thresher (C)

The amount of capital invested in a rice thresher in Thailand includes the purchase price of the machine, a diesel engine and a boat or a small locally made trucks for carrying the thresher. The cost ranged from $1076-2195 per unit from the years 1975-79 (Table 2). Only large threshers are used. In the Philippines, total investment cost comprises a thresher

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[2/] The definition of small, medium and large farms differs between countries. In Thailand, average farm size is 2.5 to 4.8 hectares. Less than 2.5 hectares are small farms and more than 4.8 hectares are large farms. In the Philippines, average farm size is 1.0 to 3.0 hectares. Below and above this figure are small and large farms, respectively.

body and a gasoline engine. The cost of large threshers ranged from $1764 - 2222 per unit from years 1974-79 and that a portable threshers from $326-1084 from 1975-79. The investment cost for large threshers is generally higher in the Philippines despite the fact that it has fewer components and uses a gasoline engine. Investment costs generally increase every year.

2. Resale value (S1978)

The resale value of the machine was evaluated by its owner at the end of crop year 1978. In calculating the present value of past investments in rice threshers, we are faced with the difficulty of determining the remaining machine life and the salvage value of the machine when it wears out. With perfectly competitive markets, the resale value of the machine should approximate the present value. We, therefore, used estimates of the resale value obtained from farmers. These resale values are shown in Table 3.

3. Quantity of rice threshed on-farm (QF)

The quantity of rice threshed on-farm for one year depends on the total crop output of the farmer (Table 4). This is because owners as well as non-owner users in the study areas use the machine to thresh all of their paddy. Total crop output depends on productivity and cultivated area. For Thailand, on-farm rice threshed by all machines in 1978 ranged from 21 to 69 tons in both provinces. Since fertilizer application and planted area of farm is not expected to change much, the expected quantity of rice threshed on farm in the future in both provinces was assumed to remain the same as the average provincial output per year in 1978, that is QF in 1979 and future years was set at 54 tons for an average farm in Chachoengsao and 47 tons in Supanburi.

On-farm rice threshed in 1978 for the Philippines is lower, ranging from 13 to 36 tons in the irrigated areas and from 7 to 12 tons in the rainfed areas. The average yields of the one farm in each specific area was used as the thresher output on farm for 1979 and the future years, that is, 19.6 tons for irrigated and 7.3 tons for rainfed Iloilo, and 18.2 tons for irrigated Laguna.

4. Quantity of rice threshed off-farm (QOF)

In order to utilize the capacity of the machine more fully, owners hire out their machines. Table 5 indicates that the amount of rice threshed off-farm in Thailand since 1975 has increased from year to year but by declining increments. In Chachoengsao, the increment fell from 96.4 per-

cent in 1977 to 8% in 1978. Thresher owners in the Philippines have lesser output from custom work but some have also shown an increasing trend in machine use, the large thresher having larger increments than the portable ones.

The levelling of the utilization rate may be due to the capacity of the machine having approached its limit or to increased market competition through new entries or the declining number of new customers. In Laguna, Philippines, farmers reported that the decrease in quantity of rice threshed through custom work was due to the entry of more threshers in the area and the decrease in rice yield because of the insufficient water supply during the period. Owners, therefore, instead of looking for more customers, spend their time for other income earning activities. These factors are important in determining the profitability of future investments.

It is rather difficult to forecast the long run demand for thresher services since the data available are insufficient to indicate a clear picture. In the case of Thailand, when we look at the available time trend of rice threshed by new thresher contractors in Chachoengsao province since 1976, the average paddy threshed was 287 tons in 1977 and 312 tons in 1978. It is reasonable to think that the quantity of rice threshed off-farm for a thresher will eventually settle at a long run equilibrium level. Unfortunately this level is unknown, although the highest level threshed in Chachoengsao is 350 tons in 1978 for a machine bought in 1976. Given that threshers introduced since 1977 were said to have a relatively higher capacity, it seems reasonable to think that the equilibrium level may be higher than 350 tons. Thus, we assumed an average of 320 tons of off-farm rice threshed in the first year, increasing by 20 tons per year to 400 tons. In Supanburi, where the adoption is 2 years behind Chachoengsao, figures showed that the diffusion of rice threshers was much faster. From only 2 machines in 1977, it increased by 21% within one year. The highest reported level of rice threshed off-farm was 420 tons in 1978. However, as more thresher investments are made, this level may fall off. The equilibrium level was still set at 400 tons. For prospective investors, we assumed a 340 ton output for the first year increasing by 20 tons per year until it reaches 400 tons. The starting level of Supanburi was set higher than in Chachoengsao since the market there is relatively new with better prospects for investors.

A recent follow up survey of the old owners in the Philippines showed a decreasing trend in their custom services due to entry of more threshers and a decrease in yield. In

1979, thresher owners in the Iloilo irrigated survey areas experienced an average decline of 50% from 1978 in their custom output, 92% in rainfed areas, 81% in Laguna using the portable thresher and 65% using the large thresher. By 1980, most were able to recover. It was further observed that there was a tendency for new investors to thresh smaller quantities (probably due to fewer customers since they are only starting) than the earlier investors. However, others who tried were able to thresh as much or even higher than the old owners. Thus, the average possible quantity that a thresher can thresh by custom services was used, that is, in 1979, 38 tons for Iloilo irrigated, 27 tons for Iloilo rainfed, 11 tons for Laguna irrigated using the portable thresher and 34 tons using the large thresher. Increases and decreases were experienced in 1980. There is a tendency for owners to experience a decrease rather than an increase in custom work in subsequent years. Given these facts, the same value was used for new and old owners as basis for the investment analysis.

Thresher owners usually try to minimize travelling costs by operating close to their homes. In Thailand, however, some machines have been found to move to neighboring provinces and spent a month there providing thresher services. In the Philippines, custom working in far places is seldom practiced.

5. Diesel/gasoline, engine oil and grease

A major concern in farm machinery investment is the expected continual rise in gasoline and diesel prices which may increase operating costs of machinery to such a level that their use will become unprofitable.

The experience from the oil crisis shows that the rate of increase in the price of petroleum products is unpredictable. Experiments were therefore conducted with a range of price increases from 10-50 percent annually. The physical comsumption of fuel and oil is set constant assuming that there are no, or only minor, changes in rice thresher technology in the near future (Tables 6-8).

6. Tractor charge (S_1)

The rate for tractor threshing in Thailand is approximately $2.07/ton both in Chachoengsao and Supanburi provinces, even though the time consumed for threshing and the rental rate of tractors in each province are different (Table 6). Tractor threshing in Chachoengsao requires less time but the rental

rate is higher than in Supanburi. This might be explained by the fact that all farmers in Chachoengsao can grow a second crop of rice, and therefore have to hurry with threshing the first crop and shift immediately to land preparation for the second crop. In addition, Ban Po and Bang Pa Kong, areas of Chachoengsao, have to thresh quickly in order to avoid possible damage of the first crop from rising seawater. This may increase the total demand for tractors during a given period, and hence the rental rate.

From the survey, it was found that two-wheel walking tractors with 6 7 h.p. engines were preferred for rice threshing in Chachoengsao whereas two-wheel tractors with 10-12 h.p. engines were favored in Supanburi.

Since tractors have been used in threshing for some time, and the custom rate appears to be stabilizing, it was assumed the future rate will remain at the 1978 level.

7. Thresher charge (S_2)

The contract charge rate of a rice thresher in Thailand usually includes expenses such as fuel, engine oil, grease and compensation for the semi-skilled worker operating the machine (Table 7). These are paid in cash. Declining contract rates from 1975 to 1979 which can probably be attributed to the new entry of thresher contractors are observed especially in Chachoengsao province. For the Philippines (Table 8) additional labor cost is included in the contract rate because usually semi-skilled operators are accompanied by 1-6 helpers who are also paid by the thresher owner. Contract rates are usually paid in kind at 5.5-7% of the gross production (Figs. 4 and 5). Contract rates have not varied from the time the threshers first operated.

In order to come as close as possible to the service charge of a rice thresher (S_2) or the net income to the owner, all of the above mentioned costs should be excluded.

8. Farm wage rates (W_t)

The farm wage rates in Table 10 apply to labor other than thresher operators (or thresher operators and helpers in the case of the Philippines). In Thailand, the daily farm wage in 1978 was $1.67 $1.83 and was paid in cash. In the Philippines, the wage for threshing was valued at $0.83 - $0.90 per manday without meals ($1.44 $1.51 with meals) in Iloilo province and at $1.36 per manday in Laguna.

The operation of a rice thresher also includes the semi-skilled thresher operator. Most owners prefer their sons or relatives to operate the machine but others hire non relatives. In Thailand. the average wage of a thresher operator in 1978 was $0.27 - $0.38 per manhour (Table 7). In the Philippines, the wage of a thresher operator and his helper companions ranged from $0.53 - $0.65 per manhour. Wages for the semi skilled worker were higher than for unskilled.

The tentative picture on rural wages in Thailand indicates a significant rise in real terms in areas such as the central plain which have experienced changes in cropping patterns, booming markets for certain crops, or expanded potential for water control. Wages have remained roughly constant in more isolated or less favored regions. Likewise in the Philippines, wage rates are higher in irrigated and double-cropped areas. Since wages in the Philippines are paid based on percentage share of the yield, these are assigned monetary values using prices of paddy (Table 9). Therefore, the situation in the prices of paddy also contribute to changes in wages.

9. Maintenance cost (MA_t)

Survey information provide repair and maintenance data only for 1978 (Table 11). But since these include machines of different ages, they were studied for a possible trend (Fig. 6). Costs were found to increase sharply for machines in the third and fourth years. It is not clear however, whether this was due to the age of the machines or the new models of threshers in 1977. For the Philippines, available data on maintenance cost was cumulative from the year of purchase to 1978 (Figure 7). These figures were used to derive the maintenance cost for 1978 and this was compared with the age of the thresher. It appears in Table 11 that maintenance cost increases as it gets older.

Experiments on the effect of maintenance costs, using values ranging from 10-40 percent, were carried out to determine the impact on the profitability of the investment.

10. Losses saved (LS_t)

Gains from losses saved in using a rice thresher were obtained by subtracting the losses incurred in using a rice thresher from losses incurred using the traditional method. Table 12 shows that traditional methods in Thailand especially tractor treading incur less losses than the large axial flow thresher. Hence, the gains from losses saved in using

the machine are negative, ranging from -0.54% to -0.72%. For the Philippines, a significant quantity can be saved using the machine, this ranging from 0.31% to 6%.

RESULTS AND DISCUSSION

History of Rice Threshing in Thailand and Philippines

Before rice threshers were used, buffalo treading was common in Supanburi, and tractor treading in both Supanburi and Chachoengsao. By contrast, hand beating was common in Laguna, and foot treading in Iloilo. The capacities of these various methods are shown in Table 13.

In 1975, the IRRI Th8 large axial flow thresher started to replace buffalo and tractor treading in Thailand. Powered with a diesel engine, the machine capacity is 752 kgs/manday or 0.68 hrs/ton. In Laguna, the large IRRI Th8 axial flow thresher first began replacing hand beating in 1974 and was followed by the IRRI portable thresher in 1975. Farmers' preference, however, was for the larger type. In this area, large thresher have an average capacity of 1070 kgs/manday or 1.1 hrs/ton while the portable types, 1136 kgs/manday or 1.7 hrs/ton.

Patterns of adoption and diffusion

For both countries, the major source of thresher innovation was the IRRI Machinery Development Program.

Most manufacturers in the study had availed of this program. Machinery diffusion will be discussed briefly for each province.

Chachoengsao province. In late 1975, a manufacturer in Bangkok received, through the IRRI program, a blue-print of the IRRI-3 large axial flow thresher and began manufacture of the first IRRI thresher in Thailand. He produced 2 units. In early 1976, the Chaiwat Panich Shop in Chachoengsao province produced 10 units. The total unit cost of the thresher was $342 but was sold at $587. Threshing capacity was 1000 kgs. rice per hour. Problems on the shaking screen and high separation loss were encountered.

At the end of 1976, while the IRRI-3 thresher was under review Chaiwat Panich Shop, plus one other manufacturer from the same province, started producing the IRRI-5 axial flow thresher. Thirty units were produced. By mid-1977, other

manufacturers and shops from both outside and inside Chachoengsao had started production of these two models.

The portable thresher was introduced to the province in late 1977 but was not well accepted by farmers because of its lower threshing capacity. Production of this machine has terminated.

At present, there are 6 thresher manufacturers in Chachoengsao and with 40.2% of national use, Chachoengsao has the largest utilization of rice threshers in the whole country.

Supanburi province. Thresher production started at the end of 1976 but at present, only one firm is producing threshers. Statistics on utilization of rice threshers are unavailable.

Laguna province. The first threshers to operate in Laguna, in 1974-75 were the IRRI large axial flow thresher and the non-IRRI portable types. Currently, however, these non-IRRI designs are used mainly on owners' farms. Use for custom work has been limited by the popular use of the large IRRI TYPES which produced a cleaner output. In 1976, smaller portable types from IRRI were introduced and were also accepted although the large type was still preferred.

The rapid spread of threshers in Laguna was enhanced by the location of Kaunlaran Industries, Inc., the biggest IRRI thresher manufacturer in the Philippines. It lies 10-20 kilometers south of the study areas. Further, the areas are traversed by the national road leading to Manila in the north and Los Baños (site of IRRI) in the south. Around 3 small machine shops are also presently producing threshers. An average of 85% of the farmers in the study areas are thresher users (Fig. 8).

Iloilo province. The first firm to produce the IRRI-designed portable thresher in Iloilo was Jamandre Industries, Inc. which produced about 80 units in 1976. A medium-scale capacity shop followed in 1977 and another in 1978. The first three manufacturers were cooperators of the IRRI Machinery Development Program. They have sold about 700 units from 1976 to June 1979. AT present, there are 4 IRRI cooperating manufacturers and approximately 10 other small manufacturers, and small welding and machine shops producing threshers in this province. An estimated 160 units have been made in these small shops. An average 75% of farmers in the irrigated villages utilize threshers (Fig. 8) and these are all the portable type.

The rapid spread of threshers occurred in Thailand in 1977-78 and in the Philippines in 1976 78 some two to three years after introduction to the country. Machines were purchased from

manufacturers or dealers in the province and sometimes in the local villages in cases where there were small shops producing threshers by order. The farmers' first encounter and knowledge of the machines was through information from salesmen and demonstration by manufacturers. The first owners and/or users influenced other farmers, and most users in the survey areas trace their initial knowledge of the machine to having seen them operate on other farms.

Factors Affecting Thresher Adoption

Besides international organizations and government agencies, which served as innovators, and manufacturers who provided the linkage for these innovations, several economic and non-economic factors affected thresher adoption.

Non-economic factors

1. Irrigation, high yielding rice variety and cropping intensity

Manufacturers in Thailand and Philippines started producing threshers when HYVs were already widespread. From the first year of manufacture to the present, production and sales are increasing. Utilization by farmers, likewise, continues to increase.

In most cases, irrigation comes first followed by HYV and then machine use (see Fig. 9 for the example of Iloilo).

Irrigation and HYVs increased cropping intensity because they made double cropping possible. The first crop is usually harvested during the rainy months and the danger of grain spoilage is high. Since HYVs spoil and shatter more easily than traditional varieties and since a second crop is to follow, more timely harvesting and threshing is required. These changes have created a labor shortage problem during the peak months of harvesting and threshing, and have led subsequently to changes in harvesting systems, including rapid adoption of mechanical threshers for efficient, faster and easier operations. These are three major reasons cited by farmers for using threshers.

2. Profile of the farmers and their farms

The average age of thresher owners, users and non-users ranges from 45 to 48 years for Thailand and 49 to 59 years for Philippines (Table 14). Educational level is low in both countries with the majority having six years of schooling or less. All Thai farmers reached grade four because education is compulsory to this level.

No significant differences are found in age or education for adopters vs. non-adopters at any of the sites. Farming experience was mostly gained from parents or friends.

Except in Chachoengsao province in Thailand where landowners tend to be thresher owners and users, it is not very clear whether land-ownership affects thresher adoption. However, the majority of thresher owners are landowners. Farm size seems to affect adoption because in both countries, the average farm size of thresher owners is higher than non-owners. Land ownership and larger farm size reflect the economic position of an individual. Thus, thresher owners tend to have a higher income net of threshing activities. Most owners also owned power tillers prior to the thresher.

High yielding varieties such as RD7 and RD11 (Thailand) and IR36, IR38 and IR42 (Philippines) are commonly planted, and no differences between adopters and non-adopters were found.

3. Farmers associations and extension programs

Most thresher users and non-users participate in farmers' associations and/or extension programs. However, the surveys in both countries indicated that these did not influence thresher adoption.

Economic Factors

1. Source of funds

For both countries, most threshers were bought for cash from personal savings derived predominantly from farm income (Tables 15 and 16). The availability and source of funds seemed to be an important factor determining thresher investment. In Thailand, the maximum loan (about $300) for thresher investment, from the commercial banks and the Bank for Agriculture and Agricultural Cooperatives (BAAC), is only 16% of the thresher investment cost for 1979. Thus, potential buyers must still use personal savings or borrow from private sources at 20-30% interest rates. This can be very unprofitable.

No agency in the Philippines finances thresher purchase and neither are farmers aware of possibilities. Interest rates of private money lenders can be as high as 25-50% per annum. For both countries, many non-owners cited lack of capital, small farm size and low production as reasons for disinterest in owning or using a thresher.

2. Contractor service system

One very important factor affecting thresher adoption is the availability of customers for contract operation. From the field survey, it was found that the quantity of rice threshed as custom work

is much higher than that threshed on own farms. Out of the total quantity of rice threshed custom operation represented 88.6% in Chachoengsao and 82.7% in Supanburi. In Iloilo and Laguna, Phil ippines, the figure was 69.4%. Contractor service is also the main way in which machines are made available to farmers who do not have the capital to buy the machines.

3. Time and cost savings

Farmers adopted threshers mainly for faster and easier threshing. The time saved can help farmers plant subsequent crops on time. Also there are cost savings due to reduced losses (with the exception of tractor treading in Thailand) and the fact that meals are rarely served to workers.

The net cost savings of thresher use are found in Table 17. Net savings from $2.7 - $4.9 are obtained, except in Laguna and those areas where meals are not served. The traditional method used in Laguna is fast and wages are low such that it is cheaper than using the mechanical thresher.

The total variable costs for all threshing methods are presented in Tables 7 - 8 and 18. In all methods, labor cost is the largest component of the total variable cost.

Reasons for adoption or non-adoption

In the Philippines, the main reasons for not using a thresher were small farms, low production, and harvesting in small quantitites. The unavailability of threshers at the time they are needed was also a major reason. Poor machine performance and harvest ers' dislike for it were rarely mentioned. In Thailand, some farmers prefer to thresh rice with tractors because they already own one. Others were not faced with labor shortage problems.

For some users and some non-users, there appears a desire to own a thresher and other machines. Table 19 shows that among farm machines, the demand for power tillers is highest in Thailand, followed by rice threshers. In the Philippines, the demand is highest for rice threshers followed by mechanical blowers for grain cleaning. The major constraint to ownership is lack of capital.

Private Cost-Benefits of Thresher Adoption

Results of the analyses of thresher investments in the past and in the future are presented in this section. The future investments were analyzed through simulation experiments.

A. Adoption on and before 1978 (past investments)

1. Adoption through purchase (by thresher owners)

As cited earlier, thresher investments in Thailand and Philippines were made from 1974 to 1978 and the net present value approach was used to determine profitability. All returns and costs of the investment were translated into base year (1978) values employing discount rates ranging from 12-50 percent. The net present value (1978), therefore, is the net income stream over the lifetime of an investment converted into 1978 values.

Table 20 shows the net present value in 1978 for Thailand and Philippines. Generally NVPs were positive but decreasing for newer investments. One exception, was the investment in 1975 in Chachoengsao Province which showed a lower value than in following years. This was because of the number and characteristics of the cases. There were only two farms which invested in 1975. Both consisted of elderly people who had no desire to hire out their rice threshers to utilize the machine capacity fully.

Another example is the NPV 1977 in Iloilo irrigated and 1976 for Laguna. Compared to 1978, 1977 owners in the Iloilo irrigated area had a relatively low level of rice threshed, lower resale value for the machine but higher investment cost. In Laguna, NPVs are higher in 1976. The negative values in 1974 and 1975 were caused by net costs to thresher use (Table 17). This can also be attributed to the relatively low level of on-farm and off-farm output over the years. The traditional method of hand beating in this province turned out to be more economical than use of large thresher.

The highest net present value in Thailand is $1937 obtained by the owner who invested in 1976. The highest net present value of $1590 in the Philippines was obtained by the portable thresher invested in 1975. Negative NPVs were obtained by some large thresher owners. Between the two countries, NPVs of thresher use with the larger types are higher in Thailand.

The benefit cost ratios are presented in Table 21 for Thailand and Philippines, respectively. They indicate a declining trend in profitability in Thailand, reflecting the relatively more intense competition faced by new investors. For example in Chachoengsao province, there were only 2 threshers in 1975 but this increased to 26 in 1978. The benefit-cost ratio for 1978 investors is about 1.41. This decline would have been more spectacular had manufacturers been able to produce

more threshers in 1977. But information obtained from talking to manufacturers suggested that production capacity was already fully utilized in that year.

The benefit-cost ratios for the Philippines do not follow a definite trend. Some are decreasing over the years while others are increasing. For Iloilo these variations were cuased by the large variability in utilization of threshers purchased in different years. In Laguna, the benefit-cost ratio declined drastically for portable threshers in 1978. This was due to competition from other portable threshers and also large threshers which farmers in the province prefer. Comparing the two provinces, the benefit-cost ratio of portable threshers is higher in Iloilo than Laguna. This can be attributed to fewer threshers in the province which reduces competition and increases utilization.

2. Adoption through contractor service (by thresher renters)

Farmers who do not own a thresher but contract for its service gain some benefits by switching from traditional methods of threshing to a rice thresher. These include the net cost saving and the grain loss saving provided by the thresher. The maximum and minimum gains of using a thresher in Thailand are presented in Table 22. The total maximum gains over tractor treading in the two provinces ranged from $36 to $123, the minimum gains from $27 to $48, and the average gains from $32 to $82. The smaller gains in each classification were those of Supanburi province, where cultivated areas for both wet and dry seasons are relatively smaller than in Chachoengsao. Compared to buffalo treading, gains ranged from $63 to $83.

The total maximum gains for portable threshers in the Philippines ranged from $6 to $278 per year and $262 for large threshers. For large threshers, generally higher maximum gains are obtained by owners in the Philippines. Gains are higher in the irrigated areas or if thresher substitutes for hand beating. Gains are higher if traditional threshing includes meals.

The maximum and minimum gains provide us with the range of gains from using a thresher over the different alternative methods but it does not tell us whether small or large farms gain relatively more. Results according to farm size are presented in Table 23 for Thailand and Philippines.

With the exception of Laguna, it appears in both countries that small farms gain relatively more per hectare, by switching from traditional methods of threshing to a rice thresher, than either the medium or large farms. This is because the net cost

saving, the losses saved and the yield per hectare are larger in the smaller farms.

B. Adoption after 1978 (future investments)

This section will show the profitability of investing in a rice thresher in 1979. Since the net present value obtained in past investments proved sensitive to the interest or discount rate chosen, various rates ranging from 12-50% should be applied to determine the likely future effect. However, such an analysis would have been too complex and it was reduced to a single appropriate discount rates.

Possible rates are those used by institutions such as banks and agricultural cooperatives usually from 12-14%, are the rate from local money lenders, which often varies from 20-50%. Since the rates charged by money lenders tend to more adequately reflect the opportunity cost of money, the mid-value of this range (i.e. 25%) was selected as the appropriate value. Subsequent discussion is therefore based on the results from using this rate.

There are a number of variables which affect the present value of thresher investments and are difficult to determine. They include the machine life future prices of petroleum products, maintenance cost and labor cost. Sensitivity analyses were carried out with changes in these variables to determine the expected profitability of investing a rice thresher in 1979. The results indicate the degree to which changes in these cost affect profitability.

For machine life span, 20 years was chosen arbitrarily as the cut off point. Although the machine might still be functional after 20 years, a newer type with a better performance will doubtless be available.

Labor cost in Thailand was estimated to increase at 3.2% growth rate annually as based on Table 10. This is quite close to the growth rate of real GNP which is equal to 3.4% per year for the period 1965-77. Labor cost for Philippines was held constant using 1978 figure.

It is difficult to estimate future real prices for petroleum products except to say that they will almost inevitably rise.

A number of fixed growth rates for these prices were therefore simulated although only three are presented in this study. They are 10, 30 and 50% per annum.

Similarly, the maintenance cost for each year is difficult to forecast due to insufficient data. Experiments on maintenance costs were therefore undertaken with 10 and 40% rates of growth.

Tables 24 and 25 show the results of the experiments based on various combinations of the change in petroleum products prices, the change in maintenance cost and the life span of the machine.

1. Experiments based on Changes in the Prices of Petroleum Products

From Table 24 for Thailand, it can be seen that increases in petroleum products' prices resulted in increases in the present value of thresher investment. This is because the physical units of diesel oil, engine oil and grease employed in tractor treading are higher than that of a thresher. Since it is reasonable to believe that petroleum product prices are likely to increase in the future, rice threshers would be in a good market position over tractors in threshing.

In the case of the Philippines in Tables 25, traditional threshing by foot treading and hand beating does not require the use of petroleum products. Therefore, as petroleum product prices rise sufficiently, a rice thresher investment would not be profitable.

2. Experiments Based on Changes in Maintenance Costs

We have shown earlier that maintenance costs are higher for old machines. In this regard, we assume that maintenance costs will tend to be higher in later years than earlier.

Results of the analyses with increased fuel prices showed that increase in maintenance cost from 10 to 40% will significantly reduce the net income stream. For most experiments in Thailand, positive net income are obtained beyond 10 years but at a declining rate. In the Philippines, positive net income are obtained up to the 4th year and 10th year only, after which it approaches zero (Table 25).

3. Experiment Based on Constant 1978 Values

This experiment was carried out on the assumption that the investor would use the available data and/ot information

in 1978 to estimate the present value of a rice thresher investment. The quantity of rice threshed both on-farm and off-farm, the price of petroleum products, the wage rate, and the maintenance costs are all assumed to be based on real unchanged 1978 values throughout machine's life.

4. Profitability of a rice thresher investment

The expected benefit-cost ratios of a possible investment in 1979 are shown in Tables 26 and 27. Thailand's cases yielded a relatively higher profitability than those of the Philippines. It takes 3 to 4 years in Thailand to recover the investment in threshers but a longer time for Philippines.

SUMMARY AND CONCLUSIONS

The adoption of mechanized threshing in Thailand and Philippines has been rapid over the past 2-4 years. Likewise, there has been a rapid adoption of modern varieties in response to the installation and expansion of irrigation facilities.

The first adoption of the rice thresher in Thailand was in Chachoengsao province in 1975. It is an IRRI-designed large axial flow type. In the Philippines, the first owner was in Laguna province in 1974, also of the large type from IRRI. It is later followed by the portable type non-IRRI designs in 1975 and the portable IRRI-design in 1976. In both countries, use of these machines has spread widely in areas with relatively good irrigation and those that are double cropped. The original sources of the innovation was the IRRI office, then followed by production by local manufacturers and then diffusion to the first buyers who, mostly have relatively large farms. Contract services by these owners for extra income became common so that use of the machine spread rapidly even to non-owners. In the Philippines, users have reached 75% of the farmers in the irrigated villages surveyed in 1978 and 45% in the rainfed one year after introduction. A follow-up survey in 1981 registered 100% users.

Contracting, rather than cooperative ownership, is the main way in which machine services has been made available to farmers who have not the capital to buy a machine. In Thailand, the average contract charge in 1978 is $2.5 - $3.4/ton. These are paid in cash. In the Philippines, contract charge is paid in kind at 5.5% - 7% of the gross production. The charge rate in Thailand covers only the semi-skilled labor cost of operating a thresher (or the machine operator), fuel and oil cost, transportation cost and the machine service charge.

The customers have to find another 5-6 laborers for threshing. In the Philippines, these laborers are included in the rate.

Thresher owners, therefore, gain from two sources: one from own farm use and another from off-farm contracting services. The present value approach indicated a high profitability for past investments. Expectations of profitability in future investments is also high in Thailand. In the survey areas of the Philippines, however, future investments are less favorable because of limited opportunities for custom work due to the large number of threshers already in use.

All users gained from the thresher adoption. The two main benefits obtained are the net cost savings and/or the gains from losses saved. In Thailand, farmers who switched from traditional threshing to mechanical threshing obtained a net cost saving of $2.70 - $3.17/ton but negative gain from losses save of -0.54% to -0.72% of the gross threshed. In the Philippines, switching from traditional to mechanical threshing gave negative net cost savings of -$0.01 to -$1.84/ton if meals were not provided for traditional threshing but positive savings of $4.50 to $4.92/ton if with meals. Positive gains from losses saved were also obtained with machine use, this ranging from 0.31% - 6% of the gross threshed rice. Already incorporated in the cost savings is the time saved in using the thresher. The time saved may be used for better farm management, increased leisure activities, or some other income generating activities. The NPV of total benefits from thresher renters and users, ranged from $7 - $18/ha. for medium farms in Thailand and from $1.0 - $28/ha for those in the Philippines. The average gains per farm ranged from $32 - $82/ha in Thailand and $3 - $120/ha in the Philippines.

Increases in fuel costs makes thresher investment in Thailand more profitable because of the relatively higher fuel consumption of tractors. In the case of Philippines, increases in fuel costs makes thresher investment more unprofitable because traditional threshing does not use fuel. As maintenance cost increases, thresher investment becomes more unprofitable.

Eventhough positive net benefits of using and investing in a rice thresher exist, other institutional factors may act as constraints to thresher investment and/or use. These are availability of credit, farm size, and availability of customers for contract service.

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Table 1. Distribution of sample respondents by survey area and group classification, Thailand and Philippines, 1978.

Country and province	Water source	Thresher owners	Thresher non-owners users	Thresher non-users (traditional threshing)				Total
				buffalo treading	tractor treading	foot treading	hand beating	
				number of respondents				
THAILAND								
Chachoengsao	Irrigated	40	71	0	7	-	-	118
Supanburi	Irrigated	23	85	8	34	-	-	150
Total		63	156	8	41	-	-	268
PHILIPPINES								
Laguna	Irrigated	7	12	-	-	-	7	26
Iloilo	Irrigated	11	14	-	-	14	-	39
	Rainfed	5	16	-	-	15	-	36
Total		23	42	-	-	29	7	101

Table 2. Purchase price of a rice thresher and its complements by investment year, Thailand and Philippines, 1978.

Investment year	Investment cost ($)*			
	Rice thresher	Engine	Boat/truck	Total
THAILAND				
Chachoengsao		Large threshers		
1975 (2)[a]	611	220	245	1076
1976 (4)	660	245	245	1150
1977 (5)	709	293	293	1295
1978 (15)	751	296	296	1343
1979[b]	833	294	392	1519
Supanburi				
1977 (2)	734	636	-	1370
1978 (21)	802	830	na	1902
1979[b]	882	823	490	2195
PHILIPPINES				
Laguna		Large threshers		
1974 (1)				1950[d]
1975 (1)				1764
1976 (3)				1888
1978[c]				2136
1979[c]				2222
		Portable thresher		
1975 (3)				326
1978 (2)				837
1979[c]				1084
Iloilo				
1977 (6)				720[d]
1978 (6)				748
1979[c]				1071
Iloilo rainfed				
1977 (2)				747
1978 (3)				789
1979[c]				1003

[a] Numbers in parentheses indicate number of observations.

[b] Prices obtained from J. Jaidee Panich and Kaset Pattana for Chachoengsao; and Thanya Engineering and Sun Radio (dealer) for Supanburi.

[c] Prices obtained from thresher owners during follow visit in the survey areas.

[d] Price includes rice thresher and engine only.

*Converted into US$ using the following exchange rates:

	Thailand		Philippines
1974		1US$ =	₱7.18
1975	1US$ = ฿20.45	=	7.88
1976	= 20.44	=	7.68
1977	= 20.44	=	7.43
1978	= 20.25	=	7.34
1979	= 20.40	=	7.38

(Source: Newsweek magazine, 1974-79)

na = not available

Table 3. Resale value of a rice thresher and its complements at the end of 1978 by investment year, Thailand and Philippines, 1978.

Country and province	Resale value by investment year ($)				
	1974	1975	1976	1977	1978
THAILAND			Large thresher		
Chachoengsao		929	1101	1149	1185
Supanburi				1321	1634
PHILIPPINES			Large thresher		
Laguna	1361	1497	1497		
			Portable thresher		
		249			837
Iloilo				626	741
Iloilo rainfed				649	781

Table 4. Average on-farm threshing of a rice thresher by investment year, Thailand, 1974-80.

Investment year	1974	1975	1976	1977	1978	1979	1980[ex]
				tons/year			
THAILAND							
Chachoengsao				Large thresher			
1975 (2)[a]		22[b]	62[c]	62	69		
1976 (4)		-	54	53	58		
1977 (5)		-	-	45	59		
1978 (15)		-	-	-	45		
1979		-	-	-	-	54[d]	54[d]
Supanburi							
1977 (2)		-	-	25	21		
1978 (21)		-	-	-	41		
1979		-	-	-	-	47[d]	47[d]
PHILIPPINES							
Laguna				Large thresher			
1974 (1)	6	6	14	14	22		
1975 (1)		16	21	21	14		
1976 (2)			30	25	36		
1978					18		
1979						18[e]	18[e]
				Portable thresher			
1975 (3)		16	16	16	20		
1978 (3)					19		
1979						18[e]	18[e]
Iloilo							
1977 (5)				16	16		
1978 (7)					13		
1979						20[e]	20[e]
Iloilo rainfed							
1977 (2)				7	7		
1978 (3)					12		
1979						7[e]	7[e]

[a] Figures in parentheses indicate number of observations.

[b] Dry season crop only.

[c] Estimated value.

[d] Provincial average values.

[e] Average rice yield of respondents.

[ex] Extrapolated values.

Table 5. Average off-farm threshing of a rice thresher by investment year, Thailand and Philippines, 1974-83.

Investment year	1974	1975	1976	1977	1978	1979 ex	1980 ex	1981 ex	1982 ex	1983 ex
THAILAND										
Chachoengsao					Large thresher					
1975 (2) a/	-	70 b/	210	240	60 c/					
1976 (4)	-	-	165	324	350					
1977 (5)	-	-	-	287	315					
1978 (15)	-	-	-	-	312					
1979	-	-	-	-	-	320	340	360	380	400
Supanburi										
1977 (2)	-	-	-	215	420					
1978 (21)	-	-	-	-	339					
1979	-	-	-	-	-	340	360	380	400	400
PHILIPPINES										
Laguna					Large thresher					
1974 (1)	0	6	9	46	109					
1975 (1)	-	0	24	18	40					
1976 (3)	-	-	89	104	132					
1978	-	-	-	-	109					
1979	-	-	-	-	-	34 d/	63	63	63	63
					Portable thresher					
1975 (3)	-	40	48	48	26					
1978 (3)	-	-	-	-	11					
1979	-	-	-	-	-	11	6	6	6	6
Iloilo										
1977 (6)	-	-	-	56	65					
1978 (7)	-	-	-	-	120					
1979	-	-	-	-	-	38	30	30	30	30
Iloilo rainfed										
1977 (2)	-	-	-	103	62					
1978 (3)	-	-	-	-	56					
1979	-	-	-	-	-	27	50	50	50	50

a/ Number of observations

b/ The machine was first introduced among farmers in the dry season crop of 1975. The figure indicated only one season's services.

c/ Wet season crop only.

d/ 1979 and 1980 values for Philippines are actual data.

ex Extrapolated values.

Table 6. Cost of rice threshing by tractor treading, Thailand, 1975-1978.

Cost item		Unit	Chachoengsao				Supanburi	
			1975[ex]	1976[ex]	1977[ex]	1978	1977[ex]	1978
1. Fuel	quantity	li/ton	2.92	2.92	2.92	2.92	2.40	2.40
	price	$/li [a/]	0.14	0.13	0.14	0.15	0.14	0.16
	cost	$/ton	0.41	0.38	0.41	0.44	0.34	0.38
2. Engine oil	quantity	li/ton	0.42	0.42	0.42	0.42	0.45	0.45
	price	$/li	0.88	0.84	0.90	0.74	0.90	0.84
	cost	$/ton	0.37	0.35	0.38	0.31	0.40	0.38
3. Grease	quantity	kg/ton	0.05	0.05	0.05	0.05	0.06	0.06
	price	$/kg	0.88	0.84	0.84	0.84	0.84	1.00
	cost	$/ton	0.04	0.04	0.04	0.04	0.05	0.06
4. Labor	no. labor used	m-day/ton	2.22	2.22	2.22	2.22	2.74	2.74
	wage	$/m-day [a/]	1.47	1.69	1.58	1.83	1.58	1.68
	cost	$/ton	3.26	3.75	3.51	4.07	4.33	4.60
5. Tractor charge	time consumed	hour/ton	2.37	2.37	2.37	2.37	2.87	2.87
	price	$/hour	0.86	0.86	0.86	0.87	0.72	0.72
	cost	$/ton	2.04	2.04	2.04	2.06	2.07	2.07
TOTAL VARIABLE COST (1+2+3+4+5)		$/ton	6.12	6.56	6.38	6.92	7.19	7.49

[a/] Prices and wages expressed in real terms. Real price/wage = $\frac{\text{nominal price/wage}}{\text{consumer price index}} \times 100$. See C.P.I. in Table 10.

[ex] Extraporated values.

Table 7. Operating cost of a rice thresher by province, Thailand, 1975-78.

Cost item		Unit	Chachoengsao 1975ex	1976ex	1977ex	1978	1979ex	Supanburi 1977ex	1978	1979ex
			Large threshers							
1. Fuel: diesel	quantity	li/ton	0.83	0.83	0.83	0.83	0.83	0.93	0.93	0.93
	price	$/li [a]	0.14	0.13	0.14	0.15	0.24	0.15	0.16	0.25
	cost	$/ton	0.12	0.11	0.12	0.12	0.20	0.14	0.15	0.23
2. Engine oil	quantity	li/ton	0.06	0.06	0.06	0.06	0.06	0.08	0.08	0.08
	price	$/li	0.88	0.84	0.84	0.88	0.89	0.87	0.88	0.89
	cost	$/ton	0.05	0.05	0.05	0.05	0.05	0.07	0.07	0.07
3. Grease	quantity	kg/ton	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	price	$/kg	0.88	0.84	0.84	0.84	0.83	0.84	0.84	0.83
	cost	$/ton	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4. Thresher Operator	rate of operation	m-hr/ton	0.61	0.61	0.61	0.61	0.61	0.80	0.80	0.80
	wage	$/m-hr	0.22	0.28	0.26	0.38	0.31	0.26	0.27	0.31
	cost	$/ton	0.13	0.17	0.16	0.23	0.19	0.21	0.22	0.27
5. Labor [b]	no. of labor used	m-day/ton	0.67	0.67	0.67	0.67	0.67	0.88	0.88	0.88
	wage	$/m-day [a]	1.47	1.69	1.58	1.91	1.91	1.58	1.57	1.57
	cost	$/ton	0.98	1.13	1.06	1.28	1.28	1.39	1.38	1.38
6. Thresher charge (opportunity cost on farm use)		$/ton	3.80	3.05	2.80	2.06	1.80	3.24	2.96	2.11
TOTAL VARIABLE COST (1+2+3+4+5+6)		$/ton	5.10	4.52	4.20	3.75	3.53	5.07	4.79	4.07

[a] Local prices and wages expressed in real terms. Real price/wage = $\frac{\text{Nominal price/wage}}{\text{Consumer price index}} \times 100$. See C.P.I. in Table 10.

[b] Thresher owners in Thailand do not provide other laborers (aside from the machine operator) in contract services so renters have to pay for this cost item themselves. Contract rates charged by owners, therefore = Total variable cost - Labor cost.

ex Extrapolated values.

Table 8. Threshing cost employing a rice thresher, Philippines, 1974-79.

Cost item		Unit	Laguna											Iloilo		
			Large thresher						Portable thresher					Portable thresher		
			1974ex	1975ex	1976ex	1977ex	1978	1979ex	1975ex	1976ex	1977ex	1978	1979ex	1977ex	1978	1979ex
1. Fuel: Gasoline	quantity	li/ton	3.80	3.80	3.80	3.80	3.80	3.80	2.16	2.16	2.16	2.16	2.16	2.73	2.73	2.73
	price	$/li[a/]	0.21	0.21	0.21	0.20	0.23	0.24	0.21	0.21	0.20	0.23	0.24	0.20	0.23	0.24
	cost	$/ton	0.80	0.80	0.80	0.76	0.87	0.91	0.45	0.45	0.43	0.50	0.52	0.55	0.63	0.66
2. Engine oil	quantity	li/ton	0.09	0.09	0.09	0.09	0.09	0.09	0.07	0.07	0.07	0.07	0.07	0.05	0.05	0.05
	price	$/li	0.68	0.74	0.77	0.72	0.82	0.80	0.74	0.77	0.72	0.82	0.80	0.70	0.82	0.80
	cost	$/ton	0.06	0.07	0.07	0.06	0.07	0.07	0.08	0.03	0.03	0.03	0.83	0.04	0.04	0.04
3. Grease	quantity	lb/ton	0.01	0.01	0.01	0.01	0.01	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	price	$/lb	0.68	0.71	0.77	0.72	0.75	0.76	0.71	0.77	0.72	0.75	0.76	0.72	0.75	0.76
	cost	$/ton	0.01	0.01	0.01	0.01	0.01	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
4. Thresher operator	rate of operation	m-hr/ton	1.10	1.10	1.10	1.10	1.10	1.10	1.60	1.60	1.60	1.60	1.60	1.70	1.70	1.70
	wage	$/m-hr[a/]	0.66	0.58	0.56	0.55	0.60	0.44	0.62	0.60	0.58	0.53	0.47	0.70	0.65	0.66
	cost	$/ton	0.73	0.64	0.62	0.60	0.55	0.48	0.99	0.96	0.93	0.85	0.75	1.20	1.10	1.12
5. Labor[b/]	no. labor used	m-hr/ton	6.38	6.38	6.38	6.38	6.38	6.38	5.44	5.44	5.44	5.44	5.44	1.70	1.70	1.70
	wage	$/m-hr	0.66	0.58	0.56	0.55	0.50	0.44	0.62	0.60	0.58	0.53	0.47	0.70	0.65	0.66
	cost	$/ton	4.21	3.70	3.57	3.51	3.19	3.28	3.37	3.26	3.16	2.88	2.26	1.20	1.10	1.12
6. Thresher charge (opportunity cost on farm)		$/ton	6.46	5.72	5.44	5.27	4.62	3.46	6.09	5.81	5.65	5.05	4.35	4.34	3.85	3.77
TOTAL VARIABLE COST (1+2+3+4+5+6)		$/ton	12.26	10.93	10.51	10.20	9.31	8.21	10.93	10.51	10.20	9.30	8.21	7.33	6.72	6.71

[a/] Local prices and wages ecpressed in real terms. Real price/wage = $\frac{\text{Nominal price/wage}}{\text{Consumer price index}} \times 100$. See C.P.I. in Table 10.

[b/] Thresher contract rates in the Philippines is a percentage of the gross production: 7% in Laguna and 5.5% in Iloilo (See Figs. 4 and 5). To assign monetary value prices of paddy per ton were used (Table 9).

Table 9. Prices of paddy in Laguna and Iloilo, Philippines, 1974-79.

Year	Southern Luzon (Laguna)	Western Visayas (Iloilo
	$/ton	
1974	126.65	120.72
1975	120.46	109.57
1976	126.93	120.18
1977	135.91	124.31
1978	133.01	122.10
1979	136.23	141.84

Source: Bureau of Agricultural Economics, Quezon City; A. Palacpac, "Data Series on Rice Statistics," Economics Department, IRRI, Philippines, 1980.

Table 10. Farm wage rate for traditional threshing, Central Plain of Thailand and Philippines, 1974-78.

Year	Wage rate : nominal ($/m-day)	C.P.I. (1978=100)	Wage rate : real[d]
THAILAND			
1975	1.22[a]	82.98	1.47
1976	1.47[a]	86.82	1.69
1977	1.47[b]	92.91	1.69
Chachoengsao			
1978	1.83[c]	100.0	1.83
Supanburi			
1978	1.67[c]		1.67
PHILIPPINES[d]			
Laguna			
1974	1.29	72.35	1.78
1975	1.23	77.10	1.60
1976	1.30	84.56	1.54
1977	1.39	93.27	1.49
1978	1.36	100.0	1.36
Iloilo			
1977	0.92 (1.53)*	93.27	0.99 (1.64)
1978	0.90 (1.51)	100.0	0.90 (1.51)
Iloilo rainfed			
1977	0.85 (1.46)	93.27	0.91 (1.57)
1978	0.83 (1.44)	100.0	0.83 (1.44)

[a] Trent J. Bertrand, "Thailand Agricultural Prices and Subsidies: A Case Study," (AGRER Division Working Paper, 1977), Table 18, p. II.54.

[b] Thailand, Ministry of Agriculture and Cooperatives, Department of Agriculture and Cooperatives, Department of Agricultural Economics, Report No. 38, 1978. (in Thai).

[c] Survey information.

[d] Wage for threshing in the Philippines is paid in kind on a percentage of the gross production; 7% for Laguna and 5.5% for Iloilo (Figs. 4 and 5).

Wage rate = % threshing fee x yield/ha in US$ ÷ threshing mandays/ha.

Average paddy yield = 3.5 tons/ha in Iloilo and Laguna
= 2.6 tons/ha in Iloilo rainfed

Mandays/ha for threshing = 26.0 for Iloilo
21.0 for Iloilo rainfed
19.2 for Laguna

[e] Adjusted by using the consumer price index (C.P.I.) for the Central Region Thailand obtained from the Bank of Thailand, Monthly Bulletin of Statistics, December 1979; for Philippines, from Central Bank of the Philippines.

*Figures in parentheses are the wage rates which include meals. The practice of providing meals for threshers was encountered in some of the survey areas in Iloilo but not in Laguna.

Table 11. Average maintenance cost of a rice thresher and its complements in 1978 by age of machine, Thailand and Philippines.

Age of machine (yr)	Investment cost ($) (C)	Maintenance cost ($) (MA)	MA/C (%)
THAILAND			
Chachoengsao		Large thresher	
1	1343	38	2.8
2	1309	50	3.8
3	1160	188	16.2
4	1136	223	19.6
Supanburi			
1	1902	38	2.0
2	1383	50	3.6
PHILIPPINES			
Laguna		Large thresher	
3	1888	102	5.4
4	1764	258	14.6
5	1950	772	39.6
		Portable thresher	
1	837	25	2.9
4	326	122	37.3
Iloilo			
1	748	22	2.9
2	720	36	5.0
Iloilo rainfed			
1	789	23	2.9
2	747	37	5.0

Table 12. Value gained from losses saved in using a rice thresher against different alternative methods, Thailand and Philippines, 1978.

Traditional method	% loss		Mechanical method	% loss	=	% value gained in using a rice thresher
THAILAND[a]						
Animal treading	1.12	-	Large thresher	1.66	=	-0.54
2-wheel tractor	0.94	-	Large thresher	1.66	=	-0.72
4-wheel tractor	1.01				=	-0.65
large tractor	0.97				=	-0.69
PHILIPPINES[b]						
Hand beating	7.34	-	Portable thresher	1.34	=	6.00
Hand beating	7.34	-	Large thresher	1.60	=	5.74
Foot treading	1.65	-	Portable thresher	1.34	=	0.31

[a] Data obtained from Suraweth Krishnasreni and others, "Threshing Method in Thailand, "Paper presented at Grains Post-Harvest Workshop, Kuala Lumpur, Malaysia, January 1980, p. 8.

[b] Data obtained from field survey through farmers' estimates.

Table 13. Quantity of rice threshed and time consumed in threshing by different methods, Thailand and Philippines, 1978.

Method	Area	Kilograms/ manday	Hours/1000 kilograms
THAILAND			
Buffalo treading	Supanburi (8)	206	22
Tractor threshing	Chachoengsao and Supanburi (37)	415	2.6
Large thresher	Chachoengsao and Supanburi (63)	752	0.7
PHILIPPINES			
Hand beating	Laguna (14)	182	1.6
Foot treading	Iloilo (24)	135	6.6
	Iloilo rainfed (20)	124	6.2
Large thresher	Laguna (5)	1070	1.1
Portable thresher	Laguna (5)	1136	1.6
	Iloilo (13)	1238	1.7
	Iloilo rainfed (5)	1316	1.6

Table 14. Profile of respondents, Thailand and Philippines, 1978.

Item		THAILAND			PHILIPPINES					
					Irrigated			Rainfed		
		Thresher owners	Thresher non-owner users	Thresher non-owner non-users	Thresher owners	Thresher non-owner users	Thresher non-owner non-users	Thresher owner users	Thresher non-owner users	Thresher non-owner non-users
Number of respondents		63	156	49	18	26	21	5	16	15
Age (yr)		48	48	45	52	50	59	50	49	49
Education (yr)		4	4	4	6.3	4.7	5.0	5.1	6.7	5.4
Tenure (%)										
Landowner	C[a]	55	40	29	56	38	57	60	60	67
	S	95	86	98						
Landless	C	45	60	71	44	62	43	40	40	33
	S	5	14	2						
Average farm size (ha)		8.9	6.0	7.5	5.1	2.1	1.8	4.4	2.7	2.4
Average yield (tons/ha)[b]		2.9	2.7	2.7	3.8	3.9	2.9	2.4	2.8	2.7

[a] C = Chachoengsao Province
S = Supanburi Province

[b] High yielding varieties: RD7, RD11 for Thailand;
IR36, IR38, IR42 for the Philippines.

Table 15. Sources of funds for rice thresher investment, Thailand and Philippines, 1978.

Source	THAILAND	PHILIPPINES	
		Irrigated	Rainfed
Number of threshers	63	24	5
		percent	
Own cash	69	83	60
Loans	7	-	-
Both cash and loans	24	17	40
Total	100	100	100

Table 16. Sources of loans for rice thresher investment, Thailand and Philippines, 1978.

Source	THAILAND		PHILIPPINES	
	Threshers (%)	Interest rate (%/yr)	Threshers (%)	Interest rate (%/yr)
Bank	74	12	17	12
Agricultural cooperatives	16	15	-	-
Private money lenders	5	20-30	33	25-80
Relatives	5	0	17	0
Not specified	-	-	33	-
Total	100		100	

Table 17. Net cost saving of switching from traditional methods of threshing to a rice thresher, Thailand and Philippines, 1978.

Area	Traditional method (1)	Cost ($/ton)	Mechanical method (2)	Cost ($/ton)		Net cost saving ($/ton)(1)-(2)
THAILAND						
Chachoengsao	Tractor treading	6.92	Large thresher	3.75	=	3.17
Supanburi	Tractor treading	7.49	Large thresher	4.79	=	2.70
	Buffalo treading	9.56	Large thresher	4.79	=	4.77
PHILIPPINES						
Laguna	Hand beating	7.47	Large thresher	9.31	=	-1.84
	Hand beating	7.47	Portable thresher	9.31	=	-1.84
Iloilo	Foot treading	6.69	Portable thresher	6.72	=	-0.03
		(11.22)*			=	(4.50)
Iloilo rainfed	Foot treading	6.71	Portable thresher	6.72	=	-0.01
		(11.64)			=	(4.92)

Source: Tables 6 - 9.

*Figures in parentheses are the net cost savings if traditional includes meals.

Table 18. Cost of rice threshing by traditional method, Thailand and Philippines, 1978.

Method	Time consumed (man/animal days/ton)	Wage ($/day)	Cost ($/ton)
THAILAND			
Buffalo treading:			
Buffalo	2.75	0.25	0.67
Labor	4.85	1.83	8.90
PHILIPPINES			
Hand beating	5.49	1.36	7.47
Foot treading	7.43	0.90 (1.51)*	6.69 (11.22)
Foot treading (Iloilo rainfed)	8.08	0.83 (1.44)	6.71 (11.64)

Sources: Tables 10 and 13.

* Numbers in parentheses are those which include meals.

Table 19. Potential demand for farm machines, Thailand and Philippines, 1978.

Machines wanted to own	Thailand	Philippines	
		Iloilo and Laguna	Iloilo rainfed
Number of respondents	268	63	36
		Percent[a]	
Power tiller	22	3	8
Transplanter	13	-	-
Sprayer	17	-	-
Water pump	14	3	11
Combiner	6	2	-
Rice thresher	19	57	67
Winnower/blower	1	33	53
Dryer	-	3	-
Others[b]	9	0	3
None	25	35	14

[a] Percent based on total number of respondents. Does not total to 100 because more than one choice of machine is allowed for each respondent.

[b] Others include power engine, rice mill, trailer and grass cutter.

Table 20. Net present 1978 value and investment cost in 1978 value at different discount rates by investment year, Thailand and Philippines.

Discount rate (%)	Net present value by investment year (1978 $) 1974	1975	1976	1977	1978	Investment cost value by investment year (1978 $) 1974	1975	1976	1977	1978
THAILAND										
Chachoengsao						Large thresher				
12		940	1937	1356	555		1580	1442	1452	1343
15		894	1925	1341	555		1711	1520	1491	1343
25		715	1877	1294	555		2197	1796	1621	1343
Supanburi										
12		-	-	1743	747		-	-	1534	1902
15		-	-	1722	747		-	-	1575	1902
25		-	-	1652	747		-	-	1712	1902
PHILIPPINES										
Laguna						Large thresher				
12	-1732	-500	1357			3068	2478	2368		-
15	-2068	-682	1289			3410	2683	2497		-
25	-3391	-1357	1051			4760	3445	2950		-
50	-8420	-3610	340			9871	5954	4248		-
						Portable thresher				
12		1154			143		458			837
15		1185			143		496			837
25		1297			143		636			837
50		1590			143		1100			837
Iloilo										
12				296(456)*	436(497)				806	748
15				280(443)	436(497)				828	748
25				232(402)	436(497)				900	748
50				109(300)	436(497)				1080	748
Iloilo rainfed										
12				495(568)	189(247)				837	789
15				486(560)	189(247)				859	789
25				454(531)	189(247)				934	789
50				375(461)	189(247)				1120	789

*Numbers in parentheses are NPVs if traditional threshing includes meals.

Table 21. Benefit-cost ratios at different discount rates by investment year, Thailand and Philippines, 1975-78.

Discount rate (%)	Investment year 1974	1975	1976	1977	1978
THAILAND					
Chachoengsao			Large thresher		
12		1.59	2.34	1.93	1.41
15		1.52	2.27	1.90	1.41
25		1.32	2.05	1.80	1.41
Supanburi					
12				2.14	1.39
15				2.09	1.39
25				1.96	1.39
PHILIPPINES					
Laguna			Large thresher		
12	0.44	0.80	1.57		-
15	0.39	0.75	1.52		-
25	0.29	0.61	1.36		-
50	0.15	0.39	1.08		-
			Portable thresher		
12		3.52			1.17
15		3.39			1.17
25		3.04			1.17
50		2.44			1.17
Iloilo					
12			1.37(1.57)*	1.58(1.66)	-
15			1.34(1.54)	1.58(1.66)	-
25			1.26(1.45)	1.58(1.66)	-
50			1.10(1.28)	1.58(1.66)	-
Iloilo rainfed					
12			1.59(1.68)	1.24(1.31)	-
15			1.57(1.65)	1.24(1.31)	-
25			1.49(1.57)	1.24(1.31)	-
50			1.33(1.41)	1.24(1.31)	-

*Numbers in parentheses are B/C ratios if traditional threshing includes meals.

Table 22. Maximum, minimum and average gains of using a thresher as compared to traditional methods of threshing, Thailand and Philippines, 1978.

Threshing method	Net cost saving value ($)[a/]			Gains from losses saved ($)[b/]			Total gains ($)		
	max.	min.	ave.	max.	min.	ave.	max.	min.	ave.
THAILAND									
Chachoengsao					Large thresher				
Tractor treading	171	66	114	-48	-18	-32	123	48	82
Supanburi									
Tractor treading	55	41	48	-19	-14	-16	36	27	32
Buffalo treading	97	73	84	-14	-10	-12	83	63	72
PHILIPPINES									
Laguna					Large thresher				
Hand beating	-83	-2.5	-36	345	10	149	262	8	113
					Portable thresher				
Hand beating	-83	-2.5	-36	361	11	156	278	9	120
Iloilo									
Foot treading	-0.8	-0.1	-0.3	10	1.2	3.3	9.2	1.1	3.0
	(119)*	(15)	(40)				(129)	(16)	(43)
Iloilo rainfed									
Foot treading	-0.2	0	-0.1	6.2	1.2	3.2	6.0	1.2	3.0
	(80)	(16)	(42)				(86)	(17)	(45)

[a/] Net cost saving value = total rice output per year (tons) x net cost saving per ton ($)

[b/] Gains from losses saved = total rice output per year (tons) x % gains from losses saved in using a rice thresher x price of paddy per ton ($)

Total rice output in 1978 (tons):	max.	min.	ave.
Chachoengsao	53.9	20.8	36.3
Supanburi	20.7	15.5	18.1
Laguna	45.2	1.4	19.5
Iloilo	26.5	3.2	8.8
Iloilo rainfed	16.3	3.3	8.5

Net cost saving per ton in 1978: See Table 17.
% gains from losses saved in using a rice thresher: see Table 12.
Price of paddy per ton in 1978 = $123.46 for Thailand; $133.01 for Laguna and $122.10 for Iloilo.

*Numbers in parentheses are NCS value if traditional threshing includes meals.

Table 23. Average gain per hectare of using a thresher as compared to traditional methods of threshing according to farm size,* Thailand and Philippines, 1978.

Threshing method	Net cost saving value($/ha)[a/]			Gains from losses saved($/ha)[b/]			Total gains ($/ha)		
	Large	Medium	Small	Large	Medium	Small	Large	Medium	Small
THAILAND									
Chachoengsao					Large thresher				
Tractor treading	19	12	23	-5	-4	-6	14	8	17
Supanburi									
Tractor treading	14	11	17	-5	-4	-6	9	7	11
Buffalo treading	24	20	31	-4	-2	-5	20	18	26
PHILIPPINES									
Laguna					Large thresher				
Hand beating	-11	-8	-6	45	35	24	34	27	18
Hand bearing	-11	-8	-6	47	36	25	36	28	19
Iloilo									
Foot treading	-0.1 (15)*	-0.1 (15)	-0.1 (19)	1.3	1.3	1.6	1.1 (16)	1.2 (16)	1.5 (21)
Iloilo rainfed									
Foot treading	0 (13)	0 (13)	0 (20)	1.0	1.0	1.5	1.0 (14)	1.0 (14)	1.5 (21)

[a/] Net cost saving value = yield per hectare (tons) x net cost saving per ton ($)

[b/] Gains from losses saved = yield per hectare (tons) x % gains from losses saved in using a rice thresher x price of paddy per ton ($).

* Farm size and yield per hectare:

Thailand

Small farms = less than 2.4 hectares; average yield = 7.4 tons/ha Chachoengsao; 6.6 tons/ha Supanburi

Medium farms = 2.4 - 4.8 hectares; average yield = 4.0 tons/ha Chachoengsao; 4.21 tons/ha Supanburi

Large farms = more than 4.8 hectares; average yield = 6.0 tons/ha Chachoengsao; 5.1 tons/ha Supanburi

Philippines

Small farms = less 1.0 hectare; yield = 3.1 tons/ha for Laguna; 4.3 tons for Iloilo; 4.0 tons for Iloilo rainfed.

Medium farms = 1.0 - 3.0 hectares; yield = 4.5 tons/ha for Laguna; 3.3 tons for Iloilo; 2.7 tons for Iloilo rainfed.

Large farms = more than 3.0 hectares; yield = 5.9 tons/ha for Laguna; 3.3 tons for Iloilo; 2.6 tons for Iloilo rainfed.

Net cost saving per ton in 1978: see Table 17.
Gains from losses saved in using a rice thresher: see Table 12.
Price of paddy per ton in 1978 = $123.46/ton for Thailand; $133.01 for Laguna and $122.10 for Iloilo.

Table 24. Discounted income stream based on various sets of assumptions at 25% discount rate, Thailand (1979 $).

YEAR	PV11	PV14	PV31	PV34	PV51	PV54	PV78
				Large thresher			
Chachoengsao							
1	544	535	549	540	554	545	4533
2	1004	978	1020	993	1037	1010	8159
3	1393	1340	1423	1370	1460	1407	11060
4	1721	1632	1770	1681	1837	1747	13381
5	1997	1865	2068	1933	2177	2042	15238
10	2,48	2228	2985	2454	3600	3068	20231
15	3001	2228	3481	2454	5643	4329	21867
20	3086	2228	3884	2454	10243	7508	22403
Supanburi							
1	835	827	839	831	843	834	833
2	1506	1479	1517	1491	1530	1503	1500
3	2043	1990	2066	2012	2093	2040	2033
4	2474	2383	2511	2422	2561	2472	2460
5	2820	2685	2874	2739	2956	2820	2801
10	3756	3225	3934	3403	4397	3865	3719
15	4066	3225	4427	3407	6053	4740	4020
20	4168	3225	4768	3407	9552	6816	4118
Assumptions: (annual increase)							
Fuel (%)	10	10	30	30	50	50	Constant at 1978 values
Maintenance(%)	10	40	10	40	10	40	

Table 25. Discounted income stream based on various sets of assumptions and 25% discount rate, Philippines.

YEAR	PV11	PV14	PV31	PV34	PV51	PV54	PV78
				1979 value ($)			
				Large thresher			
Laguna							
1	142	126	139	124	136	121	436
2	264	219	256	211	247	202	786
3	397	306	381	290	362	271	1065
4	498	347	473	321	438	286	1288
5	576	347	539	321	482	286	1468
10	752	347	632	321	497	286	1948
15	780	347	632	321	497	286	2106
20	780	347	632	321	497	286	2158
				Portable thresher			
1	118	112	117	111	115	109	116
2	196	179	192	174	187	169	209
3	257	221	248	213	237	202	283
4	304	244	289	230	270	210	343
5	339	249	318	230	286	210	390
10	421	249	355	230	289	210	518
15	435	249	355	230	289	210	560
20	435	249	355	230	289	210	574
Iloilo							
1	102 (173)*	96 (167)	100 (171)	94 (165)	93 (168)	92 (163)	356 (404)
2	161 (289)	146 (273)	155 (283)	139 (267)	148 (276)	133 (260)	640 (728)
3	207 (380)	175 (347)	195 (368)	163 (337)	180 (354)	149 (322)	868 (986)
4	242 (451)	188 (398)	222 (432)	169 (379)	195 (405)	149 (352)	1050 (1193)
5	- (506)	- (246)	- (478)	- (397)	- (434)	- (354)	1196 (1359)
10	- (640)	- (435)	- (547)	- (397)	- (444)	- (354)	1588 (1804)
15	- (671)	- (435)	- (547)	- (397)	- (444)	- (354)	1700 (1950)
20	- (674)	- (435)	- (547)	- (397)	- (444)	- (354)	1758 (1998)

*Numbers in parentheses are the thresher income if traditional threshing includes meals.

Table 26. Benefit-cost ratios based on various sets of assumptions at 25% discount rate, Thailand.

YEAR	PV11	PV14	PV31	PV34	PV51	PV54	PV78
				Large thresher			
Chachoengsao							
1	0.36	0.35	0.36	0.36	0.36	0.36	3.38
2	0.66	0.64	0.67	0.65	0.68	0.67	6.08
3	0.92	0.88	0.94	0.90	0.96	0.93	8.24
4	1.13	1.07	1.17	1.11	1.21	1.15	9.96
5	1.31	1.23	1.36	1.27	1.43	1.34	11.35
10	1.81	1.47	1.97	1.62	2'37	2.02	15.06
15	1.98	1.47	2.29	1.62	3.71	2.85	16.28
20	2.03	1.47	2.56	1.62	6.74	4.94	16.68
Supanburi							
1	0.44	0.43	0.44	0.44	0.44	0.44	0.44
2	0.79	0.78	0.80	0.78	0.80	0.79	0.79
3	1.07	1.05	1.09	1.06	1.10	1.07	1.07
4	1.30	1.25	1.32	1.27	1.35	1.30	1.29
5	1.48	1.41	1.51	1.44	1.55	1.48	1.47
10	1.97	1.70	2.07	1.79	2.31	2.03	1.96
15	2.14	1.70	2.33	1.79	3.18	2.49	2.11
20	2.19	1.70	2.51	1.79	5.02	3.58	2.17
Assumptions: (annual increase)							
Fuel (%)	10	10	30	30	50	50	Constant at 1978 values
Maintenance (%)	10	40	10	40	10	40	

Table 27. Benefit-cost ratios based on various sets of assumptions and 25% discount rate, Philippines.

YEAR	PV11	PV14	PV31	PV34	PV51	PV54	PV78
				1979 value ($)			
Laguna				Large thresher			
1	0.06	0.06	0.06	0.06	0.06	0.05	0.20
2	0.12	0.10	0.12	0.10	0.11	0.09	0.37
3	0.18	0.14	0.17	0.13	0.16	0.12	0.50
4	0.22	0.16	0.21	0.14	0.20	0.13	0.60
5	0.26	0.16	0.24	0.14	0.22	0.13	0.69
10	0.34	0.16	0.28	0.14	0.22	0.13	0.91
15	0.35	0.16	0.28	0.14	0.22	0.13	0.99
20	0.36	0.16	0.28	0.14	0.22	0.13	1.01
				Portable thresher			
1	0.11	0.10	0.11	0.10	0.11	0.10	0.14
2	0.18	0.17	0.18	0.16	0.17	0.16	0.25
3	0.24	0.20	0.23	0.20	0.22	0.19	0.34
4	0.28	0.23	0.27	0.21	0.25	0.19	0.41
5	0.31	0.23	0.29	0.21	0.26	0.19	0.47
10	0.39	0.23	0.33	0.21	0.27	0.19	0.62
15	0.40	0.23	0.33	0.21	0.27	0.19	0.67
20	0.40	0.23	0.33	0.21	0.27	0.19	0.69
Iloilo							
1	0.10 (0.16)*	0.09 (0.16)	0.09 (0.16)	0.09 (0.15)	0.09 (0.16)	0.09 (0.15)	0.48 (0.54)
2	0.15 (0.27)	0.14 (0.26)	0.15 (0.26)	0.13 (0.25)	0.14 (0.26)	0.12 (0.24)	0.86 (0.97)
3	0.19 (0.36)	0.16 (0.33)	0.18 (0.34)	0.15 (0.31)	0.17 (0.33)	0.14 (0.30)	1.16 (1.32)
4	0.23 (0.42)	0.18 (0.37)	0.21 (0.40)	0.16 (0.35)	0.18 (0.38)	0.14 (0.33)	1.40 (1.59)
5	- (0.47)	- (0.40)	- (0.45)	- (0.37)	- (0.41)	- (0.33)	1.60 (1.82)
10	- (0.60)	- (0.41)	- (0.51)	- (0.37)	- (0.41)	- (0.33)	2.12 (2.41)
15	- (0.63)	- (0.41)	- (0.51)	- (0.37)	- (0.41)	- (0.33)	2.29 (2.61)
20	- (0.63)	- (0.41)	- (0.51)	- (0.37)	- (0.41)	- (0.33)	2.35 (2.67)

*Numbers in parentheses are B/C ratios if traditional threshing includes meals.

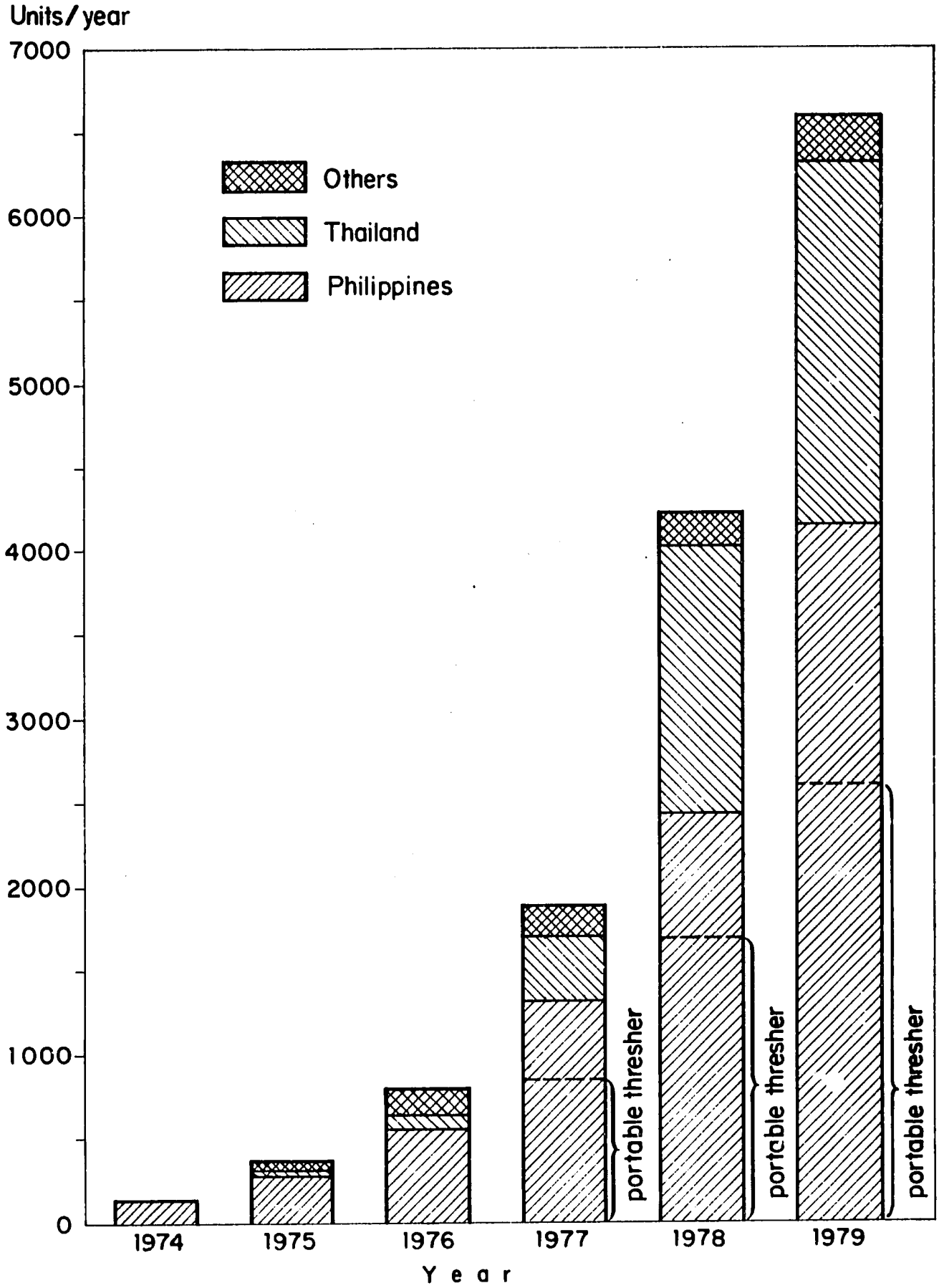


Fig. 1 IRRI axial-flow thresher production, 1974-'79.

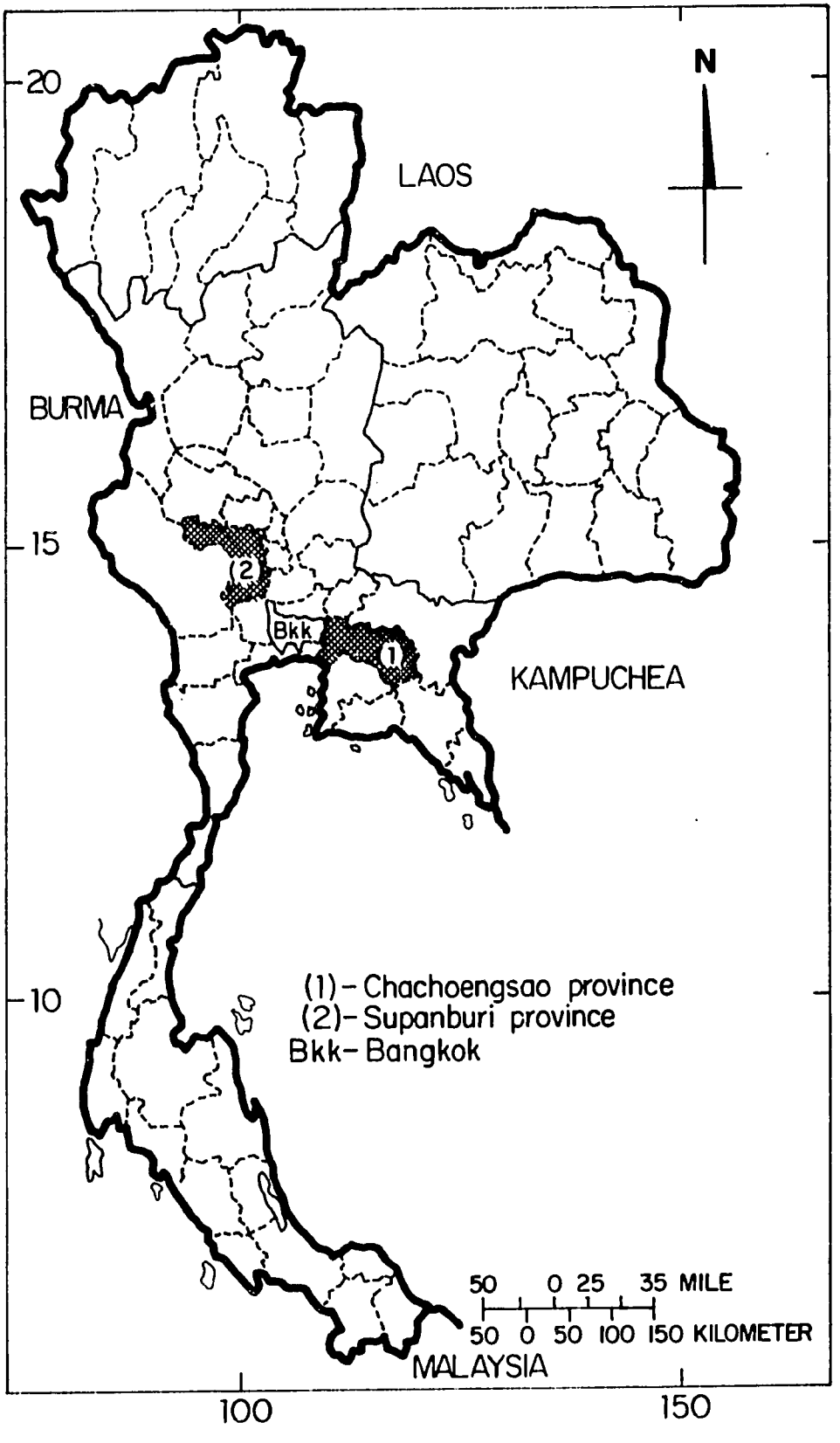


Fig. 2 Map of study areas in Thailand, 1978-'79.

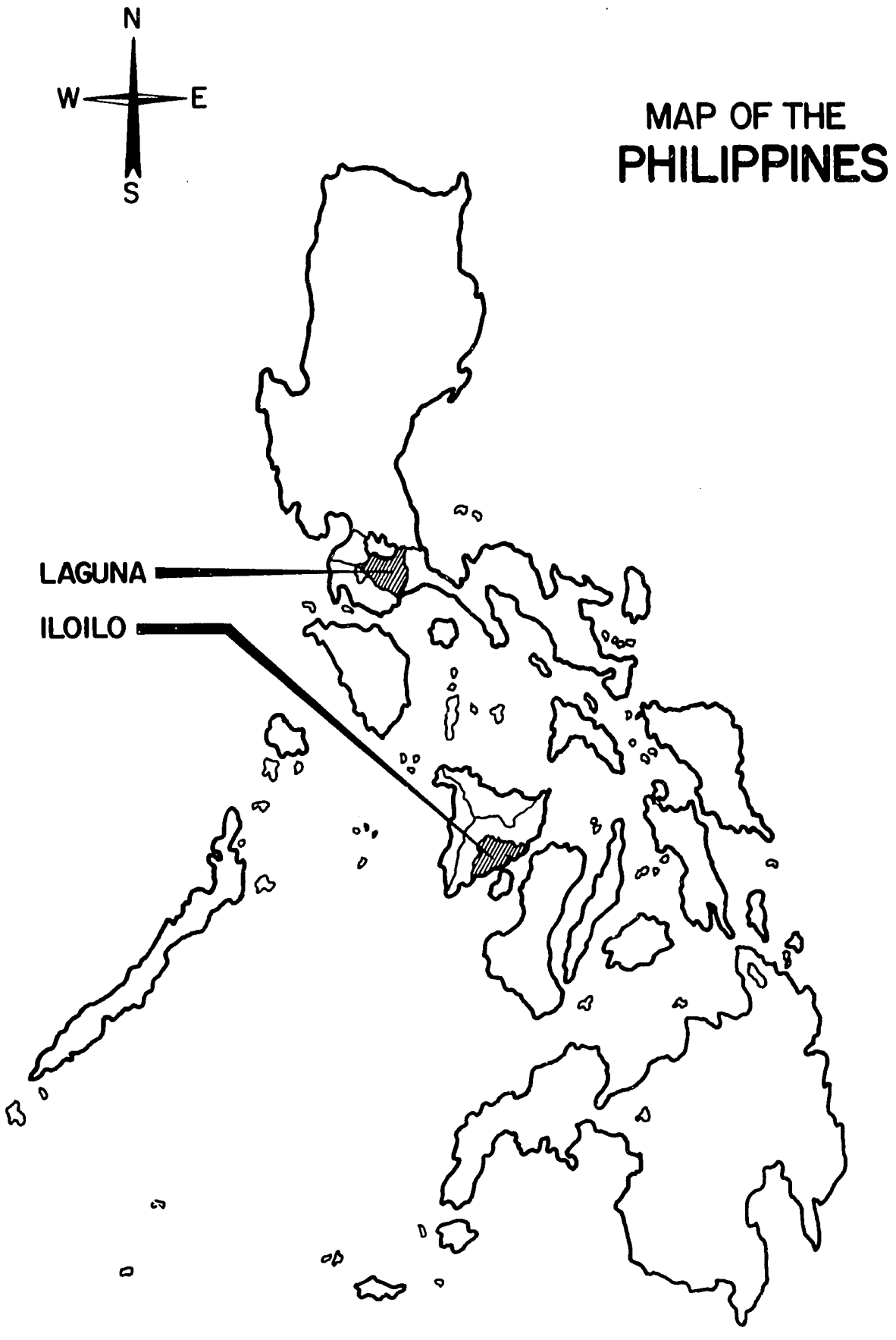
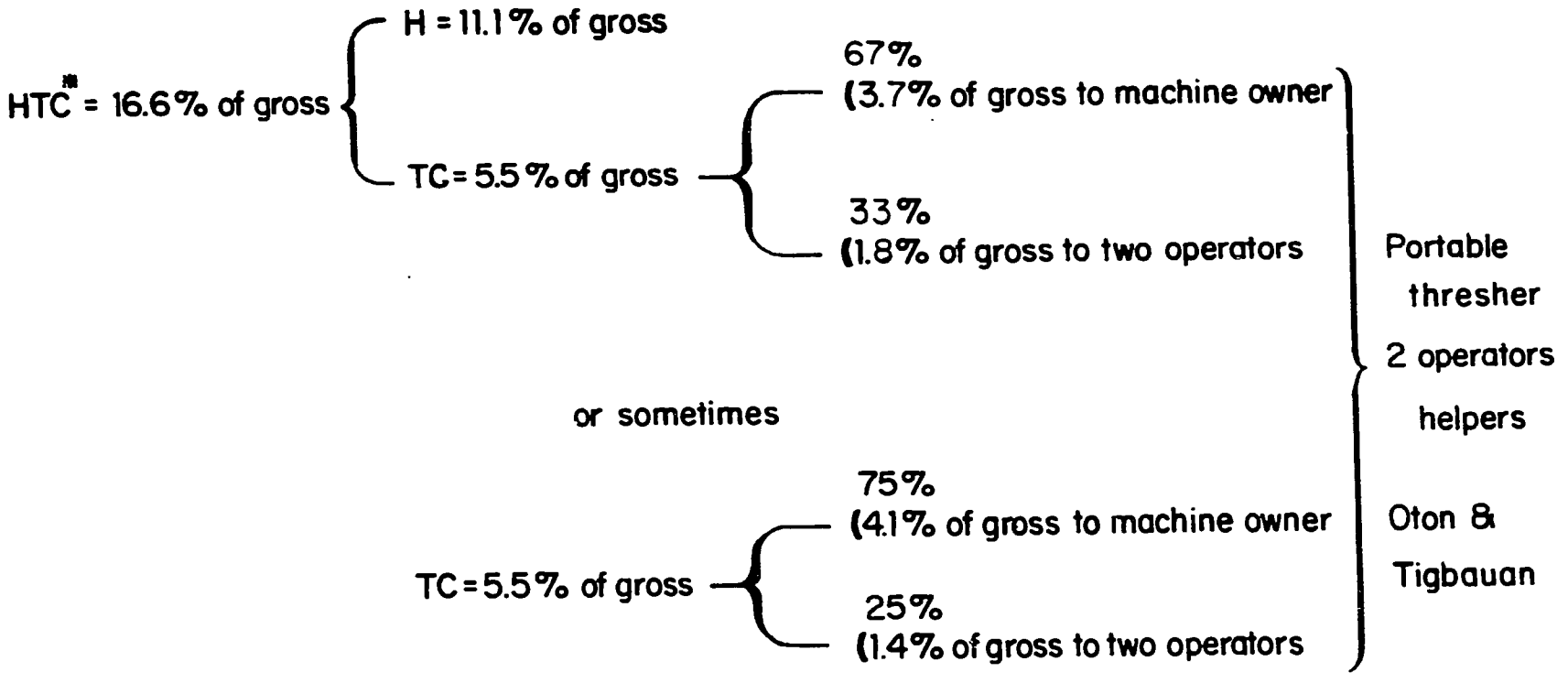


Fig. 3 Map of study areas, Philippines, 1978 - '79.



*H – Harvesting
T – Threshing
C – Cleaning

Fig. 4. Rates of payment for harvesting, threshing and cleaning in Iloilo.

- HTC* = 17 - 18% of gross
  - H = 10%
  - TC = 7%
    - 60% (4.2% of gross) to machine owner
    - 40% (2.8% of gross) to operators + helpers
  - TC = 8%
    - 60% (4.8% of gross) to machine owner
    - 40% (3.2% of gross) to operators + helpers

  } Axial flow threshers
  6 - 7 operators + helpers in Sta. Rosa

or sometimes

- HTC* = 19.4% of gross
  - H = 12%
  - TC = 7.4%
    - 60% (4.4% of gross to machine owner
    - 40% (3.0% of gross) to operators + helpers

  } Axial flow threshers
  Portable threshers
  3 - 4 operators + helpers in San Pedro, Binan and Cabuyao

* H = Harvesting
T = Threshing
C = Cleaning

Fig. 5 Rates of payment for harvesting, threshing and cleaning in Laguna.

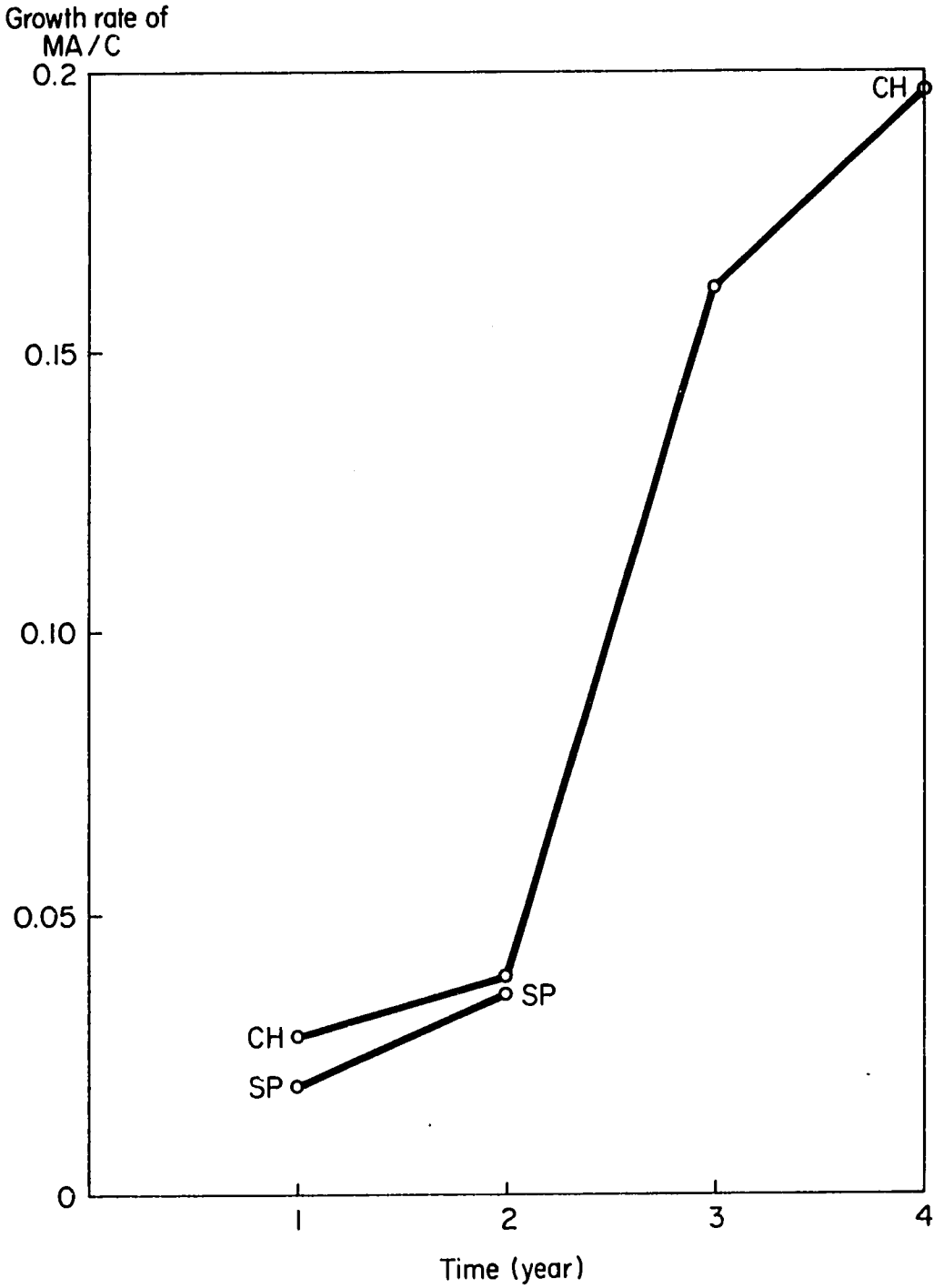


Fig. 6. Maintenance-initial cost ratio by province, Thailand.

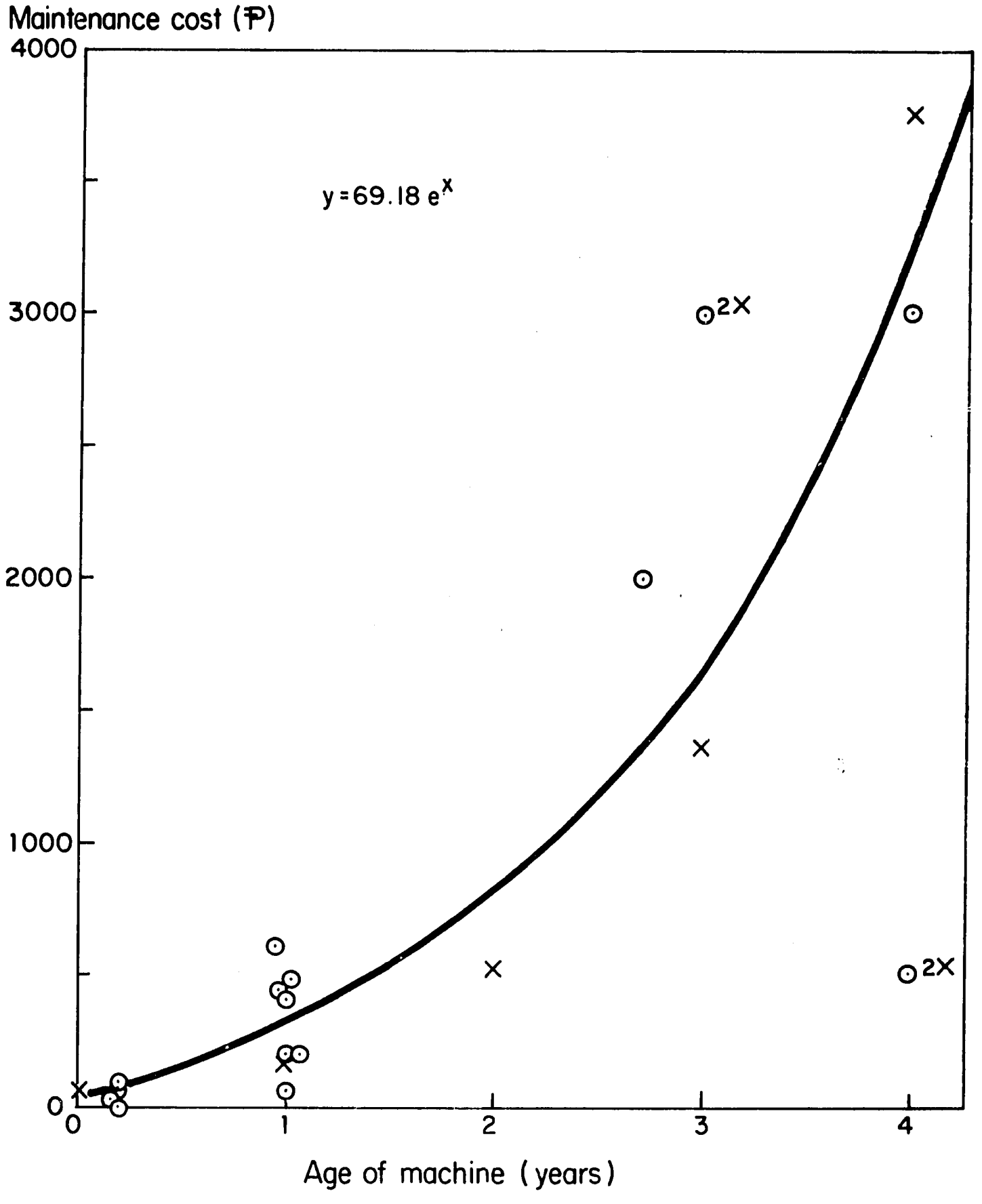


Fig. 7 Maintenance cost of rice threshing machine by age, Philippines.

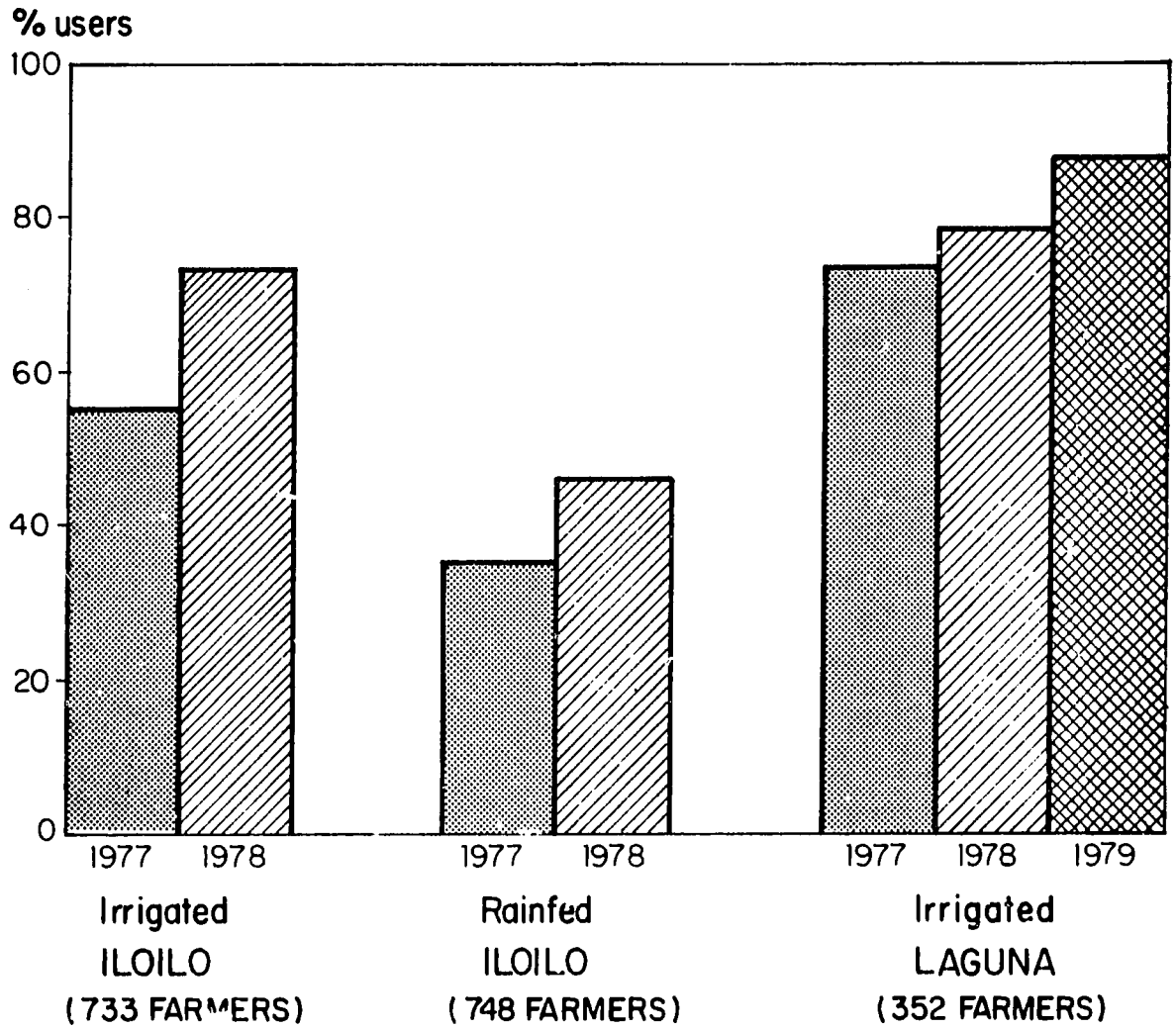


Fig. 8 Thresher adoption and utilization in three irrigated and three rainfed villages of Iloilo and six irrigated villages of Laguna, Philippines, 1978 - 1979.

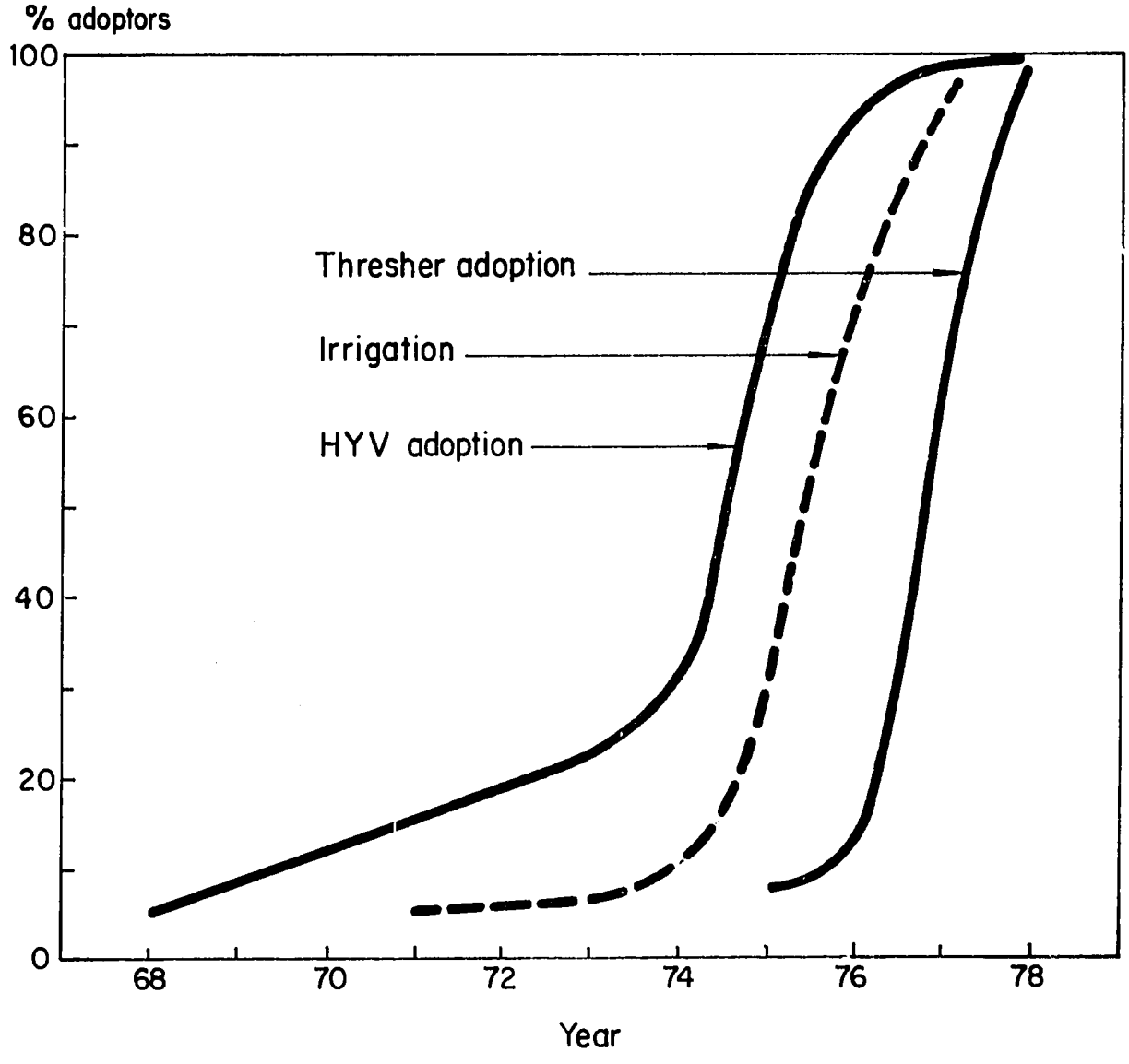


Fig. 9 Adoption of three rice production technologies in three sample irrigated villages, Iloilo, 1968-78.

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