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THE ECONOMICS OF MECHANICAL RICE THRESHING IN THAILAND

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Abstracts

This paper provides a description of the process of changes in rice threshing technology and its impacts on Thai economy. The invention and innovation of mechanical thresher resulted from the research and development of the International Rice Research Institute (IRRI) and was disseminated to Thai economy through the cooperation between local manufacturers and Thai-IRRI program. The adoption of rice thresher depends on the following factors: irrigation, double cropping, HYV rice, marketing of contractor service, the ability to invest in the machine, the establishment of local farm machinery industry, and demonstration effects. Adoption of rice thresher generates benefits to those who are engaged in its production and marketing, thresher investor, thresher users, and those in repair and maintenance sectors.

THE ECONOMICS OF MECHANICAL RICE THRESHING IN THAILAND

Renu Sukharomana

I. INTRODUCTION

Rice threshing is one of the post-production activities. In Thailand the method of rice threshing covers from the most traditional one to a fully mechanized one.[1] Traditional methods comprise of foot treading, hand beating, animal treading, and tractor treading. Rice threshed by a rice thresher is hereby classified as mechanical rice threshing. Paddy after being threshed by the traditional method needs subsequent separation of foreign materials and husk--a step not required by the mechanically threshed paddy.

Methods of rice threshing that farmers practice vary among different regions of Thailand. In the Central Region more farmers employ rice thresher than in the other three regions (North-Eastern, Northern and Southern regions). However, some farmers who grow floating-rice varieties still use tractor treading method because the rice thresher cannot work the long straw properly and results in a much lower threshing rate and hence higher cost. Traditional methods, especially animal treading, sparsely appear in

the Central Region. Moreover, hand beating and foot treading methods have never been used in the Central Region. In the North-Eastern Region, hand beating method is widely practiced by the farmers. The use of rice threshers and tractors, almost invisible, first happened in the irrigated areas. In the North, farmers want to keep rice straw long to mulch soil for second crop. Most farmers therefore employ hand beating. Wireloop-type thresher is also used but is not as popular as the traditional method. In the Southern Region, the method of rice harvesting determines the method of rice threshing. Traditionally rice harvested by ani-ani knife is threshed by foot treading and for those harvested by a sickle hand beating (by stick) is used. Rice thresher recently is introduced to the Southern Region. The models of rice thresher are either wireloop or axial-flow. [2] The former model is appropriated for rice harvested by ani-ani knife, the latter for rice harvested by sickle. Threshers in the Southern Region mostly appear in irrigated areas where second season of rice can be grown.

Rice threshers in 1975 totalled 3,955 units. Of those, about 90 per cent home in the Central Region. The Northern, Southern, and North-Eastern regions own the remaining 4.6, 2.7 and 2.3 per cent respectively. [3] (Table 1) Recent statistics from the survey by the Division of Agricultural Engineering [4] indicated that in the Southern Region in

February 1981 the number of rice threshers stood at about 1,165 units[4], figures for other regions were not reported.

II. CHANGE IN RICE THRESHING TECHNOLOGY

Technology in rice threshing in Thailand has been changed from traditional method to the use of rice thresher since 1975. The pattern and the speed of technology change are quite different among regions. The Central Region seems much more receptive to the change than other regions. Reasons behind the change can be explained by the three steps of technology changes: invention, innovation, and diffusion.[5]

1. Invention, Innovation, and Technology Transfer[6]

The invention and innovation of axial-flow rice thresher resulted from research and development efforts by the International Rice Research Institute (IRRI) at Laguna, Philippines. Modification and development of original design to suit local conditions emerge from the cooperation of local manufacturers in Thailand and the Office of Thai-IRRI Program.

Blueprints of IRRI-3 Axial - Flow thresher was firstly sent to the Office of Thai-IRRI in Bangkok in early 1975. Before distributing to the public, Thai-IRRI program conducted a test and modified the machine to suit the local

conditions. They later released the modified blueprint to Chaiwat Panich, a local manufacturer who thus is the first thresher producer in Thailand. The first 10 units were produced and sold at 12,000 baht. However, all of these machines were sent back because of the technical problem in shaken screen and high separation loss.

At the end of 1975, while IRRI-3 thresher was under review, Thai-IRRI Office received the blueprint of IRRI-5 Axial-Flow thresher. Three manufacturers--Chinadit Shop (Chachoengsao Province), Chaiwat Panich (Chachoengsao Province) and Kaset Thai (Chol buri Province)--came to ask for a blueprint and started producing IRRI-5 thresher by the end of that year. Chinadit was the sole manufacturer that succeeded in modifying IRRI-5 thresher to suit local conditions. Other firms in nearby areas subsequently started copying from its model. (Figure 1)

In 1976, the blueprint of portable thresher (Th6, Th7) were sent to Thai-IRRI Office in Bangkok. These new models are smaller, easier to transport, and require less labor for operation than IRRI-5 thresher. Chaiwat Panich produced 9 units and sold at 8,500 baht each. However, these small threshers did not gain popularity with the farmers as there exist the market of thresher service.

2. Diffusion

The diffusion of thresher to Thai farmers is depended on the conditions and the reasons of farmers adopting the machine. Factors beleived to influence farmer adoption are: (1) irrigation and double cropping, (2) high yielding rice varieties, (3) the net benefit from using and investing in rice thresher, (4) ability of farmer to purchase rice thresher, (5) contractor service system, (6) the establishment of local farm machinery industry, (7) demonstration effect, and other factors.[7] Details of each reason are presented below.

(1) Irrigation and Double Cropping

The most important factors influencing thresher adoption is irrigation. Almost every farmer who locates in irrigated areas use tractor as well as rice thresher. Farmers in non-irrigated areas usually employ the traditional method in land preparation and threshing. The underlying reason may be that irrigation will induce double cropping which creates a labor shortage problem during the peak period of harvesting, threshing, and land praparation for the next crop. Double cropping therefore necessitates a change in threshing system which appears in the form of rapid adoption of thresher for efficiency, faster and easier operations.

(2) High Yielding Rice Varieties

The high yielding varieties is proved as one of the most important factors that makes double cropping possible. The HYV reduces production period and makes rice production independent from day length. High yield varieties require new type of cultural practice, chemical fertilizer application, etc. These requirements further add to the problem of labor shortage that emerge in between two consecutive seasons. Adoption of rice thresher can help solve or remedy such a problem.

(3) The Net Benefit from Using and Investing in Rice Thresher

The net benefit is the most important economic factor that can induce farmer to switch from traditional method to the use of rice thresher.

Kittikul, J. (1980) [8] showed that the average total cost and total variable cost of rice threshing by a thresher is lower than any other alternative methods. (Table 2) These results however did not include the other benefits that a thresher might generate (such as custom service). Moreover, rice thresher is a durable capital that does not wear off within a year. The benefit of a thresher should include all benefits that may accrue over its life span. In 1980, Pathnopas, R. employed the concept of cost-benefit analysis to analyse the benefit of rice thresher under

different conditions. The study showed that investment in a thresher yielded a high return to the investor. (Table 3) Expectation of future investment is also high.

(4) Ability of Farmer to Purchase Rice Thresher

Even though farmers know that the invesment in rice thresher yield a net benefit, all farmers could not invest in rice thresher. The price of a machine is relatively high when compared to their income; only high income farmer can afford the machine.

Most rice thresher (69 per cent) were bought in cash from personal saving.[9] Farmers who do not have enough fund may borrow some money from either financial and non-financial institutes. Interest rate charged by the financial institute was 12-15 percent whereas non-financial institute charged 20-30 per cent. Availability and source of fund seems to be an important factor determining thresher investment.

(5) Contractor Service System

Farmer who could not invest in rice thresher can access to the service of rice thresher through the contractor service system. The contractor charge rate was about 80-100 baht per ton. This rate is paid in cash and covers only labor cost of thresher operator, fuel & oil cost, transporta-

tion cost, and machine service charge. Another 5-6 laborers are needed to work in conjunction with the thresher, the wage payment of which befalls upon the hiring customer.

Farmers who own thresher usually also render the service of their machines to non-owning farmers in the contract market. In Chachoengsao and Supanburi provinces it was found that the quantity of rice threshed as custom work is much higher than that threshed on own farm. The custom operation in these two areas comprises around 83-89 per cent of total rice threshed of thresher owners.

Apart from farmers who participate in contractor system, merchants and other thresher investor also enter into the market of thresher service. The high profitability seems to be the reason that induce them to the business.

Entry barrier to the contract market since the early age of machine adoption is relatively low because there is no law, regulation, or market monopoly that restrict new entrants. This free entry to the market is beleived to be a major factor that make service of machine available to farmer extensively and with a very rapid rate. The more the new entrants appear, the lower the quantity of rice threshed by established investors. Thus the market is extended and nullify the increase in contractor charge rate. Only by maintaining or lowering the existing rate can the thresher investors protect their market shares.

Moreover, since the period of demand is very short, the higher the speed (output/hour) that thresher can perform the larger is the market share that can be captured. This factor led to the development of bigger threshers with 2-3 tons/hour capacity [10] and results in the economy of scale in rice threshing. That the contractor charge rate stayed put over 1975-1982 may result from this competitive pressure.

The existence of and the high competition in the market of rice thresher service has so far been beneficial and speed up the diffusion of mechanical threshing. However, these market situations exist mainly in the Central Region where irrigation is available and double cropping can be grown. Contract market of rice thresher has also been developed in the irrigation area of other regions where double cropping was just introduced. The example of the Central Region should be introduced to those developing areas.

(6) The Establishment of Local Farm Machinery Industry

The local manufacturers have totally supplied all rice threshers to farmers since the early age of machine adoption (1975). The number of firms produceng rice threshers increased from 2-3 firms in 1975 to 24 firms in 1981. However, in addition to rice thresher

these firms produce other farm machines and farm implements. The total number of rice thresher produced by local manufacturers has never been actually reported.

Entry into rice thresher production can be done easily because there are no legal barrier to entry or any monopoly power to confine new entrant. Moreover, the established firms producing other types of farm machines can switch their production resources to rice thresher. The lack of patent right on machine design also eliminates another barrier to entry--copying products of other firms.

(7) Demonstration Effect and Other Factors

The other factors that may affect thresher diffusion and adoption are demonstration effect, level of education, and attitude.

Demonstration effects play the most important role in the early age of machine adoption. Investment in new agricultural technology is faced with a high risk because farmers are not familiar and cannot ascertain the outcome of new technology. Introducing a new technology take a longer period of time for farmer to adopt them at the begining. The government and manufacturers may not succeed in promoting the use of new farm machines if the farmers feel that there is very high risk in adoption. This might be a reason why the introduction to the use of farm tractor in the early

1950's by government and importer did not succeed. However, in the case of rice thresher, enthusiastic adoption took place in the same year of introduction.

The rapid adoption in such a very short period may come from the reason that farmers in Chachoengsao area (first area of thresher adoption) have been already familiar with new technology and have a good economic status.[11] Moreover, the guarantee of local manufacturers to take care of any performance problem of the threshers that might arise substantially reduce investment risk in these threshers.

Demonstration of the use of rice threshers by the Division of Agricultural Engineering and local manufacturers may have the effect of reducing the risk in the early adoption rice thresher. The ample information about machine performance is a way to reduce the risk in the use of rice thresher.

The attitude of farmer may affect rice thresher adoption. Farmers' decision in switching from traditional method to the use of rice thresher may not depend on economic factors but on their attitude. Some farmers in Chachoengsao Province did not adopt thresher because, they said, they already had tractors that can tread rice and they did not want to pay cash. (Pathnopas, 1980)

III. IMPACT OF RICE THRESHER ADOPTION

The impact of thresher adoption is herein delineated into two parts: (1) the impact on agricultural sector, and (2) the impact on manufacturing and service sectors.

1. Agricultural Sector

Impacts on agricultural sector will be considered from the aspects of employment, output, and income of farmers.

1.1 Impact on Employment

Rice thresher requires less labor input than any other alternative methods.[12] (Table 4) However, the resulting reduction in labor demand will not generate unemployment among farmers as there is excess demand for labor in harvesting period. Adoption of rice thresher would therefore increase farmers' productivity and at the same time release farmers to do other jobs. Farmers in Chachoengsao and Supanburi spent their saved time in land preparation for the next crop and in leisure.[13] (Table 5)

The existence of contract market for thresher service is also beleived to augment employment. Thresher requires 6-8 persons to operate. The adoption of thresher therefore increases demand for labor per unit of time. This number of labors come from family labor, exchanged labor, and hired labors. Labor can be hired at either in hour or in unit of output.

1.2 Impact on Output

Impact of thresher is not clearcut. Rice thresher may release time for farmers to plant the second crop. However, the amount of contribution of thresher to the output could not identify. In Thailand the use of thresher increases the per cent of grain loss by 0.54-0.72 per cent.[14]

Rice thresher also reduces threshing period of the second crop that is harvested in the wet season. The use of thresher reduces the per cent of output damage due to high moisture and rain. However, the rice millers complaint that paddy processed by rice thresher has a high moisture content which makes storaging difficult. The rice millers claimed that with the help of rice thresher farmers can thresh rice with a high moisture content but the traditional method cannot.[15]

1.3 Impact on Income

Farmers who adopt rice thresher will receive either explicit or implicit income from cost saving. The amount of cost saved for farmers who switch from animal treading to rice thresher was 95.00 baht/ton. Farmers switching from tractor treading to rice thresher gain 53-64 baht/ton.[16]

Farmers who invest in rice thresher also gain a higher income augmented by custom service. The average income/year was about 13,000 and 20,600 baht in Chachoengsao and Supanburi provinces, respectively in 1978/79 crop year.[17]

Farm labor who was hired to work with thresher also earned their income from the thresher service market. Market wage rate of farm labor during the harvesting period was 80 baht per day.

2. Manufacturing and Service Sector

The increase in demand for rice thresher also increases the demand for inputs in manufacturing, wholesale and retail, and maintenance service sectors. The growth rate of demand for rice thresher approximated 8-9 per cent per year. The value added contributed by a rice thresher represented about 60 per cent of production cost, or 9,155 baht/unit of thresher.[18] This value added was not included in the value of power engine that was imported from abroad. Direct labor cost in thresher production was 2,290 baht per unit of thresher.[19] The rest of the value added came from domestic material cost.

Thresher also generated additional value added in wholesale and retail farm machinery market. Usually the additional cost, over and above the prodcution cost, that is charged from wholesale and retail service was 15-20 per cent of the total cost of production.

Thresher is one among the durable capital goods and thus requires repairs and maintenance. The rapid adoption of rice thresher in Thailand resulted in increased demand for repair and maintenance services. However, the amount of value added from such a service has never been figured out.

When the number of thresher (6,224 units in 1979/80) are multiplied to the unit value added, the impact of rice thresher on manufacturing and service sectors becomes substantial. It was about 71-76 million baht at 1981 production cost.[20]

IV. CONCLUSION AND REMARKS

Rice threshing technology in Thailand comprises of the traditional methods and mechanical threshing methods. The change to mechanical threshing began in 1975. Reasons of the change can be explained by the three steps of technology change: invention, innovation and diffusion.

Invention and innovation of rice thresher took place at the IRRI at Laguna, Philippines but the spread of rice thresher technology to Thailand arises from the cooperation between local manufacturers and the Thai-IRRI program in Bangkok. Diffusion of technology to farmers depends on various factors: irrigation, double cropping, HYV rice, contractor service system, benefits accrued to thresher

users and investors, the ability to invest in rice thresher, the existence of local farm machinery industry, and demonstration effects. Among these factors, the first three factors are the preconditions for thresher adoption. The rest contribute to the forming of favourable decision of the farmers and investors towards rice thresher. However, some farmers would not adopt threshers due to their attitude. Adoption of rice thresher to Thai agriculture has employment, output, and income impacts. Its adoption does not aggravate unemployment problems since it is used during the harvesting period where the demand for labor is at its height.

On the other hand the use of thresher increases labor productivity in that period. Output impact is negative, manifesting itself in loss of grain in both quantitative and qualitative terms. But the loss is minimal when compared to the benefits. Farmers and investors also earned an additional income from providing thresher services to others.

Thresher adoption also has impacts on production, marketing, and maintenance through linkage effects. The adoption therefore generates private benefits to all those who are engaged in economic activities related to rice thresher: producers, marketing people, thresher users, and investors.

Rice thresher adoption concentrates mainly in the Central Region. Development of new irrigation areas in

other regions, the increase in double cropping practice, and the emerge of contract market for machine service would promote thresher adoption and magnify its impacts. The market structure of machine service in the Central Region should be promoted in the other regions (Northern and Southern regions) where the use of rice thresher is imminent. Further research, development, and demonstration for axial-flow thresher and wireloop-type thresher should be attempted for the Northern and the Southern regions.

FOOTNOTE

1 Data from (1) Department of Agriculture, Ministry of Agriculture and Cooperatives, "Survey on Post Production Practice in Thailand, 1976," Bangkok, 1976. (2) Chulalongkorn University, Social Research Institute, "Reduction of Post Harvest Loss of Rice," Bangkok, 1983.

2 Division of Agricultural Engineering, Department of Agriculture, Ministry of Agriculture and Cooperatives, "Testing and Evaluation of Rice Thresher for the South," Bangkok, 1980, p. 2.

3 Distribution of rice thresher by regions obtained from Sukharomana, S. (1981), Table 4. Per cent of distribution calculated from Agricultural Statistic of Thailand Crop Year 1975/76, Table 90, pp. 183-90.

4 Department of Agriculture, Ibid.

5 According to Schumpeter, Joseph A. The Thoery of Economic Development: An Inquiry into Profits, Capital, Interest and the Business Cycle. (Cambridge, Mass.: Harvard University Press, 1934).

6 Pathnopas, R. (1980).

7 Pathnopas, R. Ibid.

8 Kittikul, Jirapa. (1980).

9 Pathnopas, R. Op cit.

10 Observed information gained from the field survey on The Consequences of Farm Mechanization in Thailand, November, 1982.

11 Ronald Ng. found that Thai farmers who employed new technology usually have relatively good economic status and good education background. For farmers in Chachoengsao, the same is true in the case of economic status but for the level of education it seems to be uncorrelated. However, good education should not be considered only from the level of education but also from the degree of technology perceptiveness.

12 Supachat Sukharomana, "The Impact of Farm Power Strategy in Thailand," A paper presented at the International Seminar on Farm Power, 25-29 October 1982, Agrarian Research and Training Institute, Columbo, Sri Lanka, Table 14, p. 68.

13 Pathnopas, R. op cit., Appendix Table F, p. 142.

14 Krishnasreni, S. and other, "Threshing Method in Thailand," A paper presented at Grain Post-Harvest Workshop, Kuala Lumpur, Malaysia, January 1980, p.8.

15 Comments of rice millers in Supanburi Province and Khonkhaen Province in 1982 and 1983, personal survey.

16 Pathnopas, R. op cit., Table III-7, p. 63.

17 Loohawenchit, C. and Pathnopas, R., "Evolution and Role of Farm Machinery in Thailand," Thammasat University Journal, Vol. 10, No. 3, September 1981, p. 54. (Thai version)

18 Sukharomana, S. op cit.

19 Ibid.

20 Calculated by the number of rice thresher produced in 1979/80 and the value added of rice thresher production plus the wholesale and retail value added.

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Table 1. Number of manufacturers engaging in farm machinery and farm implement production, 1979.

Type of machine and implement	Number of firms*
Two-wheel tractor	100
Small four-wheel tractor	20
Large tractor	3
Rice thresher	21
Other grain threshing machine	19
Water pump (axial flow)	10
Water wheel	3
Plough	29
Disc plough for tractor and blade	11
Trailer	11
Puddler	3
Rotary Hoe	2
Plough handle	2
Locally made truck for farm	1
Implement for sugarcane	3

*More than one product produced by a firm.

Source: Pisit Samahito and Karnket Kongkietngarm, "Farm Machinery and Farm Equipment Production: Part I Farm Tractor and Power Tillers," Bank of Thailand, Bangkok, 1979.

Table 2. Average cost of rice threshing by different threshing method.

Unit: baht/ton

Threshing method	Fixed cost (1)	Variable cost (2)	Total cost (3)=(1)+(2)
1. Hand beating			
- on basket	14.35	63.51	77.86
- on mat	4.52	62.18	66.70
2. Buffalo treading	39.40	94.20	133.60
3. Two-wheel tractor			
- imported	19.63	102.83	122.46
- diesel engine	10.38	102.29	118.67
- gasoline engine	14.22	104.94	119.16
4. Small four-wheel tractor			
- imported	27.17	95.10	122.27
- domestic	19.65	93.81	113.46
5. Tractor treading			
- life span 8 years	24.76	71.92	96.68
- life span 10 years	28.00	72.10	100.10
- life span 12 years	30.36	72.10	102.42
6. Axial-flow thresher			
6.1 Diesel engine			
- life span 6 yrs	10.97	63.15	74.12
- life span 7 yrs	12.40	63.23	75.64
- life span 10 yrs	15.80	63.23	79.03
6.2 Gasoline engine			
- life span 6 yrs	8.54	65.50	74.04
- life span 7 yrs	9.66	65.56	75.22
- life span 10 yrs	12.30	65.56	75.66

Source: Jirapa Kittikul, "Cost of Rice Threshing and Its Economic Impacts," Master Thesis, Faculty of Economics, Thammasat University, Bangkok, 1980, Table 3.8, p. 55. (in Thai)

Table 3. Benefit-cost ratios at different discount rates by investment year, 1975-78.

Discount rate (%)	Investment year			
	1975	1976	1977	1978
Chachoengsao				
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

Source: F. Juarez and R. Pathnopas, "A Comparative Analysis of Thresher Adoption and Use in Thailand and the Philippines," September 1981, Working paper No. 28, Table 21.

Table 4. Labor input used in rice threshing activity, by different method.

Unit: man-day/ton

Threshing method	Source of information		
	Kittikul's	Pathnopas's	
		Supanburi	Chachoengsao
Hand beating	1.86	-	-
Animal treading	1.02	3.84	-
2-wheel tractor	1.80	1.76	1.49
4-wheel small tractor	1.50	-	-
Large tractor	1.11	-	-
Rice thresher	0.62	0.98*	0.73*

Threshing capacity in Chachoengsao Province = 0.60 ton/hour and 0.80 ton/hour in Supanburi Province.

Source: Supachat Sukharomana, "The Impact of Farm Power Strategy in Thailand," A paper presented at the International Seminar on Farm Power, 25-29 October 1982, Agrarian Research and Training Institute, Columbo, Sri Lanka, Table 14, p. 68.

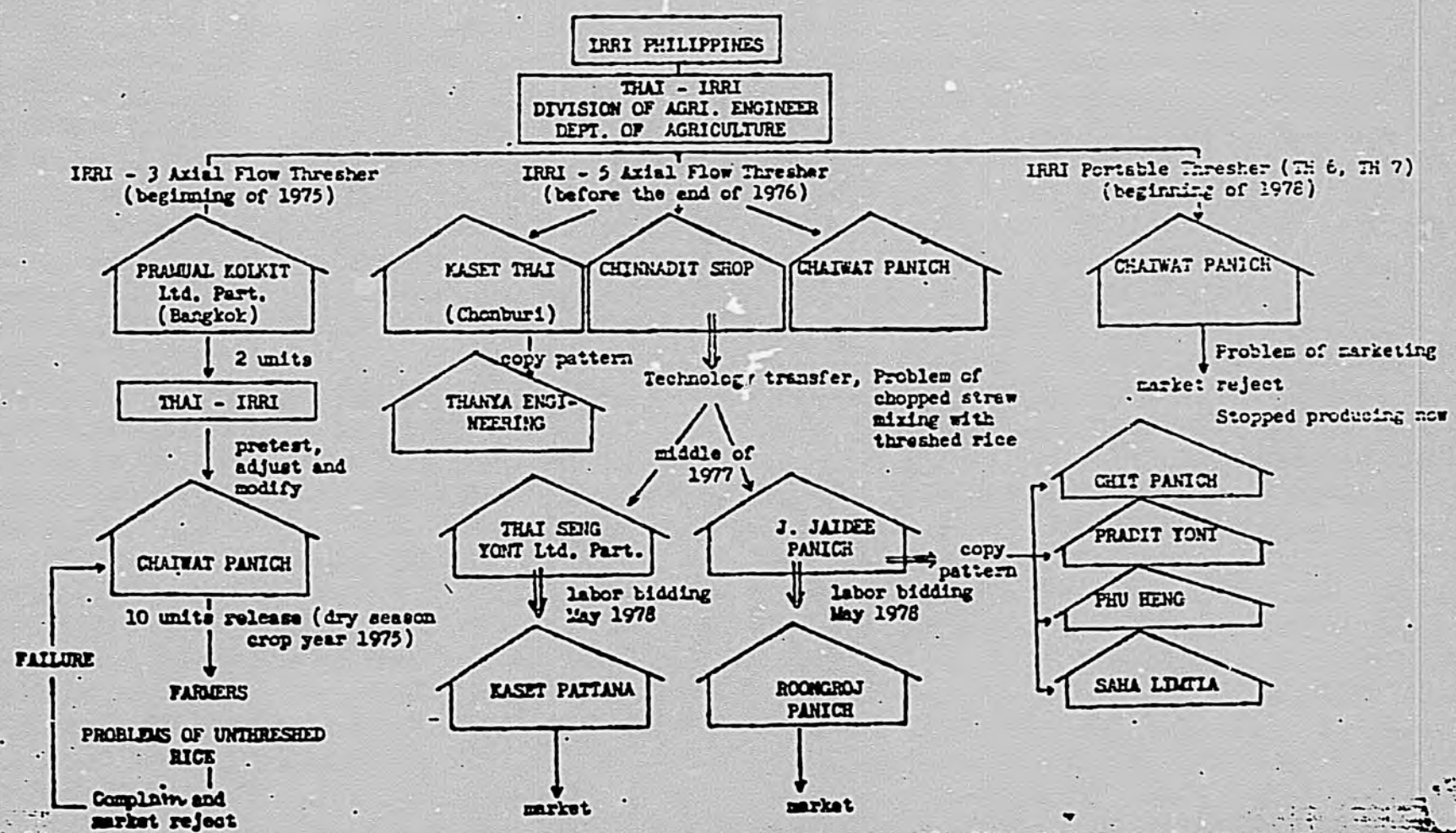
Table 5. Utilization of time saved.

Activity	Farmer owners-users		Farmer user	
	household	%	household	%
leisure	16	24.4	45	28.8
Land preparation for next crop	34	54.0	19	12.2
Hire out thresher	19	30.2	0	0
Labor for land preparation	1	1.6	12	7.7
Labor for harvesting	0	0	2	1.3
Exchange labor for threshing	1	1.6	4	2.6
Fishery	4	6.3	16	10.2
Government officer	1	1.6	1	0.6
General job	7	11.1	16	10.2
No answer	0	0	44	28.2
	(n = 63)		(n = 156)	

n is number of sample size.

Source: Renu Pathnopas, "The Economics of Rice Threshing Machines in Thailand: A Case Study of Chachoengsao and Supanburi Provinces," Master thesis, Faculty of Economics, Thammasat University, Bangkok, 1980. Appendix Table F, p. 142.

Figure 1 Flow Chart of the Development of Technology Transfer and Adaptation of Locally Made Rice Thresher (A Historical Background)



Source: Remu Pathnopas, "The Economics of Rice Threshing Machines in Thailand: A Case Study of Chachoengsao and Supanburi Provinces," a Master's Thesis, Faculty of Economics, Thammasat University, Bangkok, 1980, Table II-7, p. 30.