THE IMPACT OF FARM MACHINERY ON THAI AGRICULTURE: AN EVALUATION OF THE IRRI INDUSTRIAL EXTENSION PROJECT

Vasantha Narendran

Dow Mongkolsmai

Rapeepun Jaisaard

BEST AVAILABLE

FORWARD

The goal of the International Rice Research Institute industrial extension project is to increase small farmer production, income and employment by facilitating greater cropping intensity, less spoilage, better tillage etc. This goal is to be achieved by the purpose of disseminating IRRI's machines to manufacturers who will build them and sell them to farmers.

The purpose of this report is to, first, assess the consequences of machanical technology in Thailand and then to appraise the IRRI extension programme within the context of farm technology development in the country.

Faced with severe constraints on time, the entire exercise is rather brief and the survey is limited to only two areas, one in the central plains and the other in the north. The work in the central plains was carried out in Supanburi province by a team from Thammasat University headed by Dr. Dow Mongkolsmai. We were also very fortunate to have been allowed to use the data from the "Consequences of Farm Mechanization" an on-going project funded by USAID in conjunction with IRRI. The valuable information derived from the Consequences survey has substantiated considerably our own data collection.

Dr. Rapeepun Jaisaard, (from Chiengmai University), coordirated the team, which carried out the survey in the north. She was ably assisted by Supasark Simpiti, an agricultural engineer who was responsible for the survey on the farm machinery fabricators.

Mention has also to be made of Dr. Chesada Loohawenchit who within the very short time available to him was willing to survey the manufacturers of farm machinery in the greater Metropolitan Bangkok area. Fortunately for us again, Dr. Chesada is presently involved in an ILO sponsored project on farm machinery industry. Data from this survey has proved most useful.

Last but not least we want to thank all our imformants, without whose cooperation a survey of this kind would have hardly been possible. We had only 5 weeks to prepare the questionaire, issue the surveys and write up the report.

Vasantha Narendran

Dec. 6, 1979

Bangkok

TABLE OF CONTENTS

		Page
1.	Introduction	6
2.	Farm Studies	7
	a. Central Plains	7
	b. The North	26
3.	Survey of Farm Machinery Fabricators	48
4.	Summary of Findings	63
5.	Case Studies	72

Introduction

Agricultural production in Thailand, especially of rice, is developing rapidly from subsistence production to commercial production. Until quite recently this increase in production was attributed to the expansion of the cultivated land. Now, however, it is recognized that Thailand has exhausted her agricultural land and continuing agricultural growth in the country is seen to be a function of intensive cultivation of limited land and the increasing use of high yielding varieties. To achieve this agricultural growth, farm mechanization together with irrigation and biological and chemical innovation is being induced with increasing frequency.

In the light of mechanical technology becoming more prominent in Thai agriculture, the efforts and design of the International Rice Research Institute (IRRI) farm mechanization extension programme need to be assessed. This document has thus been designed to address the extent to which IRRI designed farm machinery has gained a foothold among farmers in the country. The analysis is thus two-fold:
(a) a quick assessment of the consequences of mechanical technology in Thailand, by way of introduction to (b) an appraisal of the IRRI extension programme in terms of IRRI product development to suit local conditions; provision of technical assistance to manufacturers to upgrade production quality; the promotion of IRRI designed machinery to farmers and; the extent to which IRRI and manufacturers of IRRI designs incorporate the practical advice and complaints of farmers into product design.

Mechanization of small farmers in Thailand, as elsewhere in developing nations, is a controversey centered around three majour issues: does mechanization enhance output and if so, how; to what degree is labour displaced by farm machines and what are alternative employment opportunities for that labour and; to what extent are the benefits of mechanization felt in all levels of the farming populace.

Mechanization poses a paradox. On the one hand, the direct function of mechanization is often seen as the replacement of labour. This is undesirable in labour intensive countries. On the other hand, mechanization permits faster, less laborious completion of farm tasks, is claimed to raise yields and permit greater intensity of land use and raises labour productivity and income. Then, the issues for Thailand, as for other developing Asian countries and development assistance agencies revolve around the questions of whether mechanization will speed or retard the pace of development, increase or decrease the degree of income equality, reduce or increase employment, and whether it will speed or slow the rate of food production.

Central to this study is a series of two-week farm level survey studies of the production, resource use, income and employment effects of farm mechanization. A small survey, undoubtedly does not adequately capture the dynamic implications of mechanization in allocation of resources within farm households and village communities.* Be that as it may, the survey constitutes cross sectional field research in

---

*The "Consequences of Farm Mechanization" study which will be completed in 6/82 will provise a more In-Depth Investigation of the Impact of Mechanization in Thailand.

two regions in the country: the central plains and the north. The samples include cells which cut across different water regimes (rain-fed, irrigated or both) as well as different farm technologies (animal traction, mechanization or a combination).

For the central plains, amphoe Don Chedi in Supanburi province was chosen as the site. It is one of the older settled areas of the central region; amphoe Don Chedi is a majour rice growing area; it was also among the first areas to adopt new varieties of rice, mostly for dry season planting. In 1977, 59% of the area planted to wet season crop was also planted during the dry season crop. Most farms that grow two crops per year have mechanized their land preperation. Small tractors (of less than 15 h.p.) of both two and four wheeled designs are popular, but most small tractor uses also keep at least one buffalo. Mechanical threshing is also begining to make inroads and there are several thousand low lift propeller pumps in operation.

The sample households from the central plains have been tabulated below. They reflect the extent to which ecology and a water regime combine with the general pattern of farm technology. As will become clear later when we present a series of case studies flushed out from the research in Don Chedi, mechanization is not a function of a singular variable but a combination of variables. Thus, for instance, farms in the rain-fed area in the central plains are much larger than those in the irrigated area, and land preparation is mechanized. In the north, the rain-fed farms are larger too but farm technology is totally dependent on animal traction. This only goes to show that the correlation between farm technology and any other related variable is subject to local agro-climatic and other conditions.

TABLE 1

SAMPLE HOUSEHOLDS IN THE CENTRAL PLAINS

Rainfed Area (RF): Talaybok Village # 6		
Animal	4	households
Animal + Machine	5	" "
Tractor + Power Tiller	1	" "
Total	10	households
Irrigated Area (IR): Plubplachai #3,4, Rairot #1, Donchedi #6		
Power Tiller (Hire)	5	households
Power Tiller (Own)	6	" "
Animal + Machine	3	" "
Animal	2	" "
Power Tiller (Borrow)	1	" "
Tractor (Hire)	1	" "
Tractor (Own)	2	" "
Total	[illegible]	households

The study in the North was spread over two districts. Chiang-Dao does not have an irrigation canal but nontheless has a reliable water supply all year round. This has made it possible for the villagers to multi-crop, rice of the traditional variety in the wet season and garlic in the cool season. Land preparation is mechanized with most of the farmers owning power tillers, of the IRRI design, manufactured locally in Chiang Mai. All tillers were bought directly from that one manufacturer. This IRRI designed tiller has in fact turned out to be the most suitable: it has a rotary tiller and can be used for dry land cultivation; it is lighter and the farmer has no problems carrying it over the rice bunds which tend to be higher than the rice fields. Furthermore, the smaller wheels combined with the light weight of the machine enables the farmer to negotiate turns with relative ease. Farm mechanization in Chiang-Dao is a relatively recent phenomenon which has remained at land preparation. IRRI designed threshers have not been introduced in the North as yet. Anusarn, the manufacturer of IRRI designed power tillers has produced a proto-type power thresher but responses to the thresher have not been encouraging. There are a number of reasons for this lack of enthusiasm which will be discussed later on in the report.

The other research site in the North was San Kamphang, an area of rain-fed agriculture dependent on animal traction. Subsistence is derived from the rice field while off-farm employment provides the cash income. Listed below is a tabulation of the sample households for the North.

TABLE 2

SAMPLE HOUSEHOLDS IN THE NORTH

Rainfed Area (RF): Sankamphang		
Animal (Own)	17	households
Animal (Hire)	3	" "
Total	20	households
Reliable Water Supply Area (IR): Chiang-Dao		
Power Tiller (OWN)	7	households
Power Tiller (Hire)	2	" "
Animal and Machine	3	" "
Animal (Own)	10	" "
Animal (Hire)	3	" "
Total	25	households

To assess the consequences of farm mechanization in general and the role of IRRI has played thus far in the expansion of mechanical technology in Thai agriculture, this study would be meaningful only if the fabricators were involved too. Thus, a sample series of fabricators in the metropolitan Bangkok area has been included.

We document our study by first presenting our findings from the farm level survey in the two research areas. This is followed by the report on farm machinery manufacturers. The paper is brought to a close with a summary of our findings; to substantiated these findings we present six case studies which will contextualize if not make more meaningful the data presented here.

Farm Studies

A. Central Plains

Don Chedi is one out of nine amphoes in Supanburi Province. It covers an area of 234,375 rai or 375 square kilometres. There are 5 tambons or 29 villages in this area. The population is around 45,000 persons. Amphoe Don Chedi shares a common border with the following amphoe:

North - Amphoe Sam Chuk, Supanburi Province

South - Amphoe Uthong, Supanburi Province

East - Amphoe Sriprachand, Supanburi Province

West - Kanjanaburi Province

Supanburi Province has been well know as a rice producing area in Thailand for quite sometime. About 84 per cent of the total agricultural holding area is planted to rice. It is well supplied with rain water for about six months of the year, from May to October.

In the past few years as a result of newly completed irrigation facilities, farms in Amphoe Don Chedi have started producing a second crop of rice. From official statistics collected in 1977, the area planted to a second crop of rice is as high as 59 per cent of the area planted to the main rice crop.

In areas where double cropping has taken place, there is now widespread use of farm machinery, especially two-wheel tractors. For areas outside the irrigation system, farming still employs mostly traditional

methods such as buffalo ploughing. In such areas there is only one planting of rice a year.

The average rice yield in Amphoe Don Chedi is about 54 tang or 567 Kg. per rai. The varieties of rice used are mostly traditional ones especially Lueng Patiew. The new RD varieties have also been adopted recently.

Household Samples

The sample of 34 households consists of 24 mechanized farms, 6 non-mechanized, and 4 landless laborers. Six of the mechanized and four of the non-mechanized farms were randomly chosen from Talaybok, village # 6, a rainfed area in Amphoe Don Chedi. The rest of the samples are from the irrigated areas of Rairot, village # 1 and Don Chedi, village # 6 in Amphoe Don Chedi; Plubplachai, village # 3 and 4 in Amphoe Uthong, South of Amphoe Don Chedi.

Basic Farm Information

Farms in rainfed area, whether mechanized or non-mechanized, tend to have a larger landholding than farms in irrigated area. The average farm size of mechanized farms, however, is greater than non-mechanized ones. For the rainfed area, the average size of mechanized farms is 63.5 rai or about 10.2 ha., while non-mechanized farms average about 33.75 rai or 5.4 ha. The figures for the irrigated area are 19.4 rai or 3.1 ha. and 12 rai or 1.9 ha. for the mechanized and non-mechanized farms respectively. One implication that may be drawn from these figures is that farmers may be able to remain non-mechanized if their farms are small. Although farmers

TABLE 3

BASIC FARM INFORMATION OF SAMPLE HOUSEHOLDS THAT HAVE MECHANIZED

Household Number	Family Size			Size of Land Holding (Rai) (c)	Cropping Pattern (Rai) (d)			Cropping Intensity (d/c) X100	Yield (kg./Rai)	Type of Farm Technology Make & Year of Purchase	[illegible]	[illegible] of Farm Technology (Season)	
					Wet		Dry						
	M	F	Total		Rice	Others[1]	Rice					Wet	Dry
RF													
418	4	5	9	89	86	3	-	100		Tractor + Buffalo		[illegible]	
420	3	2	5	65	60	-	-	92		Tiller + Tractor		[illegible]	
421	6	4	10	79	64	10	-	94		Tiller + Buffalo		[illegible]	
423	5	4	9	67	43	24	-	100	av.	Tractor + Buffalo		[illegible]	
424	2	3	5	43	43	-	-	100	300	Tractor		3(a)	
426	2	3	5	38	38	-	-	100		Tiller + Tractor		1(a)*	
IR													
101	2	1	3	13	13	-	-	100		Tiller		[illegible]	
157	1	3	4	10	10	-		100		Tiller + Pumpset		1(a)*	
102	-	5	5	27	25½	-		94		Tiller+Tractor+Pumpset		1(a)*	
Kun (#4/3)	2	1	3	7	7	-		100		Tiller		1(a*)	
Keow (#140/1)	2	6	3	10	10	-		100		Tiller + Buffalo		1(a)	

Note: [1]Others include maize millets, vegetables, mungbeans.

Key: 1. Machine technology
2. Animal traction
3. Machine technology and animal traction
(a) technology used in land preparation
(b) technology used in post harvest
*farmer rents machine
**farmer hires both buffaloes and machine (no rental of pumpsets).

TABLE 4

BASIC FARM INFORMATION OF SAMPLE HOUSEHOLDS
THAT HAVE MECHANIZED (CTD)

Household Number	Family Size			Size of Holding (Rai) (c)	Cropping Pattern (Rai) (d)				Cropping Intensity (d/c) X100	Yield (Kg./Rai)	Type of Farm Technology Make & Year of Purchase	Type of Payment for Farm Technology	Use of Fa Technolog (Season)	
					Wet		Dry							
	M	F	Total		Rice	Other	Rice	Other					Wet	Dr
IR											Tiller (Mitsubishi) 1969			
130	1	5	6	40	40	-					Pumpset 1978	Cash (Savings)	1(a)	
136	1	4	5	15	15	-					Tiller (Robin) 1976	Cash (Savings)	1(a)	
142	3	1	4	7	7	-	av.				Tiller (Kubota) 1978	Cash (Savings)	1(a)	
140	-	3	3	52	52	-	60%				Tiller (Kubota) 1977 Pumpset 1977	Cash (Savings)	1(a)	
147	3	2	5	14	14	-	of		av.	av.	Tiller (Mitsubishi) 1974	Cash (Savings)	1(a)	
Sawang	3	2	5	37	37	-	wet		160	570	Tiller (Mitsubishi) 1973 Pumpset (Mitsubishi) 1978	Cash (Savings)	1(a)	
155	2	2	4	10	10	-	season				Tiller+Pumpset+Buffalo		3(a)*	
Bang	2	1	3	9	9	-	rice				Tractor + Buffalo		3(a)*	
Tongkam	2	2	4	10	10	-					Tiller+Buffalo		3(a)*	
Somdet	1	2	3	14	14	-					Tiller (Borrow)		1(a)	
154	-	4	4	20	20	-					Tractor+Pumpset (Honda) 1972		1(a)*	
Yong	5	2	7	25	25	-					Tractor (Mitsubishi) 1977 Pumpset (Yamaha) 1976	Cash (Savings)	1(a)	
Dokmai	4	4	8	29	29	-					Tractor (Mitsubishi) 1977 Pumpset 1978	Cash (Savings)	1(a)	

TABLE 5

BASIC FARM INFORMATION OF SAMPLE HOUSEHOLDS
THAT HAVE NOT MECHANIZED

Household Number	Family Size			Size of Land Holding (Rai) (a)	Cropping Pattern (Rai) (b)			Cropping Intensity (b/a)X100	Yield Kg./rai
	M	F	Total		Wet		Dry		
					Rice	Others[1]	Rice		
RF									
402	2	1	3	16	$15\frac{3}{4}$	¼	-	100	av. 300
408	2	1	3	50	49	1	-	100	
415	3	6	9	30	29	1	-	100	
413	6	3	9	39	25	14	-	100	
IR									
313	4	1	5	14	14	-	av. 60% of wet season rice	av. 160	av. 560
Bho	4	2	6	10	10	-			

Note: [1]Others include maize, millets, vegetables, mungbeans.

in the rainfed area grow only one crop of rice per year, the large size of their land holding may have necessitated mechanized land preparation in order to be in time for the rain. The irrigated farms which have not mechanized are relatively small and land preparation even for 2 crops a year can be handled by buffaloes.

The cropping patterns and intensities are more distinct between rainfed and irrigated than between mechanized and non-mechanized farms. In rainfed area, although most of the land is under rice in the wet season, other crops such as maize, millet and vegetables are also planted, especially in the high land area where there is insufficient water for rice, even in the rainy season. In the dry season, however, the land is too dry for any kind of crop to be grown and farmers have to seek off-farm work in nearby villages. Thus the cropping intensity is rather low compared with the irrigated area, where double cropping of rice is normally practised. It is noted that no other crops are grown in the irrigated areas in the wet or dry season since the land is most suited to rice; water is not a constraint in such areas.

Among the mechanized farms, the predominant types of machinery used are also distinct between rainfed and irrigated areas. Tractors are more often used by farms in the rainfed villages as well as those in the irrigated side of the mixed villages (Don Chedi # 6 and Plupplachai #3 and 4) while power tillers are generally found among farms irrigated villages. The above patterns of farm technology may be explained by the existence of upland crop areas such as sugar cane in and around the rainfed villages. Tractors are more suitable for such areas than power tillers

and their owners usually provide custom services to nearby rice farmers. It is noted that all mechanized farms in the rainfed area hire machines to work on their farms. Besides, these farmers may not find it worthwhile or be able to afford buying a machine since they can only grow one crop a year. Most of them still maintain buffaloes for field work.

For those farmers who own a machine, most of them bought a power tiller not more than 6 years ago. Only one bought it as early as 1969. The farmers either paid for these machines from their savings or borrowed part of the money from relatives. Credit from institutional sources are very recent and the amounts are rather small. The major purposes of these institutional credits are for purchase of supplies (fertilizer, etc.) and for hiring labor.

Production Costs

Non-mechanized farms, especially in the rainfed area, hardly hire labor or apply fertilizer and pesticides. Their cash payments for farm inputs are therefore small relative to mechanized farms. Among the latter, irrigated farms spend more on hired labor as well as supplies than rainfed farms. It is interesting to note that mechanization and hiring of labor tend to appear together while application of fertilizer and pesticide only takes place in irrigated farms, whether mechanized or non-mechanized. The limited data available here, however, do not allow any conclusions to be made regarding the effect of mechanization on employment of labor.

TABLE 6

PRODUCTION COSTS (CASH PAYMENT) PER RAI OF MECHANIZED FARMS: WET SEASON 1979

Household Number	Size of Parcels (Rai) and Land Tenure[1]			Hired Labor[2]		Interest (฿ per Year)	Supplies (฿ per Rai)		Land Rental ฿ per Rai	Machine Rental ฿ per Rai
	Parcel #1	Parcel #2	Parcel #3	Man-Hours per rai	฿ per rai		Fertilizer	Pesticide		
RF										
418	52 (O)	21 (O)	16 (R)	-	-	2,400	-	-	depenson output	50
420	25 (O)	40 (O)	-	1	40	-	-	-	-	60
421	40 (O)	34 (O)	-	1	21	360	-	-	-	50
423	18 (O)	29 (R)	20 (R)	1	16	360	-	-	128	60
424	43 (O)	-	-	2	69	600	-	-	-	50
426	38 (O)	-	-	2	60	3,720	-	-	-	40
IR										
101	12 (O)	1 (O)		24	294	-	248	27	-	50
157	8 (O)	2 (O)		9	140	960	159	10	-	85
102	4 (O)	20 (R)	3 (R)	8	74	360	-	-	-	67
Kun (#4/3)	7 (O)			61	287	-	94	-	-	50
Keow (#140/1)	7 (O)	3 (O)		16	226	2,400	44	19	-	100

TABLE 6 --continued

Household Number	Size of Parcels (Rai) and Land Tenure[1]			Hired Labor[2]		Interest	Supplies (฿ per Rai)		Land Rental ฿ per Rai	Machine Rental ฿ per Rai
	Parcel #1	Parcel #2	Parcel #3	Man-Hours per rai	฿ per rai	(฿ per Year)	Fertilizer	Pesticide		
130	40 (O)			15	49	840	6	19	-	
136	5 (O)	10 (R)		28	199	261	29	14	500	
142	7 (O)			3	21	-	336	8	-	
140	30 (O)	10 (R)	12 (O)	20	137	480	154	8	dependson output	
147	14 (R)			41	163	5,400	14	9	310	
Sawang (50)	4 (O)	20 (R)	13 (R)	19	123	600	13	25	dependson output	
155	10 (O)			18	180	600	18	40	-	80
Bang	9 (O)			23	214	200	2	34	-	100
Tongkam	10 (O)			49	176	-	182	4	-	80
Somdet	10 (O)	4 (O)		11	50	-	286	75	-	
154	20 (R)			16	233	-	92	45	438	80
Yong	25 (O)			24	78	360	3	-	-	
Dokmai	29 (O)			28	193	-	109		-	

Note: [1]O = owned R = rented

[2]not including harvesting and threshing

TABLE 7

PRODUCTION COSTS (CASH PAYMENT) PER RAI OF NON-MECHANIZED FARMS: WET SEASON 1979

Household Number	Size of Parcels (Rai) and Land Tenure[1]			Hired Labor[2]		Interest (฿ per Year)	Supplies (฿ per Rai)		Land Rental ฿ per Rai	Machine Rental ฿ per Rai
	Parcel #1	Parcel #2	Parcel #3	Man-Hours per rai	฿ per rai		Fertilizer	Pesticide		
RF										
402	6 (O)	10 (R)	-	-	-	-	-	-	78	-
408	50 (O)	-	-	-	-	-	-	-	-	-
415	10 (O)	20 (R)	-	-	-	600	-	-	67	-
413	25 (O)	14 (O)	-	.05	4	600	-	-	-	-
IR										
313	14 (O)	-	-	-	-	-	-	1	-	-
Bho	10 (R)	-	-	16	70	-	6	5	depends on output	-

Note: [1] O = owned R = rented

[2] not including harvesting and treshing

The expenditures on hired labor vary a great deal among farms, depending mainly on the number and type of farm activities. Since most farmers own their land, rent constitutes a large part of the total expenditure only for a few farmers.

Farm Technology

Draft animals are used by non-mechanized farms. Most of them own more than three buffaloes, the prices of which range from 800 to 6,000 baht each depending on the sex and age of the animals.

All mechanized farms in the rainfed area hire either a tractor or a power tiller for land preparation. The rental rates vary between 40 and 60 baht per rai. These farmers also use draft animals for land traction.

Mechanized farms in the irrigated area which hire machines pay between 50 and 100 baht per rai for the service. Note that these rental rates are higher than in rainfed area. For those who own a machine, six of them own a power tiller and two own a tractor. The tillers were purchased from Saengchai, Saha Limtia, and Chak Pet Tractor, while the 2 tractors were purchased from Ayuthaya Tractor. Both of the tractor owners rent out their machines while only two of the tiller owners do so.

Labor Utilization

Non-mechized farms mostly employ family labor for their field work. Data for harvesting and threshing are not available since farmers can provide exact answers only for the present wet season and since

TABLE 8

FARM TECHNOLOGY INFORMATION: MECHANIZED FARMS

Household Number	Type of Farm Technology	Own						Rent	
		Engine	Year of Purchase	Seller	Price (฿)	Value (P x Q)	Age (Year)	฿/Rai	Rent out
RF									
418	Tractor	-	-	-	-	-	-	50	-
	Buffalo (4)	-	-	-	4,000(2) 5,000(2)	18,000	1-3(2) 1-3(2)	- -	- -
420	Tiller,Tractor	-	-	-	-	-	-	60	-
	Oxen (6)	-	-	-	5,500(2) 3,500(4)	25,000	1-3(2) 1-3(4)		
421	Tiller	-	-	-	-	-	-	50	-
	Buffalo (7)	-	-	-	1,500(1) 7,500(2) 4,500(3) 4,500(1)	34,500	<6 month(1) 1-3(2) 1-3(3) 12 (1)	- - - -	- - - -
423	Tractor	-	-	-	-	-	-	60	-
	Buffalo (Rent)	-	-						
424	Tractor	-	-	-	-	-	-	50	-
426	Tiller, Tractor	-	-	-	-	-	-	40	-
IR									
130	Pumpset	No. Answer	1978	No Answer	1,200	1,200	1	-	-
	Tiller	Mitsubishi	1969	Saengchai	20,000	20,000	10	-	-
136	Tiller	Robin	1976	Saha Limtia	(second hand) 6,000	6,000	3	-	-
142	Tiller	Kubota	1978	Saha Limtia	21,000	21,000	1	-	130฿ per ra

TABLE 9

FARM TECHNOLOGY INFORMATION: MECHANIZED FARMS (CTD)

Household Number	Type of Machinery	Own						Rent	
		Engine	Year of Purchase	Seller	Price (฿)	Value (P x Q)	Age (Year)	฿/Rai	Rent out
IR									
140	Pumpset	Kimula	1977	Prasertsuwan	3,500	3,500	2	-	-
	Tiller	Kubota	1977	Saha Limtia	21,500	21,500	2	-	-
147	Tiller	Mitsubishi	1974	Saha Limtia	18,000	18,000	5	-	-
Sawang(50)	Pumpset	Mitsubishi	1978	No Answer	2,850	2,850	1	-	-
	Tiller	Mitsubishi	1973	Ckak Pet Tractor	14,800	14,800	6	-	60฿ per ho
101	Tiller	-	-	-	-	-	-	50	-
157	Tiller	-	-	-	-	-	-	85	-
102	Tiller, Tractor	-	-	-	-	-	-	/	-
Kun	Tiller, Tractor	-	-	-	-	-	-	50	-
Keow	Tiller, Tractor	-	-	-	-	-	-	100	-
	Buffalo (5)	-	-	-	2,000(1)		< 1(1)	-	-
					6,000(2)	26,000	1-3(2)	-	-
					6,000(2)		> 3(2)	-	-
155	Tiller	-	-	-	-	-	-	80	-
	Buffalo	-	-	-	3,000(1)	3,000	> 3(1)	-	-
Bang	Tractor	-	-	-	-	-	-	100	-
	Buffalo (5)	-	-	-	500(1)		<6 month(1)	-	-
					6,000(2)	27,000	> 3(2)	-	-
					7,000(1)		1-3(1)	-	-
					3,000(1)		1-3(1)	-	-

TABLE 9 --continued

Household Number	Type of Machinery	Own						Rent	
		Engine	Year of Purchase	Seller	Price (฿)	Value (P x Q)	Age (Year)	฿/Rai	Rent out
Tongkam	Tiller							80	-
	Buffalo				5,000(2) 3,000(1)	13,000	1-3(2) 1-3(1)	- -	- -
154	Tractor	-	-	-	-	-	-	80	-
Yong	Pumpset	Yamaha	1976	No Answer	3,000	3,000	3	-	-
	Tractor	Mitsubishi	1977	Ayuthaya Tractor	32,000	32,000	2	-	70฿ per Ra
Dokmai	Pumpset	No Answer	1978	Patanajakkoi	2,000	2,000	1	-	-
	Tractor	No Answer	1975	Ayuthaya Tractor	45,000	45,000	4	-	60฿ per Ra

TABLE 10

FARM TECHNOLOGY INFORMATION
NON-MECHANIZED FARMS

Household Number	Type of Farm Technology	Own			Rent	
		Price (฿)	Value (P x Q)	Age (Year)	฿/Rai	Rent out
RF						
402	Buffalo (1)	4,500 (1)	4,500	> 3	-	-
408	Buffalo(10)	800 (1)	48,300	< 6 months	-	-
		5,000 (2)		1-3	-	-
		6,000 (4)		> 3	-	-
		4,500 (3)		> 3	-	-
413	Buffalo(11)	6,000 (6)	66,000	> 3	-	-
		6,000 (5)		> 3	-	-
415	Buffalo (3)	1,500 (1)	9,000	1-3	-	-
		4,000 (1)		1-3	-	-
		3,500 (1)		1-3	-	-
IR						
313	Buffalo (5)	2,000 (3)	1,400	< 1	-	-
		4,000 (2)		1-3	-	-
Bho	Buffalo (6)	1,500 (1)	23,500	< 1	-	-
		5,000 (2)		> 3	-	-
		4,000 (3)		> 3	-	-

TABLE 11

LABOR UTILIZATION: MECHANIZED FARMS

Unit: Man-hour

Household Number	Family Labor					Hired Labor					Exchange Labor					Planted Area (Rai)
	Land Prep.	Planting	Care of Crop	Harvesting	Threshing	Land Prep.	Planting	Care of Crop	Harvesting	Threshing	Land Prep.	Planting	Care of Crop	Harvesting	Threshing	
RF																
418	3,900	1,200	-	-	-	15	-	-	-	-	-	-	-	-	-	89
420	552	262	-	-	-	40	-	-	-	-	-	-	-	-	-	60
421	704	325	-	-	-	36	-	-	-	-	-	-	-	-	-	74
423	2,540	88	-	-	-	36	-	-	-	-	-	-	-	-	-	67
424	180	32	-	-	-	80	-	-	-	-	-	-	-	-	-	43
426	144	25	-	-	-	64	-	-	-	-	-	-	-	-	-	38
IR																
101	213	163	6	-	-	54	264	-	-	-	-	-	-	-	-	13
157	-	202	19	-	-	24	64	-	-	-	-	-	-	-	-	10
102	10	1,050	9	-	-	44	150	-	-	-	-	-	-	-	-	25½
Kun (#4/3)	16	34	10	-	-	30	400	-	-	-	-	-	-	-	-	7
Keow (#140/1)	44	194	17	-	-	102	48	9	-	-	-	-	-	-	-	10
130	88	38	5	-	-	-	600	-	-	-	-	-	-	-	-	40
136	77	88	29	-	-	-	424	-	-	-	-	-	-	-	-	15
142	113	36	2	-	-	17	5	-	-	-	-	251	-	-	-	7
140	442	129	53	-	-	-	1,056	-	-	-	-	-	-	-	-	52
147	69	41	2	-	-	-	573	-	-	-	-	-	-	-	-	14
Sawang (50)	358	200	4	-	-	-	688	-	-	-	-	-	-	-	-	37
155	264	144	2	-	-	16½	160	-	-	-	-	-	-	-	-	10
Bang	163	33	6	-	-	16½	192	-	-	-	-	-	-	-	-	9
Tongkam	234	526	3	-	-	44	448	-	-	-	-	-	-	-	-	10
Somdet	94	188	10	-	-	-	160	-	-	-	-	-	-	-	-	14
154	4	407	7	-	-	44	280	-	-	-	-	-	-	-	-	20
Yong	252	325	97	-	-	-	600	-	-	-	-	-	-	-	-	25
Dokmai	79	245	63	-	-	-	800	-	-	-	-	-	-	-	-	29

TABLE 12

LABOR UTILIZATION: NON-MECHANIZED FARMS

Unit: Man-hour

Household Number	Family Labor					Hired Labor					Exchange Labor					Planted Area (Rai)
	Land Prep.	Planting	Care of Crop	Harvesting	Threshing	Land Prep.	Planting	Care of Crop	Harvesting	Threshing	Land Prep.	Planting	Care of Crop	Harvesting	Threshing	
RF																
402	210	59	-	-	-	-	-	-	-	-	-	-	-	-	-	16
408	1,400	260	-	-	-	-	-	-	-	-	-	-	-	-	-	50
415	1,240	90	-	-	-	-	-	-	-	-	-	-	-	-	-	30
413	480	42	-	-	-	2	-	-	-	-	-	-	-	-	-	39
IR																
313	312	769	1													14
Bho	632	333	7	-	-	-	160	2	-	-	-	-	-	-	-	10

the survey took place before harvest. Generally, however, family labor is largely employed in all types of activities for non-mechanized farm.

Mechanized farms, on the other hand, hire labor largely for planting and harvesting. In the rainfed area, however, additional labor was hired to supplement family labor for land preparation but planting was done by family labor alone.

In irrigated areas, land preparation was mostly done by family labor while supplementary labor was hired for transplanting. Application of fertilizer, pesticides and weeding was all done by family labor. Exchange labor is now very rare; only one case was found.

Sample farmers in the rainfed area began mechanizing their land preparation as recently as 1975, three of them only started in 1977. One farmer in the irrigated area started using a power tiller in 1966, another one in 1969, and the rest in 1970's. None of these farmers have mechanized threshing.

The main reasons for mechanizing are timely planting (10 farmers), saves time (10 farmers), and eases physical burden (6 farmers). A few farmers stated that the machine can also be used for transportation. Lack of hired farm help/draft animal, deeper ploughing, and increased acreage under cultivation were also mentioned.

As for the decision to mechanize, 13 cases were prompted by family members and five cases were influenced by neighbours.

Most farmers (14) indicated that mechanization enables family members to seek off-farm employment but the income from such employment is not used for purchase of machinery.

As far as credit is concerned, the two main sources of institutional credit are the BAAC and Farmers' Cooperative. Both of these sources charge and interest rate of 12 per cent p.a. Non-institutional sources include friends and relatives who charge from 12 per cent to 24 per cent p.a.

None of the farmers who own a machine belongs to groups which jointly owns machinery and each ourchased his machinery from a dealer. Those farmers who own a pump set as well as a power tiller or a tractor purchased each of these machines from different dealers.

Among the cases of machine break-down, 6 cases broke down after 3-4 years of purchase, 3 cases after 1-2 years and 2 cases after 9-10 years. Five of the farmers repaired their own machine, four of them hired a mechanic to repair it while the other four did both. Only one farmer reported that the mechanic came out to the farm. Three farmers had to send their machine to the workshop in the village, 4 farmers sent it to workshops in the amphoe or province. In any case, spare parts are readily available. Each time the machine broke down the farmers had to wait from less than one hour to 3 days before the machine is serviceable again. Judging from this period of waiting it does not seem that the delay would be a major hindrance to production, except in the case of late land preparation where heavy rains might come before farmers are through with land preparation.

Dealers of machinery generally do not provide a manual or technical information to farmers when they made a purchase. Farmer often obtain such information from neighbours who also have limited technical knowledge.

For farmers who have not mechanized, one of the major reasons is lack of water. Farmers who do not have access to irrigation facilities can only grow one crop a year. The average income of these farms is generally lower than that of irrigated double cropping farms. Thus, farmers can afford to purchase or hire a machine only if he can grow two crops of rice a year or if his land is large enough. It seems that for most rainfed farmers water comes as a first priority, before machinery.

Among the 4 samples of landless laborers, all of them reported that their occupation has not changed after mechanization took place in the village. Only one family obtains its income from carpentry and poultry raising as well as field labour in rice farms. The other three families obtain their income solely from working in rice farms. The average income per family in all four cases is below 50 baht per day.

3. The North

The village, Muang Ngai, in amphoe Chiang-Dao is approximately 82 kilometers to North of Chiang Mai and is easily accessible by road which cuts through rather hilly terrain, as is typical of the Northern region of Thailand. The village is made up of 275 households all of whom cultivate one crop of rice and at least one other cash crop, usually garlic but occassionally tobacco and vegetables too.

Two rivers, Mae Ngai and Mae Kon provide a reliable water supply all year round. The water level in both rivers is higher than the fields and this, coupled with forty or so diversion weirs that have been constructed along the rivers, has provided the villagers with a good natural irrigation system, thus enabling them to multicrop. The effects of crop diversification and the cultivation of cash crops after the rice season is reflected in the rather high standard of living of the villagers. They maintain two temples and village contribution has made it possible for the construction of a monument in honour of King Narasuan, one of the hero Kings in Thai history who fought the Burmese; they have modern sanitary facilities, a clinic, a daily market and a primary school till grade five. In addition, there are two small diesel rice mills and the village has electricity facilities.

Although our sample size is only about ten per cent of the total population of the village the figures are fairly representative. Included in the sample are 10 households which have mechanized and 15 households which have not. The 10 mechanized households represent about 20% of the total population of households (50) that own farm power tillers which have been used in the village since 1972 when the first "innovator" bought his machine from Anusarn, a local manufacturer (but then dealer) in Chiang Mai. Only one farmer in our sample owns a power tiller not bought from Anusarn.

In 1975 Anusarn stopped being a dealer for Japanese produced Honda tillers and went into the manufacture of their own tillers based on an IRRI blue print. Thus, all tillers bought as of 1975, from Anusarn, are of the IRRI design. In the sample then 5 of the tillers manufactured

by Honda in Japan and 4 were manufactured locally using an IRRI blue print, the brand name of the one tiller which was not purchased in Anusarn is unknown. In addition to the tillers, only one farmer owned a Mitsubishi pump set while another three (including the farmer with the pumpset) owned draft animals. Of the 10 farms with power tillers only one provides custom service. One other farmer used his tiller for the sole purpose of preparing land for his garlic crop; he hired buffaloes to prepare the rice fields, payment for such being in kind (total of 1,050 kg. of rice for the nine rai).

Average farm size is about 9.14 rai (1.52 hechares) although the actual size ranges from 1.5 rai (0.25 hechare) to 21 rai (3.5 hechares). The average acreage brought under cultivation by the farms which have mechanized, is only 9.85 rai (1.64 hechares). On the other hand, the farm size of these households with machinery ranges from 4.5 rai (0.75 hechares to 21 rai (3.5 hechares). Thus the median farm size for those who have mechanized is about 8.25 rai (1.36 hechares). This compares with the median of 7.75 rai (1.26 hechares) for farms that have not mechanized. These statistical computations and land acerage comparisons of farms that have mechanized and those that have not indicates that, at least in the sample, mechanization does not, or only very slightly, affects amount of land under cultivation. Neither is mechanization a function of land holding size. Refering to tables 13 and 14 farm 304 with 4.5 rai (0.75 hechares) owns a power tiller while farm 40 with 17 rai (2.82 hectares) works his land with draft animal (3 buffaloes and oxen).

All farms, irrespective of technology used in production cultivate one crop of rice (Meui Nong, a traditonal glutinous variety)

Household Number	Family Size			Land Acerage (rai) (c)	Cropping Pattern (acerage: rai)(d)					Cropping Intensity (%) x 100	Type of farm technology; make and year of purchase	Type of Payment for farm technology	use of farm technology (season)	
	Male	Female	Total		Rain	Dry/Cool							rain	coo/dry
					Rice	tobacco	garlic	Soyabean	Vegetable					
304	2	1	3	5.2	5.2		3.0			158	Tiller (Anusan) 1975	Cash (Savings)	1(a)	1(a)
2	2	1	3	5.0	5.0		5.0			200	Tiller (Honda) 1974	Cash (Savings)	1(a)	1(a)
8	2	1	3	5.0	5.0	2.0	3.0			200	Tiller (Honda) 1974	Cash (Savings, sale of oxen)	1(a)	1(a)
386	3	2	5	8.0	8.0	2.0	2.0			150	Tiller (Honda) 1974	Cash (Savings)	1(a)	1(a)
98	1	1	2	9.0	9.0		3.0			133	Tiller (Anusan) 1975	Cash (Savings)	2(a)*	1(a)
219	4	2	6	10.0	8.0		10.0			180	Tiller (Anusan) 1975 (10 buffaloes)	Cash (Savings)	2(a)	1(a)
214	2	2	4	10.0	10.0		4.0			160	Tiller (Anusan) 1975	Cash (Savings; sale of garlic)	1(a)	3(a)
42	1	4	5	11.0	11.0	2.0	6.0			173	Tiller (Honda) 1974 Pumpset (Misubushi) 1970 oxen (2)	Cash (Savings)	2(a)	1(a)
194	3	2	5	15.0	13.0	2.0	4.0			127	Tiller (Honda) 1972	Cash (Savings+us an from BAAC)	2(a)	1(a)
134	2	2	4	21.0	21.0		8.0			138	Tiller (Honda) 1972 Buffalo (10)	Cash (us an from BAAC)	3(a)	1(a)
Total	22	18	40	109.2	95.2	8.0	48			1,619				
Average	2.2	1.8	4	10.92	9.52	0.8	4.8			162				

TABLE 13

BASIC FARM INFORMATION OF SAMPLE HOUSEHOLDS THAT HAVE MECHANIZED

Key :

1. machine technology
2. animal traction
3. machine technology and animal traction

(a) technology used in land preperation

(b) technology used in post harvest

* farmer hires buffaoes (2); pays 1050 kg of rice for such hire.

Household Number	Family Size			Land Acerage (rai) (a)	Cropping Pattern Acerage (rai)(b)					Cropping Intensity $(\frac{b}{a}) \times 100$
					Rain	Dry/Cool				
	Male	Female	Total		Rice	Tobacco	Yarlic	Soyabean	Vegetable	
69	2	1	3	1.5	1.5	1.0	1.0			233
136	2	1	3	3.0	3.0		1.0			133
203	2	2	4	4.0	4.0		2.0	2.0		200
128	1	2	3	6.0	6.0		5.0			183
71	2	4	6	6.0	6.0		3.0			150
130	3	3	6	7.0	7.0	2.0	5.0			200
114	4	1	5	7.0	7.0	3.0	4.0			200
22	3	3	6	8.5	8.5	2.0	2.5			153
198	3	1	4	9.0	9.0	1.0	0.5			117
230	2	2	4	9.0	9.0		9.0			200
382	2	1	3	10.0	10.0	2.0	3.0			150
242	3	2	5	11.0	11.0		6.0			155
68	4	2	6	15.0	15.0		9.0			160
372	4	2	6	16.0	10.0	4.0	6.0		10	188
40	2	1	3	17.0	17.0		6.0			135
Total	39	28	67	130	124	15.0	62.5	2.0	10.0	2557
Av.			4.46	8.67	8.27	1.0	4.1	0.1	0.7	170

TABLE 14

BASIC FARM INFORMATION OF SAMPLE HOUSEHOLDS THAT HAVE NOT MECHANIZED

in an average of 8.74 rai (1.45 hechares). Only 4 of the sample farms grow tobacco in about a total of 23 rai (2.9 hechares). Production levels for tobacco are very low because of the high input requirement for the crop. Furthermore, the curing barns serving the village have a limited capacity; most of the tobacco growers are encouraged to cultivate only about 2 rai (0.38 hectare).

Garlic, however, is an important cash crop which every farmer cultivates. But the acreage under cultivation is not comparable to that of rice: it is reduced by at least 50%. Cultivating garlic is labor intensive (infact, some of the farmers would not mind a garlic seeder), if not capital intensive (seed, fertilizer) and prevailing market prices are not conducive. Fresh garlic fetches about ฿ 5 (25¢) per kilo. Dried garlic fetches higher prices (฿ 16-18 for normal year), but then the farmer is faced with a storage problem. Also because the inputs for the crop are fairly costly, the farmer needs to earn his production capital. quickly. Finally at least 45% of the crop has to be retained for seed and home consumption since between harvesting and planting a crop the following season, there is a weight reduction of about sixty per cent due to loss of moisture.

Although the agro-climate of Northern Thailand is suitable for three seasons - rainy,cool, dry, most of the farmers grew only 2 crops: rice during the rainy season and garlic and/or tobacco in the cool season. Only one farmer in the sample grew a dry season crop of soybean; two other farmers grow vegetables (depending on the variety and availability of water, vegetables can be grown in both the cool and dry season).

The cropping intensity index reflects the extent to which the land is used to cultivate crops other than the main subsistence crop. It generally increases with mechanization because with facilities for land preparation and/or harvesting, more land can be brought under cultivation for a second and following seasons. In Chiang-Dao though, those farms that have mechanized indicate a cropping intensity index lower than that of farms which still depend on animal traction. The difference is not large enough to cause alarm (170 in the case of animal traction and 163 in the case of mechanization) but goes to show that cropping intensity is not a function of mechanization alone. Other variables that need to be present and which were stressed by the farmers themselves include the use of fertilizers and insecticides and of course, the availability of water.. Finally, there is not much land left in the village for agricultural expansion. In this situation no amount of mechanization will increase acreages. And as already mentioned previously, garlic and tobacco cultivation are labor and capital intensive. Thus as it is now stands, each farm is probably cultivating a close to maximum possible acreage of at least garlic.

Farm mechanization in Chiang Dao began in 1972 when the first tiller (Honda) was used by farmer 194 for land preparation. He bought the machine on being prompted by friends and with savings which had to be supplemented by a 12% interest loan from the Bank of Agriculture and Agricultural Cooperatives. At that time he decided to mechanize land preparation for the rice crop because of a labor shortage and also because some of his friends had mechanized. Now 7 years later the farmer has

reverted back to animal traction to prepare his land for rice; the power tiller is used only for his garlic and tobacco crops.

All farmers in the sample use mechanization for their cash crops. Only one (farmer 214) uses a combination of mechanization and animal traction. The fact that only 50% of the sample use the power tiller for the rice crop could reflect (a) the unsuitability of the machine for wet rice land; (b) that there is no critical labour bottle neck for rice cultivation; (c) that since practically none of them cultivates a dry season crop there is a sufficient period of time-between harvesting the cool season crop (d) and planting the wet season rice crop - for manual land preparation (also because of the reliable, water supply all year around, their planting cycle is not really affected by the time of arrival of the rains).

Invariably, all those who have mechanized said that they did so because of a shortage in hired labour. Only ten per cent of the villagers are landless and work as hired farm help. Some of the farmers thus related as to how they had to beg these wage labourers to come help in their fields. Other reasons given for mechanization include (a) shortage of draft animals; (b) availability of funds either from savings or from loans; (c) need for timely planting; (d) saves time and eases the physical burden of manual work.

Comparing production yields per rai of the ten farmers, before and after mechanization, yields have increased in most cases. Farmer 304, for instance, has been cultivating the same rice acerage as he did before mechanization. His yield has increased by 16.65% per rai. Similarly his

household number	Area (rai)	crop	Before Mechanization					After Mechanization					Effects				
			h. labour		Supplies (฿)			h. labour		Supplies (฿)			h. labour		Supplies (฿)		
			M/D	฿	Capital	Fert	Pest.	M/D	฿	Capital	Fert	Pest.	M/D	฿	Capital	Fert	Pest.
304	5.2	R	-	-	333	333	-	-	-	444	511	-	-	-	111	+178	-
	3.0	G	10	750	500	187	-	8	333	685	517	45	-2	-417	+183	+330	+45
2		R	n/a														
	5.0	G	10	150	1000	100	-	4	106	1000	100	-	-6	-44	0	0	-
8	5.0	R	5	79	400	80	-	5	108	500	80	-	0	+29	+100	0	-
	2.0	T	6	110	1500	450	50	3	90	1500	500	75	-3	-20	0	+50	+25
	3.0	G	5	78	1000	433	-	3	60	1000	433	-	-2	-18	0	0	-
386	8.0	R	-	-	-	19	-	-	-	-	19	-	-	-	-	0	-
		G	n/a														
98	9.0	R	4	76	-	-	-	4	93	-	-	-	0	+17	-	-	-
	3.0	G	3	50	2000	-	-	3	100	1000	133	-	0	+15	-1000	+133	-
219	10	R	1	15	200	-	-	-	-	200	30	-	-1	-30	0	+30	-
		G	n/a														

TABLE 15 EFFECTS OF MECHANIZATION ON PRODUCTION COSTS (Per Rai)

household number	Area (rai)	crop	Before Mechanization					After Mechanization					Effects				
			h. labour		Supplies (฿)			h. labour		Supplies (฿)			h. labour		Supplies (฿)		
			M/D	฿	Capital	Fert	Pest.	M/D	฿	Capital	Fert	Pest.	M/D	฿	Capital	Fert	Pest.
214	6	R	3	10	-	-	-	.6	30	-	-	-	+.3	+20	-	-	-
	6.	G	7.3	240	-	33	-	3.8	115	200	58	-	-3.5	-125	+200	+58	-
42	8	R	4.6	75	-	-	-	4.6	125	-	-	-	0	+50	-	-	-
	2	T	6.5	130	-	80	15	5	100	-	150	30	-1.5	-30	-	+70	+30
	6	G	2	73	-	17	2.5	1.8	48	-	33	2.5	-.2	-25	-	+33	0
194	12	R	2.3	50	-	17	-	2.3	71	-	17	-	0	+21	-	0	-
	3	G	4	48	2333	100	-	1.3	26.6	3333	100	-	-2.7	-2.14	+1000	0	-
	2	T	-	-	200	15	-	-	-	-	200	30	-	-	-	0	+15
134	21	R	3.3	66.6	9.5	-	-	3.3	61.9	-	-	-	0	-47	-9.5	-	-
	8	G	-	-	-	50	-	4.0	7.5	1375	230	10.5	+4	+75	+1375	+80	+10.5

TABLE 15 EFFECTS OF MECHANIZATION ON PRODUCTION COSTS (Per Rai)
(continued)

Key :
M/D man days
฿ baht
Fert. Fertilizer
Pest. Pesticide

garlic yields have increased by 51.99%. To take another example, farmer 8's rice yield per rai before mechanization was 320 kg. With mechanization yields have increased by 5.8% to 340 kg./rai. His garlic yields have increased by 0.14%; tobacco yields have however remained constant. Farmer 98 has not mechanized land preperation for rice but he has done so for garlic (he has increased the acerage by 1 rai) which now yields him a 100% increase from 1,000 kg./rai to 2,000 kg./rai. On the other hand, farmer 214, who has mechanized his rice land preparation, does not report an increase in yields. For his garlic crop he uses both animal traction and mechanization and yields have moved up by 4.38%. Farmer 42 is also an interesting case. He uses animal traction in his rice fields and although he has increased his acreage by 3 rai, yields have decreased by 4.56%. But for both his cash crops, garlic and tobacco for which he uses mechanization (acreages have remained the same) yields have increased by fifty and twenty-five per cent respectively.

The farmers do not however think that mechanization alone contributed to the increase in yields. They seem to think that good weather conditions and a steady water supply are very important factors. In fact only one of them thinks that mechanization alone contributes to an increase in production levels. Five of them were of the opinion that the impact of machinery could be felt only with the increased use in fertilizer and pesticide; a good water supply is assumed, of course. Three farmers did not think that mechanization affected production yields.

With the exception of two cases, mechanization appears to have affected the number of man days per rai; the amount of hired labour used

average of only 4 members above the age of 15 years. In four instances the respondents claimed that mechanization helped release family labour for work on other farms. In one case the "surplus" labour was channelled into construction work. All income earned from work outside the family farm was not reinvested into productive capital but used to purchase consumption items of which the television and radio rank very high.

All farmers were asked if they felt any other kinds of machinery would help solve labour bottlenecks. Three replied that they would like a transplanter; a couple of them would like harvesters but, in general everyone agreed that their power tillers were of great help. It has to be remembered that the labour bottleneck that is referred to is not a result of high field wages-daily field wages range from 20 ฿ ($1.00) to 30 ฿ ($1.50)-but the shortage of this labour force. As previously mentioned only 10% of the villagers are landless and seek work as field labourers. On the other hand, exchange labour in the village has become institutionalized to the point that it now is an important social activity.

3 farmers in the sample felt that mechanization has no social consequences; 3 others were unhappy of the reduction in exchange labour caused by mechanization; yet 3 other farmers claimed that it was causing a lower level of socializing. The last farmer in the sample thought that mechanization was contributing to the out migration of the younger generation.

Household number	Appreciated improvements for existing machinery design	constraints to farm mechanization	Social consequences	Reasons for mechanization.
304	make it lighter	a, d, e	3	faster, saves labour
2	no improvements needed	d	1	don't have to feed machines
8	no comment	a, d, c	1	don't have to feed machines, faster
386	Steering gear for turning	a	5	faster
98	Steering gear, reversing gear	b, a	5	faster
219	Steering gear	a	5	machinery can be used to plough hard land
214	no comment	a, d, e	2	Saves time and labour
42	Steering gear, lighter machine less fuel consumption	b, a, d	3	faster, better land preperation
194	less fuel consumption	b	3	faster
134	Steering gear improvement on plough and rotatiller	a, e	1	faster

TABLE 16

COMMENTS BY SAMPLE FARMERS WHO HAVE MECHANIZED.

Key:

Constraints

a. fuel shortage
b. lack of credit facilities.
c. insufficient information on farm machinery
d. high investment risk
e. maintainance costs
f. poor technical knowledge

Consequences

1. reduction in exchange labour
2. out migration of young
3. low level of socialization
4. reduction in communal activities
5. no consequence

Finally, if Table 17 is refered to it will give an idea as to the kinds of information provided by the dealer or the manufacturer when the farmer first purchased the machine. Table 16 is equally important if not interesting because it reflects the views, of our sample farmers, as to the constraints of farm mechanization and what kinds of improvements should be made to farm machinery, especially power tillers.

The 15 non-mechanized farms in the village all felt that draft animals were better than machines for reasons listed below:

(a) cheaper to maintain because of the easy availability of forage;

(b) no repair costs

(c) draft animals produce off spring, a capital gain;

(d) the manure is important fertilizer;

(e) draft animals appreciate over the years; machines depreciate;

(f) draft animals are better for land preperation since they can be used for fields of small size and irregular shape.

All of them also felt that draft animals could be used to pull carts. Their main concern however is that power tilling can affect soil fertility: the tiller ploughs too deep and in the long run soil nutrients are lost because the weeds are not given a chance to ferment in the lower layers of the soil.

Mechanization has however affected those farms which are still dependent on draft animals. The demand for labour at the critical periods has increased and this has brought about an increase in field wages.

household number	Name of manu./ dealer	Warranty	kind of technical information	Manual	information on safety precautions
304	Anusarn	No	2	yes.	yes.
2	Anusarn	Yes-1 yr.	2	yes.	yes.
8	Anusarn	Yes-1 yr.	2	yes.	No.
386	Anusarn	Yes-1 yr.	2	yes.	yes.
98	Anusarn	No	2	No.	don't know
219	Thai Hong Long	No	2	yes.	yes.
214	Anusarn	Yes-1 yr.	1	yes.	yes.
42	Anusarn	Yes-1 yr.	2	yes.	yes.
194	Anusarn	No	1	No.	No.
134	Anusarn	Yes-1 yr.	2	No.	No.

TABLE 17

TYPE OF INFORMATION PROVIDED BY MANUFACTURER/DEALER

key : technical information

1. how to use
2. how to use and maintain
3. how to use maintain and repair

Surprisingly enough, there is very little custom work in the village probably because there are enough draft animals, field acerages are small enough to be managed by manual labour and; the water supply is reliable. Only two farmers in our sample of those who have not mechanized hire power tillers.

4 of the 15 farmers hire their draft animals; the remaining farmers own either buffalo or oxen or, as in one instance, a combination of both. The oxen seems to be the more popular of the two animals probably because they can be used to pull carts. All those who own draft animals would rather put the animals to use in the farms than to have to hire farm machinery. At the same time they all agree that mechanization would help save time and cut labour costs. Apparently they are willing to mechanize only if they have the cash to purchase the machine. Another frequent reply was that if they bought machinery they would not know what to do with their draft animals although 10 of the 11 farmers said that they would sell off the animals when they no longer are able to work in the fields.

To summarize then, the farmers with buffalo and oxen are still dependent on animal traction because:

(1) land acerages are small,

(2) draft animals appreciate over the years and produce off-spring,

(3) mechanization can affect soil fertility because of deeper ploughing,

(4) oxen can be used to pull carts and,

(5) animals can be easily sold off to convert the investment into readily available cash.

Village Buak Kang is located in amphoe San Kamphang which is 13 kilometers to the east of Chiang Mai. There are no irrigation facilities and agriculture is dependent on rain which falls during the months of July to October. The main crop grown is rice, primarily for home consumption. Cash crops include garlic, tobacco, chilli peppers and groundnuts-these are grown in the cool season. Some of the villagers grow soya beans during the dry season.

Compared to villages with irrigation facilities average land holding size is between 4-9 rai (0.66 to 1.33 hect). There was one villager, in the sample of 20 households who owned 32.5 rai (5.41 hect). There was yet another villager who owned only 1.5 rai (0.25 hect). Much of the individual land holdings appear to be fragmented into a number of parcels, each of which is limited in size. Rice is grown in all land available; cash crops, however, are grown in a small portion of the land holding. Farmer 46. for instance, owns 32.5 rai of land, all of which is put under rice, in the wet season. During the dry season he cultivates groundnuts, but in only 7 rai (1.1 hect) of the land; similarly, farmer 8 owns 16 rai (1.66 hect.) of rice land. Of this only 0.75 rai (0.12 hect) is used for garlic cultivation.

This reduced cropping intensity, an average of 105, is a function of the lack of a continuous water supply. Rice is grown during the rainy season and since it is a subsistence crop, the maximum amount of land that is possible for agricultural production is brought under cultivation. In the cool and dry seasons, however, because there is only a limited supply of water, it is natural that the total amount of land that is cultivated is reduced considerably.

The lack of irrigation facilities coupled with a low cropping intensity has resulted in a complete dependence on animal traction. (in Buak Kuang only 2 of the villagers have mechanized) This has also meant that families cannot depend solely on farm income; seasonal employment has to be sought in Chiang Mai. At other times, the villagers depend on construction work and work in local cottage industries in San Kamphang.

Most of the villagers own their draft animals, both oxen and buffalo. Only 3 of the farmers in the sample hired buffaloes, an additional one farmer owned 3 oxen but hired a buffalo too. Payment for the hire of such animals is almost always paid in kind: 50 taang of rice per animal. In instances where cash is paid for the hire, it amounts to an average of 100 ฿ per animal per rai ($5). Payment is by piece work and not by the day.

All the sample farmers felt that animal traction was better than machanization. The reasons given are listed below:

(a) better ploughing

(b) animals are cheaper and less costly to maintain

(c) capital gain from the off-spring

(d) use of animal manure as fertilizers

(e) no fuel cost

(f) draft animals are readily available

(g) animals are cheaper to hire, appreciation of the animals over the years

(h) animals can be used to pull carts.

A sample size of 20 does not quite reflect the general village situation but be that as it may, it appears that farmers' opinions are such that it will be a while before any form of mechanization of farm activities can take effect. 16 of the farmers did not think that mechanization would increase yields. Neither is there a labour shortage such that mechanization might help ease critical labour bottlenecks. Ten of the farmers who were willing to think of mechanizing their farm operations said that if they were to buy a power tiller it would be only to help save time so that more family labour can be channeled into off-farm employment. It appears that water is the ultimate constraint to mechanization. Since the area is dependent on rainfed agriculture, only a limited amount of the total village land can be cultivated thus restraining the cropping intensity. The farming family then becomes dependent on off-farm employment which provides the majour source for cash income; the farm provides the subsistance food crop.

This availability of employment alternatives outside the farm has to be given careful thought. If the farm household is completely dependent on land for its income then it would naturally endeavour to increase production levels. In this village, there are no such attempts; understandably so because of the lack of a continuous water supply. On the other hand, most of the farmers did not even want an improved plough which could prepare the land more efficiently, if not faster. Afterall, in rainfed agriculture, proper timing is very important so that the rice crop can be planted before the water dries out. And these villagers are still growing the traditional rice variety.

One other reason for the lack of mechanization in the village is the lack of cash resources to purchase farm machines. There were, however, some villagers who simply are averse to the idea of switching from animal traction to mechanization. There were four other instances of farmers who felt that animal traction and manual labour is less strenuous than operating a power tiller.

Oxen and buffalo cost less. The former averages about 5,000 ฿ ($250) while the latter costs roughly about 3,500 ฿ ($175). The initial capital investment is quite large but even then it is less than the investment needed for machinery. At the same time these animals can be used in the fields, for as long as 10 years, compared to a power tiller which would probably not last for more than 5 years. No special forage is required-animal feed is made up of rice straw and grass cut along the rice fields. In the dry season the animals are left to graze on the fields. Where labour is hired to herd the animals, the cost is very low: about 2฿ ($.104)a day or 25 tang (250 kilo) of rice per year. In some instances the herder and the owner of the animal will divide the off-spring. If' there is an uneven number of off-spring then one of the animals is sold and the money divided equally.

There is also an institution in Chiang Mai called the cattle market which is held periodically and on a rotating circuit. As the name suggests, the market is a place where draft animals are bought and sold. At the same time there are facilities for transactions of the kind where the animal is exchanged for say, a bicycle or a motorcycle. This transaction is not permanant but is only for a period of time. The farmer might bring in his animal during the dry season when there is no farm

activity going on and exchange it for a bicycle which he rides to his job in the town. With the advent of the rains when agricultural work begins again, the bicycle is taken back to the market and re-exchanged for the animal. Thus the farmer is not only able to obtain a bicycle to take him to his job but his has one animal less to feed during the dry season when forage is limited.

13 of the farmers in the sample are not interested in mechanizing. Surprisingly enough, most of them have fairly large acerages averaging about 7.5 rai (1.21 hect). Thus mechanization need not necessarily be a function of land acerage. It is dependent on family size (the larger the family labour force the less the need for farm machinery); availability of off-farm employment opportunities; promotional activities of the machine manufacturer/dealer; type and variety of crop grown including the cropping intensity. Primarily, however, mechanization becomes an important consideration only when there is a reliable water supply and there is enough of an incentive to put all land available under cultivation for a good part of the year. Once the farmer is assured that he can definitely increase his levels of production and his cropping intensity then he will inevitably start thinking of measures needed to time each of his production activities accurately. And with everyone being busy increasing production levels, the demand for wage labour (which is inevitably limited in supply) will increase, thus creating a definite need for mechanizing the more labour intensive farm activities, at least transplanting and threshing.

Survey of Farm Machinery Fabricators

General Overview

a. Capacity, Production and Imports

According to an unpublished study by the Bank of Thailand (BOT), there were altogether 102 factories producing tractors and power tillers in Thailand in 1978. Although this figure might have changed in the past year, it is believed that the changes are not much in terms of numbers. There are some firms which have not been included in this population, but then quite a number of firms listed in this study have gone out of business or stopped production. The exact number of factories are difficult to ascertain because of the large number of small family workshops. There are constant entries and exits of such firms each year into and out of the industry. But since such firms account for a small proportion of industry production, it may be possible to look at the number of firms in this industry by concentrating on large and medium factories. According to a report of the Industrial Services Section, there were altogether thirty large and fifty medium size factories. The number of small factories was said to be difficult to estimate.

The general impression gained from a present ongoing study at Thammasat University is that quite a number of small firms are closing down. Some of the possible explanations are the lack of government promotion, the keen competition, the energy crisis, the saturated market, and the present tight money situation.

Out of the 102 factories in the BOT study, ninety nine are producers of power tillers while the other three are tractor producers.

The three tractor producers are Louis T. Leonowens (Tractor) Co., Ltd. (assemblers of John Deere machines), Ford Motor (Thailand) Co., Ltd. (assemblers of Ford machines)and Yontrapand Co., Ltd. (assemblers of International Harvester machines). All these three firms may be considered large by Thai standards. They are mainly assemblers of parts and components of machines imported from abroad. Little domestic content is used in production. The total combined production capacity of these firms is about 3,000 units per year.

For factories producing power tillers, the majority are small scale producers of less than 500 unit capacity per year. There were sixty two such factories. Medium size factories of between 500 - 1,000 unit capacity per year numbered twenty three factories. The remaining fourteen factories are large scale producers of more than 1,000 units per year. Looking at the small scale producers, there are 31 firms whose production capacity is less than 100 units per year.

The total production capacity of power tiller factories is about 64,000 units per year. Of these 64,000 units, 12,000 units or 19 per cent belong to the small scale producers; 16,000 units or 25 per cent belong to the medium scale producers; and 36,000 units or 56 per cent belong to the large scale producers. The total production capacity can be divided into production of two wheel and four wheel power tillers of 57,000 units and 7,000 units per year, respectively.

Actual production of tractors in 1978 was about 2,158 units. For two wheel and four wheel power tillers, there were 39,568 units and 3,808 units, respectively. The increase in production for the past few

TABLE 18

DOMESTIC PRODUCTION AND IMPORT
OF TRACTORS

Year	Domestic Production		Import		Total	
	Units	Per Cent	Units	Per Cent	Units	Per Cent
1974	-	-	912	-	-	-
1975	2,426	54.4	2,031	45.6	4,457	100.0
1976	2,232	48.6	2,357	51.4	4,589	100.0
1977	2,380	50.2	2,361	49.8	4,741	100.0
1978	2,158	56.6	1,654	43.4	3,812	100.0

Source: Bank of Thailand.

TABLE 19

DOMESTIC PRODUCTION AND IMPORT
OF TWO WHEEL POWER TILLERS

Year	Domestic Production		Import		Total	
	Units	Per Cent	Units	Per Cent	Units	Per Cent
1974	24,808	99.4	150	0.6	24,958	100.0
1975	27,860	93.9	1,800	6.1	29,660	100.0
1976	31,766	93.0	2,400	7.0	34,166	100.0
1977	35,465	92.2	3,000	7.8	38,465	100.0
1978	39,568	96.6	1,400	3.4	40,968	100.0

Source: Bank of Thailand

TABLE 20

DOMESTIC PRODUCTION AND IMPORT
OF FOUR WHEEL POWER TILLERS

Year	Domestic Production		Import		Total	
	Units	Per Cent	Units	Per Cent	Units	Per Cent
1974	2,324	97.9	50	2.1	2,374	100.0
1975	2,582	86.6	400	13.4	2,982	100.0
1976	2,914	85.4	500	14.6	3,414	100.0
1977	3,258	80.3	800	19.7	4,058	100.0
1978	3,808	88.4	500	11.6	4,308	100.0

Source: Bank of Thailand.

years averages about 12 per cent per year for power tillers while tractors seem to be experiencing a decline in production (see Tables 18-20). It seems that all were producing under capacity. For tractors, it was approximately 72 per cent of capacity. For power tillers, they were 69 per cent and 54 per cent for two and four wheel tillers, respectively. This seems to imply that competition may be stiffer for power tillers than tractors.

Looking at import figures in Table 18, tractor imports has leveled off in the past couple of years while domestic production also seems to show a slight decline for the past few years. This may imply that the market for tractors has reached a saturation point. The import share for tractors for the last four years was somewhere between 43-51 per cent.

For power tillers, import figures seem to show a steady increase in imports for the past five years except 1978. The shares of import on two wheel and four wheel power tillers also show an increasing trend prior to 1978. They topped 7.8 per cent and 19.7 per cent in 1977 for two wheel and four wheel power tillers, respectively. Since import and production figures were not yet complete for 1978, no concrete conclusions may be drawn except that prior to 1978 there seem to be an increasing trend of competition from abroad for the domestic power tiller market.

In terms of production value, it is estimated by BOT to be about 500 million baht for tractors; 210 million baht for two wheel power tillers; and 70 million baht for four wheel power tillers. The industry therefore has a total production value of 780 million baht.

b. Employment

From the same BOT study, the three tractor factories employ a total of 400 workers in 1978. Power tiller factory employment were estimated to total 1,800-2,000 persons. But due to the seasonal nature of production especially in power tiller production, the employment figures may be under-estimated. In Thailand, the production of power tillers is influenced by the agricultural sector. Farmers usually purchase machines between the period after harvest up to the beginning of the new crop season, since this is when farmers have sufficient cash from the sale of their crops and it is also practical in the sense that tillers will not be idle for long after purchase as would be if the crops have already been planted. Because of this the production season of power tillers is mainly between January - June. But since the BOT's survey was done during the latter part of 1978, employment figures estimated may apply to the off-season period. Information from the same survey estimated that production during January - June may be 20 per cent higher than July - December.

In terms of the effect of factory size on employment in the power tiller industry, the small scale factories employ about 2-10 workers per factory; the medium scale factories employ about 20-50 workers per factory; and the large scale factories employ about 30-70 workers per factory. For the small scale producers, most are family type of businesses such as repair and lathe shops which use very little outside or hired labor. There are usually only 2-5 workers and production capacity are usually less than 300 units per year. There were about 44 firms in this category in the BOT study.

c. Financial Sources

The total investment in tractor production is about 200 million baht while that in power tiller production is around 150-200 million baht. All the three tractor firms have received promotional privileges and involve foreign capital. For power tiller producers, only one has received promotional status and only recently. It also involves foreign financing. Almost all the investment funds in power tiller production are from family sources. It accounted for 70 per cent of total funds invested. The remaining are obtained mainly from borrowing in the unorgainzed money market.

Due to the seasonal nature of demand for power tillers, producers face financial problems of tiding over the off-season period when there is little demand for machines. It is also the lack of working capital during the off-season that has forced producers to curtail production instead of accumulating inventories. Most of the working capital is obtained through the unorganized money market (which charges a higher interest rate) and from friends and relatives.

d. Regional Distribution of Production and Use

Similar to other industries, the production of tractors and power tillers is mainly concentrated in the Central Region. There were 80 factories in this region according to the BOT survey. It accounts for more than 90 per cent of total production in the country. Most of these factories are concentrated within the Bangkok Metropolitan area and the surrounding provinces such as Ayuthaya, Chachoengsao, Samut Prakarn and Pathumtani. The number of factories for the North, Northeast and

Southern region are thirteen, six and three, respectively.

A look at Table 21 will show that the Central Region is also the main market for tractors and tillers. It accounted for about 38 per cent, 76 per cent and 64 per cent of the number of tractors, 2 wheel power tillers and 4 wheel power tillers used in the country, respectively. The lower percentage on tractors is because tractors are not suitable for use in rice production and the region is mainly a rice production area. The Northern Region accounted for a large share of the tractor used. It is about 34 per cent of that for the whole country. The region is also the second most important employer of power tillers after the Central region. The Northeastern and Southern regions do not account for a significant share of machines used except may be for tractors in the Northeastern region which accounted for about 24 per cent of the country total.

e. Prices and Taxes

Table 22 shows the prices of power tillers both domestic and imported ones. As can be seen the prices of domestic two wheel power tillers are significantly lower than the imported ones while this is less so for four wheel power tillers. The differences in prices may reflect differences in quality and the complexity of machines. Imported machines usually have more features such as a gear box of more than one forward speed including also a reverse gear and the ability to be used for multi-purposes.

Although the local machines are cheaper, local producers have frequently protested the unequal tax burden paid by them as compared to

TABLE 21

NUMBER AND PERCENTAGE OF
TRACTORS AND POWER TILLERS BY REGIONS

REGION	tractors		two wheel power tillers		four wheel power tillers	
	units	percent	units	percent	units	percent
Central	5103	38.3	68271	75.9	10802	64.3
Northern	4474	33.5	11220	12.5	4109	24.5
Northeastern	3164	23.7	3058	3.4	1401	8.3
Southern	597	4.5	7452	8.3	480	2.9
TOTAL	13338	100.0	90001	100.0	16792	100.0

SOURCE: Division of Agricultural Economics, Agricultural Statistics of Thailand: Crop Year 1975/76.

TABLE 22

PRICES OF POWER TILLERS
(baht)

Type of power tillers	domestic machines			imported machines
	body	engine	total	
two wheel(8hp.)	4100- 4800	13700-18000	18000-22800	32800-36600
four wheel(15hp.)	25000-30000	21600-32900	46600-62900	61000-90000

SOURCE:

imported machines. For imported machines, the taxes paid include a five per cent import tax (based on C.I.F. price), a three per cent business tax (based on retail pri), an eleven per cent standard profit tax (based on retail price) and a ten per cent local tax (based on total business taxes collected). This amounted to a total tax burden for two wheel and four wheel power tillers of 8.85 per cent of the C.I.F. value as calculated by the Industrial Services Section. The same source also estimated the total tax burdens for a domestically produced two wheel and four wheel power tillers. These come to about 13.55 and 11.27 per cent, respectively. The higher taxes paid by domestic machines are due to the bias in the tax structure within the country which in turn is the result of the government's import substitution policy. This difference in tax burden has often been used by domestic producers to point out the government's neglect of the farm machinery industry.

f. Cost of Production

The production of tractors and power tillers in Thailand involves only the production of machine bodies and equipment and not engines. Engines are mainly imported. The engines used consist of both benzene and diesel types. The latter is more expensive but preferred by farmers because of low fuel consumption.

The production process in most small scale factories involve assembling parts and components together. These firm do not produce their own parts or components but purchase them from larger factories or component producers. The medium and large scale factories usually produce their own parts and components from raw materials. Most of these involve cutting iron sheets into sizes suitable for building the body. This may be why

larger firms tend to have a lower cost of production. Larger firms also benefit from a lower price of raw materials due to size of purchase.

Table 23 shows the cost structure of producing tractors and power tillers. The cost of producing tractors comes almost entirely from raw materials (97 per cent). Of these, only 14 per cent are raw materials from local sources. The remaining 86 per cent are imported. Production cost of power tillers does not rely as much on raw material as tractors, but still it accounted for about 70 per cent of total production cost. Of these, about 45-65 per cent are of imported content and about 35-55 per cent are of local content. In monetary terms, the cost of a tractor, a two wheel power tiller and a four wheel power tiller are about 190,000-270,000 baht, 3,500-5,500 baht and 10,000-15,000 baht, respectively.

The figures also seem to show that the production of power tillers in Thailand is more labor intensive as compared tractors as witnessed by the larger share of the wage bill.

Survey Findings

The total number of firms surveyed is seventeen. But one of these firms turns out to be a producer of tractor components which cannot be considered a firm producing farm machinery. The questionaire used was therefore inapplicable. Of the remaining sixteen factories, nine are producers of two wheel power tillers; two are producers of rice threshers; two are producers of both two wheel power tillers and rice threshers; two are producers of rice milling machines; and one is a producer of water wheels and winnowing machines.

TABLE 23

COST STRUCTURE OF PRODUCING
TRACTORS AND POWER TILLERS
(percent)

Type of cost	tractors	two wheel power tillers	four wheel power tillers
raw materials	97.0	74.9	68.5
labor	0.7	11.5	14.6
electricity	0.1	4.7	7.8
others	2.2	8.9	9.1
Total	100.0	100.0	100.0

SOURCE: Bank of Thailand

Of the firms questioned, there are six who answered that they have had previous contacts with IRRI. Out of these six, five have received design blueprints or advice; three have received production advice from IRRI; four have received advice on power tillers; and three have received advice on rice threshers. All believe that the advice provided was useful. These figures may be misleading in showing IRRI's importance, since none of these firms produce machines based directly on IRRI designs although this may be less true of threshers. For power tillers, this is especially true. Most tiller producers not only rely on IRRI designs as a guide or base but they also use machines from other sources such as the Japanese models. The present power tillers are said to be copied and modified from many sources until they no longer resembles an IRRI designed machine. The only area in the country said to be suitable for IRRI designed tillers is the Northern region. It was not accepted in the Central region where farm machinery is mostly widely used.

Although IRRI designed machines are not actually employed to any degree in Thai agriculture, it may have provided a starting point or guide for local producers. This is especially true of rice threshers. It is IRRI's efforts and designs that have provided a starting point for domestic thresher producers.

Out of the six fabricators who have had contact with IRRI, four think IRRI should also be providing technical assistance in other areas as well. Two mentioned the rice harvester which is still totally new to Thailand; one would like advice on speeding up production; and one would like assistance on marketing.

It seems that IRRI's superiority in machine design is also its weakness. IRRI machines can be used for multi-purposes. This makes it more complex and difficult to understand and fix. Farmers may also not need a multi-purpose machine. A single purpose machine may be cheaper.

From the survey, there does not seem to be any other institutional sources besides IRRI where producers can go to get technical assistance except the Division of Agricultural Engineering (DAE). But since IRRI works in close conjunction with the DAE, this does not mean much in terms of additional assistance. Five out of the six who have had contact with DAE are also the ones who have had contact with IRRI.

Other Results from the Survey

Through copying and modifying, most of the machinery designs are similar or does not have much different. Almost all (at least 13 firms) firms do not think that there are any dissimilarities in their machine designs. If there are to be any differences, it is in the quality of machines in terms of durability and efficiency. There were at least three answers which cited differences in durability and two which cited efficiency. From the ongoing survey at Thammasat, the impression is that the firms that went out of business or are in trouble are usually small firms whose products are of low quality. It is the producers of quality products who do not have as many marketing problems.

Questions concerning raw materials or components constantly bring out the importance of quality. Almost all the answers given on the requirement of producing a good quality machine mentioned the quality of inputs. Although it seems that Thailand can produce almost all the components used in tiller production which is what the survey indicated, local producers are skeptical of using these components since they are

believed to be inferior to imported ones. The imported components mentioned most are ball bearings and chains.

Most of the marketing of machines was found to pass through middlemen. Only five out of the sixteen said they sold their products directly to farmers. Five sold all their products through agents or contractors. The rest employ both methods, but the majority of products sold are through middlemen. . Of the answers given in this last group, about 70-98 per cent of products are sold through agents. This may be the reason why firm do not seem to have any strategy to promote sales except through salesmen, demonstration and a low price. Warranty services of usually about one year are also provided by almost all firms.

Thirteen of the sixteen firms think farmers are already provided with sufficient information on the machines they bought. When asked what information was provided, the majority of answers were on the operation and maintenance of the machines and not much else.

Almost all producers do not feel their products' prices are too high. They also feel the present prices cannot and should not be lowered. Reasons given are that the costs of production are high while prices are rather competitive.

Most producers usually provide repair services. For those who do not, they usually sell their products through agents. Due to the simplicity of the machines, farmers are said to be able to repair their own machines if it does not involve the use of tools or if it involves only changing components or parts.

Close supervision in production has also been mentioned by some firms to be a very important factor in ensuring the quality of machines produced.

Summary of Findings

Having presented the survey of production, socio-economic and financial results of increased mechanization the resulting analysis is twofold. First, we want to assess the extent to which mechanization has affected the standard of living of these farmers who have turned to machine technology as compared to those who have still retained animal traction; at the same time we have to ask ourselves why the latter have not mechanized. It is often enough assumed that machine technology will take affect only when there is a reliable water supply. This is undoubledly true. Our informants in the rain-fed areas kept telling us that (since they grew only one crop of rice and in as much as timely land preparation was critical) they were content with their draft animals. They would and could mechanize only if they had proper irrigation facilities. On the other hand, as had been indicated in the previous pages, there are farms in the rain-fed zone, in the central plains, which average about 30 rai and which are completely mechanized. Here the farms are too large and the soil type unsuitable for animal traction. So it is understandable as to why farmers have mechanized and that too with heavy machine technology (4-wheel, 75 h.p. tractors.) Yet these very farms have to rely on the monsoon varies which are most unpredictable. This only goes to prove that mechanization is not solely dependent on a reliable water supply. In the north month, farm sizes are small, the rice is transplanted, field labour is generally available and farmers prefer to retain their draft animals rather than to purchase or even hire farm machinery. In the central plains, rice cultivation has been commercialized, farms are larger, field labor is scarce and production costs are minimized if farm technology is mechanized, even if there are no irrigation facilities. It is actually difficult to conceptualize a

general pattern of functional relations between mechanization and certain key variables. The relationship might hold in one situation but not in another.

In any case, the second level of analysis will be to determine which of the IRRI designed agricultural machines offer the greatest potential for production and profitable mechanization and the extent to which IRRI designed machines are meeting local farm level needs.

Our findings from the farm level surveys indicate that farm mechanization becomes an important engine to growth only when field labour becomes scarce especially during the critical periods of labour intensive farm activity. 18.18 per cent of Mung Ngai, the village in Chiang-Dao, has mechanized. This relatively high frequency is due to the fact that the farmers are involved in multiple cropping with garlic (which requires intensive labour activity) as a second crop. Only 10 per cent of the villagers are landless. Thus hired field labor is difficult to find. Farmers recounted of how they had to literally beg field labourers to work their fields. We heard similar complaints from farmers in the central plain too.

Labour, at least field labour, is in short supply because of out migration of the younger people, but more importantly, because of the availability of off-farm employment opportunities where wages are higher than field wages which have been, it has to be pointed out, on the rise too. Inevitably working outside the farm, especially for the younger generation, is more desirable. So, with less labour available in the village, the farmer is forced to mechanize especially if he is involved

in intensive cultivation; double cropping in the central plains and multiple cropping in the north. Thus mechanization appears to be a correlate of the cropping intensity. The higher the cropping intensity index, the higher the rate of mechanization. With labour shortages the only solution to maintaining intensive cultivation is through mechanical technology.

In the above situation we are tempted to conclude that off-farm employment opportunities and ensuing labour shortage on the farm are factors initiating mechanization. On the other hand, many farmers in the central plains informed that they had turned to mechanization so that the family members would have more time available for off-farm employment. The villages in the North (Buak Kang in San Kamphang) are highly dependent on off-farm employment, yet only two of the farmers have mechanized. The area is dependent on the rain and only one crop of rice is grown. In some parts of the central plains a similar agroclimatic situation holds yet the farmers have mechanized. The only difference however is that in the central plains, land acreage are large. Be that as it may this is yet another example to show that the causality between mechanization and other variables is not unidirectional but multidirectional.

There are a whole range of reasons for mechanization. Other than a shortage of field labor, farmers have begun to mechanize also because they feel that tractorization allows deeper tillage than bullocks and this contributes to increased production. There was a farmer in Supanburi (Central Plains) who cultivates a fairly large farm with two crops of rice and four years ago he bought a four-wheeled tractor because he had some money saved up. But he decided to make the purchase because animal

BEST AVAILABLE

traction was not making it possible for the rice stubble to be turned into the soil. Yet farmers who prefer animal traction claim that they have not mechanized because deeper ploughing affects soil fertility since it prevents the rice stubble from fermenting and increasing the nutrient content of the soil.

But even if tractorization allows for deeper tillage we have no evidence from any of our samples from the central plains of increased yields. On the other hand we have failed to maintain that the survey has been conducted in a most inappropriate time. Farmers have not recovered from a drought which has hit them over the last three consequtive years. Be that as it may, all our informants were only quick to point out that they themselves did not think that mechanization would contribute to increased yield unless it was in conjunction with improved quality of seed and the increased use of fertilizer and insecticide.

The farmers in the north have not been affected by the drought but they have cut back their production of garlic because (due to a flooding of the market with Chinese garlic) market prices last year were very low. Their rice yields have however remained fairly constant before and after mechanization.

Mechanization has undoubledly raised the farm income from the level of subsistence. If subsistence farming means a lack of a "reliable source" of cash income because of the lack of sufficient job opportunities outside family farm, then mechanization has indeed improved the standard of living of the farmer. It enables the farmer and his family to seek employment outside the farm. In most cases, the income earned from this is used to pay for the hire of farm machinery but be that as it may

mechanization implies that the farmers' alternatives to employment are increased. This is of special concern in areas of monocropping: mechanization leaves time for off-farm employment. At the same time, the monocropping farmer needs to find off-farm employment because the farm provides him with only a subsistence.

It appears that in irrigated areas, mechanization provides for intensive cultivation; in rain-fed areas, it provides for off-farm employment. On a different note now, machine technology of the IRRI designs are limited to tillers and threshers. In the north however, only tillers are used. Threshers have not yet been introduced on a large scale and if they were, serious modifications would have to he made before the machine would be acceptable. The northerners make use of the rice straw for a multitude of purposes, all of which require that the straw retains its length. Unfortunately, the present thresher is not designed to save the straw. Also, experiments at the Institute of Agricultural Technology Mae Jo in Chiang Mai indicate that the amount of broken rice when threshed mechanically is more than when rice is threshed manually. This is apparently due to rice being threshed by the beating method than by the combing method.

Furthermore, the farmers in the north think that mechanical threshing requires more man hours. As one farmer pointed out, "you need four men to carry the machine to the field, more people to carry the bundles to the machine and the straw away after the rice has been threshed." The fact that the work is completed much faster by mechanical threshing and thus total labour costs are reduced does not seem to be of concern to the farmer. Also, exchange labour still remains an important social institution: harvesting and threshing are indeed important social events.

The IRRI designed tillers are selling very well in the north, although there is only one manufacturer who has the maximum capacity to produce only 100 units a year. The small size coupled with the light weight makes it convenient for the farmer to carry the machine over the rather high rice bunds. Furthermore, the IRRI model allows for the quick attachment and detachment of implements.

The IRRI model does however have certain setbacks. It cannot be modified to be used for rice threshing and its general performance in rice fields is not as good as the other tillers available in the Thai market. It's work rate too is slower and the farmer would really prefer a machine with a steering clutch and facilities for sitting.

In the central plains, the IRRI designed machine that is in demand is the thresher,understandably so since there are no other designs on the market yet. Threshers are important in those areas of double cropping where the wet season crop is threshed mechanically: there is a high frequency of manual threshing for the dry season crop though.

The eleven manufacturers actively fabricating IRRI designs built 613 threshers and 80 power tillers in the first half of this year. This indicates that the greater potential for IRRI-Thai activity appears to be threshers; power tillers and other land-preperation machinery were introduced into Thailand even before IRRI came into the scene.

At present there are only two IRRI designs which are being manufactured: tillers and threshers but as explained above the former machinery (of the IRRI design) is not popular in the Thai market. In the light of this then, IRRI should start introducing machinery which

have not as yet appeared in the market. Such would include transplanters, seeders, harvesters and land levelers all of which are potential implements to be used in rain-fed agriculture. The general aim of IRRI should be to design and implement a selective farm mechanization policy geared to the system of small farmers who are naturally inclined to be very selective in their choice of mechanized farm equipment. As farmers in the rain-fed areas are quick to say, "come back later and talk to us about farm mechanization, ..., after we receive irrigation facilities." Since much of Thailand has yet to be irrigated IRRI might indeed want to concentrate on machinery suited to a rain-fed water central regime. As it is, there is hardly any such machinery available in the market and as in the case of threshers IRRI can be one of the first to be introducing designs, which keeping with IRRI tradition are easy to manufacture, simple, clean, cheap and easy to maintain.

It is however disconcenting to note (semi annual report: R.C. Fisher) that total employment in the manufacturing exterprises of IRRI designs, has declined by 13 per cent since the beginning of this year. Production has declined because of (a) the lack of credit facilities to manufacturers; (b) the fuel crisis and, (c) reduction in farmers' incomes resulting from last year's crop damage caused by floods.

If production of IRRI designed farm machinery is on the decline for reasons of the present condition of the Thai economy coupled with competition from manufacturers of non-IRRI designs then, to reiterate what has already been said, IRRI should be concentrating on those designs of machinery which have not, as yet, been introduced. As it appears now many Thai farmers especially so in those areas which are not or only

partially mechanized - are facing at least one of the following problems: (a) limited size of farm; (b) lack of cheap and easily available credit facilities and more importantly;

(c) lack of sufficient irrigation water. And, since many of the farm households own at least one draft animal IRRI could possibly be paying more attention to the design of animal drawn equipment: disc harrows, seed drillers, animal powered water lifting devices. On a different note, other than designing and introducing, quickly, farm machinery, IRRI should undertake to work closely with the fabricators themselves.

Twenty six manufacturers had signed the IRRI memorandum agreement which constitutes a three-phase procedure. On receiving the IRRI blue print the manufacturer fabricates and tests a proto-type machine before plunging into commercial production. On fabricating the proto-type, the manufacturer submits it to IRRI for testing and evaluation. The manufacturer cannot produce or market the IRRI machine until IRRI has approved, in writing, his prototype machine. Of the 26 above mentioned manufacturers only 7 were producing threshers. Four of them have abandoned the programme while 6 of them never became active. The remaining manufacturers are all involved in the production of non-IRRI designs. There are thus a series of questions that come to mind as to why IRRI designs were abandoned or, in some cases, not accepted in entirety.

(a) are manufacturers apprehensive of building smaller machinery items with a narrower profit margin?

(b) are certain features of an IRRI design not suitable for Thai farming systems and crop varieties?

(c) are IRRI designs producing units which are too small-in terms of engine capacity (usually 5-7 hp.) for farmers' requirements?

It is only natural for manufacturers to try to cut back costs and increase net profits. This they do by using inferior materials and not providing adequate parts and service facilities. This of course increases maintainance costs. At the same time, the life of the machine is much reduced. The farmer is, with reason, left apprehensive about farm machinery. The problem can be overcome, somewhat, by IRRI keeping a close watch on its fabricators to see that (a) designs are not completely changed so as to adversely affect performance and; (b) a high quality is maintained in the finished product. In trying to maintain quality control IRRI should work closely with the small Tractor Manufacturer Forum of Thailand. IRRI could provide technical advice on quality, safety and standardization in the mechanization programme as well as provide such advice as shop lay out, industrial management etc.

Finally, IRRI should also work more closely than it has with the Industrial Service Institute of the Ministry of Industry. IRRI has the kinds of technical skills which can be used to conduct training sessions in which participants can be given some kind of engineering knowledge of farm machinery. As it is now fabricators make alterations to IRRI designs without ever understanding the basics in engineering technology. This can only contribute to the poor performance of the machinery and a dampening of the farm mechanization programme.

Finally, IRRI should be more actively involved with the dissemination of information to farmers who can then because aware of machinery which is cheap, adequate for their farms and simple to operate.

Case Studies

Herewith we present 6 case studies from village six, tambon Don Chedi (Amphoe Don Chedi) in the central plains. In many instances, this village is typical of rice farmers in the central plains. There is a high rate of land tenancy;[1] land-holdings average about 24 rai (3.9 hectares) and a good number of the villagers are actively involved in off-farm employment.[2] At the same time the village is rather interesting. It has access to two kinds of water regimes (rain-fed and irrigation) and correspondingly, two types of farm technology i.e. animal traction and mechanization; in some farms a combination of both technologies is used. Similarly, there are two types of rice planting procedures. In the rain-fed area the rice seeds are broadcast and two ploughings are necessary. The first ploughing is to prepare the land and a high frequency of mechanization is used in this phase of the agricultural cycle. A second ploughing is crucial after the seeds have been broadcast. The aim here is to turn over the soil to ensure that the germinating seed is firmly embeded in the lower layers of the soil. In instances when surface moisture is minimal it becomes even more important for the seed to be deeply implanted so that the root of the seedling will have access to subterranean water. Farmers have mixed views as to the type of technology best suited for this second ploughing. Some feel that the tractor is better because it enables deeper ploughing. Others favouring animal traction do so because the tractor or tiller is heavy and would damage the germinating seeds.

---

[1] In an agricultural sector assessment done in 1976, it was found that 55 per cent of the farm households in the Central Plains were tenant households.

[2] 44 per cent of total farm income is derived from non-farm activities.

Surprisingly, a number of those farmers who have rice fields in the rain-fed area and who thus can manage only one crop, have mechanized at least their land preparation; they hire their machinery to do so. This has been made possible by the presence of three or four traders in the village who own large tractors and threshers and provide custom service. And, with the availability of off-farm employment the farmer uses the income earned from such to pay for the hire of farm machinery. The rice fields assure subsistence food and off-farm employment provides the household cash. Thus, we are tempted to hypothesize that, for this particular village in the central plains, mechanization in a rain-fed area is a function of the availability of off-farm employment opportunities and the presence of farm machinery contractors who provide custom service at fairly reasonable rates.

The following case studies will help flush out the statements we have made thus far.

Farm 601, located in the rain-fed area, cultivates only one crop of rice of the traditional variety and depends completely on animal traction. This family is made up of five members and with the exception of the wife of the head of the household, the rest work in the rice fields. In the off-season the father works as a carpenter and two children take in laundry.

The farm is made up of 22½ rai of land of which 20 rai is cultivated with broadcast rice. The family also owns five buffaloes, two of which were inherited by the farmer twenty years ago, from his parents. All farm work is completed by the family. The farmer did not seem to think that mechanizing either land preperation or threshing would be of

any benefit to his farm. He had sufficient family labour and five draft animals. Furthermore, he grew only one crop of rice and the family had no problem preparing the land in time for the broadcasting of the rice seeds. He did however state that if he has a reliable source of water, the whole year round he would double crop a high yielding variety. In that case mechanization would be important, if not necessary.

The farmer does concede that mechanization would cut back, tremendously, the man days involved in farm activities. This would then release his family members for employment outside the farm. At this point in time, however, he does not have the cash resources to buy farm machinery. And, rather than to pay for the hire of a tractor and/ or thresher, he would rather put the money aside for a rainy day.

Farmer 601 is firm in his arquement that mechanization does not contribute to an increase in yields; an improvement in production levels is dependent upon (a) rainfall (b) fertilizer (c) pesticide. He contends further that even if production yields were to increase, the inevitable increase in input costs would counter-balance the increase in yields. Then, when he does buy a tractor it would be for the sole reason of being able to finish the farm work faster so that the family can increase its cash income earned from off-farm employment.

The farmer is adamant that animal traction is better. Although draft animals have to be fed and taken care of more carefully than an item of farm machinery, a buffalo drawn plough is more suited to the wet rice fields. It is also easier to manage an animal when negotiating the difficult corners in an irregularly shaped rice field. Furthermore,

the draft animals can be used to pull carts. The farmer is a logger and he uses a buffalo drawn cart to transport the timber from the hill to his homestead.

Farm 602 is headed by a young farmer, Yi, who, together with his wife, cultivates 28 rai of rice. During the off-season Yi is a carpenter or seeks employment in construction work.

The land holding is made up of 3 parcels, one of which (10 rai) is rented from Yi's younger brother. Payment for such is by kind - 60 kg. of rice/rai, the standard market rate for land rent in the village. The other 2 parcels 8 and 10 rai each - are located approximately 2 kilometers away from the household.

Since all land is located in the rain-fed area of the village, Yi and his wife cultivate only one crop of rice of the traditional variety. The seeds are broadcast. But, unlike farm 601, Yi hires machinery for land preperation and for threshing. He also rents a water pump at 30 ฿ an hour.

For land preperation Yi hires a four-wheeled tractor at a cost of 50 ฿/rai. He uses the tractor for both ploughings, although a number of his villagers prefer to use animal traction for the second ploughing. Yi feels that the second ploughing by a tractor does not affect the seedlings. The work is performed faster and he has more time available for off-farm employment. With mechanization Yi can plough his 25 rai of land in two days. Previously, it took 2 men and one buffalo 2 months to plough the same area.

Although the land holding size has remained the same while labour inputs in terms of man hours has decreased considerably Yi has no idea of the extent to which his yields have been affected by mechanization although when he first decided to hire a tractor in 1976, it was because he was aware that a deeper ploughing would enable better soil areation which, inevitably, would improve yields. It should not however be surprising that Yi is not able to report higher yields. The entire area has been suffering a drought for the last three years. Last year he was able to reap only 3 tons of rice from his 25 rai. If at all yields improve, Yi thinks that the increase will be between 10 to 15 kg. per rai. On the other hand, he was quick to point out that he was not sure whether the increase would be due to deeper ploughing or due to an increase in rainfall.

For post harvest farm activity he hires a thresher (85 ฿/ton). Heretofore, with two helpers and a buffalo it took him 12 days to complete threshing 3 tons of paddy; now, with four helpers, the thresher completes his work in 4 hours.

Although the climate has been dissapointing and yields have not been up to expectation, Yi is glad that he has mechanized. The rice that he and his wife cultivates is sufficient for family subsistence (the 3 children are still very young) and he has a fairly regular cash income from his off-farm employment. At times however, to pay for the hire of farm machinery, he has had to borrow from the village trader or from friends. On a couple of occassions he has sought loans from the Bank of Agriculture and Agricultural Credit.

Yi insists that mechanization has been a very important development in Thai agriculture because it helps reduce the labour input required for farming rice. The "surplus" labour can then be directed into other forms of employment. In short order, mechanization provides alternatives for employment outside the farm. Yi is fortunate that these off-farm employment alternatives are readily available and he has the time, away from his farm, to seek such employment. Farmers who have mechanized, but who grow 2 crops of rice, have a different view. Many of them complain that there is hardly any time left for off-farm employment. And, since serious debts have been incurred in purchasing or even renting farm machinery, there is an urgent need for intensive cultivation and an increased cropping intensity so that bigger harvest is available for the market.

Farm 603 has rice fields in both irrigated and rain-fed areas of the village. The family owns a total of 29 rai, 5 of which is under irrigation and is rented from a neighbour at an annual cost of 500 ฿/rai. The remaining land is made up of two parcels. To reiterate, the farm household owns 3 plots of land: parcel one of 10 rai is owned by the family and one rice crop of the traditional variety is cultivated; parcel two of 5 rai is irrigated and 2 crops of rice of the high yielding variety are grown; parcel three of 14 rai is owned and used for sugar cane cultivation.

In all 3 parcels of land he uses machinery for land preperation Further, in the case of parcel one where the rice is broadcast he uses animal traction for the second ploughing, although if rainfall is minimal then he would resort to using a tractor. If the moisture content in the

soil is fairly low, due to poor rains, then animal traction will not afford the necessary depth in ploughing. With limited surface water it is crucial that the seeds be implanted deeper into the soil so that there is enough moisture for germination.

The tiller is hired for both ploughing and puddling; payment is 150฿/rai. In the case of land preperation for sugar cane, a tractor (75 h.p.) is hired at a rate of 50 ฿/rai. In addition, the farmer hires an 8½ inch diameter pump, to irrigate parcel two, at 20 ฿/hour. Rice is threshed mechanically at a cost of 100 bundles of rice for 85 ฿ (110 bundles when threshed will constitute 1 ton of paddy).

Two buffaloes are part of the homestead. They were inherited from Chai's (head of household) parents. One animal is six years old and the other, a year and a half.

Chai started mechanizing land preperation in 1976 because it (i) enables timely planting and; (ii) allows for deeper ploughing. His yields, however have not improved with mechanization. Formerly, his 10 rai yielded 3 tons of rice; now, after mechanization, yields remain unchanged. But because mechanization of land preperation has helped cut back the amount of time involved in farm activity, the family is now able to cultivate an additional 5 rai of land which yields 3 tons of the high yielding variety per season.

Mechanization has increased the labour input. Granted, the amount of land under cultivation has increased and, in the irrigated area two crops of rice are grown. Be that as it may, transplanting now

requires additional hired labour costing 100 ฿/rai. Similary, at least an additional 4 persons are required for the mechanized threshing. Fortunately, help for such is readily available from exchange labour.

The entire Chai household agreed that mechanization helped overcome labour constraints to production. On the other hand, they also concede that there has been an increase in the wages of field labourers, thus increasing the overall cost of production. In any case, even with mechanization, there are critical bottlenecks, especially during transplanting and harvesting. Thus Chai is not sure whether the increase in wage costs is due to an increase in the demand for hired labour or whether it is a reflection of increasing fuel prices and inflation in general. Be that as it may, Chai argues that mechanization of land preparation is very important, especially for irrigated agriculture. Here, the soil is of clayey loan, making it difficult for the buffalo to tread upon. The animal gets hired rather quickly. Animal traction is best for rainfed agriculture in the upland areas. As for a comparison between locally manufactured tractors and imported ones, Chai thinks that local tractors are most suitable for swampy land while the larger imported tractors perform in drier land of higher elevations.

In general, Chai is rather unsure of the effects of mechanization. He has mechanized his farming because he and his family work 3 different plots of land, cultivating 2 types of crops, one of which is of two varieties. Mechanization has allowed him proper timing of his various agricultural activities. He insists, however, that an increase in yields would have to depend on (i) the availability of water (ii) use of fertilizer (iii) variety of rice.

When asked if he thought that mechanization generated any negative social consequences, he replied in the negative but qualified that if transplanting and harvesting were to be mechanized then the landless field labourers would be totally displaced. Furthermore, the institution of exchange labour will gradually disappear and there would be less need for economic cooperative between villagers. Consequently, social articulation will decline.

Finally, when asked his views on the comparative advantages of mechanization and animal traction, he insisted that mechanization is far superior for both land preperation and threshing. The only advantage, in Chai's opinion, to animal traction is that draft animals are cheaper to maintain. Also, the initial investment is much lower than that needed for farm machinery.

Farm 604 of a household size of eleven cultivates rice in 20 rai of land, in the rainfed area. Although rice farming is the majour occupation, 6 of the family members also work as labourers during the off-season. The land holding is made up of 2 parcels, each 10 rai in size. One of the parcels in rented from a relative; payment is 60 kg. per rai per year. In addition the household owns 3 buffaloes, one of which was inherited.

Only the traditional rice variety is cultivated but farm technology includes a combination of animal traction and mechanization. The first ploughing is mechanized while the second one is completed by a buffalo drawn plough. Preecha uses two types of machinery, a power tiller (7 h.p.) and a 75 h.p. tractor.

Preecha began mechanizing land preparation in 1977. He decided to do so because he found out from his friends and neighbours that mechanization enabled timely planting and provided opportunity for off-farm employment. Hired help was also becoming hard to find. Before mechanizing, he depended on family labour and 2 animals. The work was slow and friends were often not ready in time for planting. When he started using the power tiller and tractor, the work was completed within a matter of hours. Family labour was thus released into employment outside the farm.

Only the first ploughing is mechanized. The second ploughing is performed by draft animal and family labour. The only concern then is to turn over the soil lightly so that the seeds are implanted deep into the soil. Contrary to another informant (Yi/Farm 602), Preecha contends that for the second ploughing, after the seeds have been broad-cast, mechanization could damage the soft, geminating seedlings. The tractor or tiller is heavy and is more likely to push the seedling too far down into the soil.

Before mechanization, the family harvested 2 tons from the 10 rai. Now there is an increase in yields of 50 kg. per rai.

Threshing too has been mechanized. What used to take two days can now be completed within 4 to 5 hours at 80 ฿ per ton. In general, Preecha thinks that mechanization helps his household prepare the rice fields in good time for the rains. Also, the availability of extra time from farm labour has encouraged the family members to seek employment in other farms. The income earned from such goes towards the payment of

hiring farm machinery. Finally mechanization has helped increase his production levels.

Preecha's majour constraint to mechanization is the lack of capital for the hire of farm machinery. Very often he has had to borrow from the Bank of Agriculture and Agricultural Cooperatives at an interest rate of 12 per cent per annum. He avoids borrowing from village traders who charge as much as 5 per cent per month.

Farm 605 is completely dependent on animal traction. The family comprises 11 members, 7 of whom work in the rice fields and after the crop has been harvested they turn to a multitude of occupations. One son is a tailor and 2 daughters are cooks. The remaining 3 children tend the father's numerous buffaloes and oxen. Rice-traditional variety-is grown in 27 rai of rain-fed land. In addition, the family owns 7 buffaloes and about 120 head of oxen which are reared for the market.

All farm activity is performed manually and by animal traction. Land preparation takes 3 man days. Transplanting too is completed by the family and takes an additional 3 man days. The rice is harvested with help from exchange labour and threshing is performed by buffaloes. According to the farmer, he is more than happy to rely solely on his family labour and an animal traction. He thinks that mechanizing his farming activities would be ineffective since there are no facilities for a reliable water supply.

When he has the resources to do so he would like to invest in a tube well. Then, eventually he will think about buying a tractor but only if he had the cash to do so. Right now he even refuses to hire a

tiller because such would entail having to borrow to pay costs. He does however admit that mechanization of land preparation would help cut back labour inputs because, "the machine can work faster; it does not suffer from fatigue as does a buffalo and the man pushing the plough."

Farm 606 cultivates 41½ rai of rain-fed land. The family rents all land from relatives at the market price of 60 kg./rai. Only one crop of the traditional variety is cultivated for land preperation: both first and second ploughing. Threshing, however, is performed manually.

The farmer has 5 buffaloes which he rents out for 500 kgs. of rice per animal. This income is used to pay for the hire of the tractor 40 ฿/rai.

Soochai Started mechanizing in 1975 because the income from the farm was hardly sufficient to maintain the family. He and his children needed to seek off-farm employment; but to do so they had to be able to finish off farm work quickly. Mechanizing land preparation, he found out from his friends, reduces the man hours considerably. Also, it is less strenuous and, "the family still had energy left for construction and other heavy manual work."

Previously it took him 45 days, 3 animals and 3 of his household members to complete preparation of 41½ rais. Now he can finish the work in 2½ days. But, although work time has been cut back yields have not increased. On the other hand, the last 3 years have been affected by the continuous drought. Last year Soochai was able to harvest a total of only 4 tons of rice. Since yields are rather low Soochai is thinking of

reverting to animal traction which, for him, would be more economical because he already owns 5 buffaloes and the rice seeds are broadcast.

REFERENCES

1. Bank of Thailand, "The Power Tiller Industry", an unpublished study, 1978.

2. Industrial Services Section, Department of Industrial Promotion," The Power Tiller Industry," an unpublished report, 1979.

3. A survey of sixteen firms. (See questionaires)