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THE CONSEQUENCES OF SMALL RICE FARM MECHANIZATION PROJECT

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ECONOMIC ANALYSIS OF FARM MACHINERY INDUSTRY AND TRACTOR CONTRACTOR BUSINESS IN THAILAND

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ABSTRACT

The purpose of this paper is to add information on farm mechanization in Thailand by looking at local farm machinery industry and the economics of using farm machinery in the case of hired service. The local farm machinery industry, developed during the past two decades, is now facing high competition both within the country and from abroad. It is the duty of the government to decide whether this industry should be truely supported in order to develop its potential and to provide farmers with low-cost machinery. The tractor contractor has generated farm mechanization throughout the country. The study showed some profitability among contractors. However, due to increase in operating cost and competition, the contractor is making less profit while the farmers still have to pay high custom rate.

INTRODUCTION

In most developing countries, national food policy has been geared towards increasing food production through improved modern technology. This includes the development of new crop varieties, proper cultural practices, efficient irrigation systems and farm mechanization. These technological changes bring forth increases in food production directly and indirectly. The use of farm machinery allows the cultivation on the heavier and more difficult soils at a faster speed, therefore, permits more efficient use of land through double cropping.

Although mechanization may be blamed for increasing unemployment in areas with abundant farm labor, it is frequently justified by the increase in agricultural productivity and food production. It is often found that farm mechanization in developed countries is generated from labor scarcity and high wage rates and therefore will not cause serious unemployment problems. On the contrary, in most developing countries where labor is abundant, an attempt to introduce ever higher levels of mechanization to the country requires careful investigation both of social and economic benefits. In other words, to answer the question of whether to mechanize or not to mechanize, the planner needs to know the employment situation in the country, the ability of the non-agricultural sector to absorb the displaced laborers and the most economical way to mechanize.

In Thailand, many case studies of these questions have been conducted. This paper reports on two different sides of the problem; the development of local farm machinery industry which generates farm mechanization in the country and the economics of using farm machinery from the viewpoint of those who own the machines and use them both in their own land and custom services.

THE USE OF FARM MACHINERY IN THAILAND

There is no record showing when the first farm machine was imported to Thailand. However, according to Kitdhakorn (1971), one of the pioneers of the modern farming in Thailand, the first tractor was imported during World War I for experimental use in the paddy fields near Bangkok but was not successful because it was too heavy for the soil conditions. In 1920 Kitdhakorn used a tractor for cultivation of upland crop in Pracheub Kirikhan, a province about 200 kilometers south of Bangkok.

After World War II, the use of farm tractors became necessary when there was a need for heavy mechanical equipment to open up new land for cultivation of upland crops. Imports of farm tractors increased along with the expansion of new highways in the north and

northeastern region of the country. In 1957, the Department of Customs recorded the import of 267 unclassified tractors mostly from England. It was not until 1970 that farm tractors imported were recorded separately from other tractors. The imports of farm tractors peaked in 1977 when 6,161 tractors were recorded as shown in Table 1. The decline in imported tractors thereafter was mainly due to the increase in the number of tractors both locally produced (four-wheel tractor and two-wheel tractor or power tiller) or assembled (full-size tractor). The Office of Agricultural Economics (1980) reported that there were 230,591 two-wheel tractors, 31,158 small four-wheel tractors, 33,285 full-size tractors and 8,000 motor rollers working in the field throughout the country during the 1979/80 crop year, an average of 1 tractor per 51.4 hectares. Tractors are used mainly for land preparation. Some full-size tractors (45 h.p. and over) may power corn shellers or rice threshing machines during the harvest season. Smaller tractors and power tillers are also used for threshing, by driving on the piled-up stalks as well as hauling farm produce and generating power for water pumps.

Farm tractors can be classified into three sizes according to the power of the engine: (i) full-size tractors, that is imported tractors with more than 45 horsepower (most of these are used for cultivation of upland crops and broadcasting paddy land); (ii) small four-wheel tractors, both locally produced and imported with engines ranging from 13 to 35 horsepower and generally used on dry land; and, (iii) power tillers or walking tractors which are small two wheel tractors with engines ranging from 7 to 10 horsepower locally produced and imported, used mainly in wet paddy land.

DEVELOPMENT OF THE FARM MACHINERY INDUSTRY IN THAILAND

The government has taken part in the development of the farm machinery industry in Thailand. The Engineering Division, Department of Agriculture, Ministry of Agriculture and Cooperatives has long been involved in developing and trying out farm machinery. The division, under the leadership of M. R. Tebaraddhi Devakul successfully developed the well-known Tebariddhi pump in 1955 and the "Iron Buffalo" in 1958. The objective of the division is to develop farm machinery that can be well adapted to the Thai cultivation system. Several models of "Iron Buffalo" were developed during early 1960 and sold by a private company (Taenkam, 1980). However, due to small scale operation, relatively high price and high competition from other local and imported machines, the company ended its operation in 1967.

Beside government work in farm machinery, various private firms have claimed to be the originators in designing and producing of the power tiller or two-wheel tractor. However, the original design was simplified from an imported Japanese power tiller. According to the survey of 35 firms during March 1980, several firms have accredited "Singkru Utsahagam," one of the innovators in Prapradaeng, as their source of design. The owner of the firm, Kamnan Prung Fakkeaw, who has some experience with long-tailed boat engine, simplified a two-wheel tractor from the imported Mitsubishi power tiller in 1963. His first two-wheel tractor was tested and redesigned to suit local conditions. In 1965 his two-wheel tractors were marketd in the area. This locally produced tractor has gained popularity among farmers because of its low price, as compared to the imported one, and its ability to work in local conditions. Since the design of this two-wheel tractor is so simple and requires no special technology to build, its popularity has induced new manufactures both in Prapradaeng area and other provinces.

Even though the demand for small,locally produced tractors is increasing, there is some competition among producers. Many large producers who have access to credit and modern equipment are capable of producing a large quantity at a lower cost than the smaller firms. Marketing and the managerial ability of the owner are important factors determining the success of the firm. During the survey it was found that many firms, especially those in Prapradaeng area (including "Singkru Utsahagram), have recently dropped out of business because of this keen competition.

The development of an alternative small four-wheel tractor to the "Iron Buffalo" of the Division of Engineering started a few years after the local two-wheel tractor was widely accepted. During the early stage, the simple four-wheel tractor was developed by a group of firms in Ayutthaya, a main rice growing province 100 kilometers north of Bangkok. This tractor was derived from the two-wheel tractor by adding two more wheels at the end so that the driver could operate on a seat instead of walking behind the tractor. Later the design of the small four-wheel tractor was modified to include gear and hydraulic systems similar to those imported from Japan. Development of small four-wheel tractors is still in progress while the two-wheel tractor seems to remain unchanged.

CHARACTERISTICS OF THE EXISTING FIRMS

The Industrial Service Institute of the Department of Industrial Promotion classifies small tractor manufacturing firms into three groups based on production and labor employment as follows:

1) Large scale firms: a firm with average production of more than 1,000 tractor per year. There are approximately 30 firms located in Bangkok and nearby provinces such as Ayutthaya, Chacheongsao and Prathum Thani. Each of these employs 30 to 200 workers.

2) Medium scale firms: a firm with average production between 100 and 1,000 tractors per year. There are about 100 firms in the Central Region and each employs 10 to 50 workers.

3) Small scale firms: a firm with 2 to 10 workers and producing less than 100 tractors per year. There are up to 1,000 such firms. These are scattered all over the country and produce only seasonally or by order. They are developed from local welding and mechanical service shops.

In general, a farm machinery firm will produce more than one type of machinery in order to fully utilize its resources and to meet the market demand. For example, a firm may produce small tractors between January and June, prior to the planting season, and produce rice threshing machines and water pumps during the rest of the year. According to the survey which covered most major firms in Bangkok Metropolis and the nearby provinces, more than one third of the firms produce only two-wheel tractors, 20% of the firms produce both two-wheel and four-wheel tractors and another 20% produce both two-wheel and rice thresher while 9% produce all three types of machines (Table 2).

Since manufacturing firms produce more than one type of farm machinery, it is better for further analysis, to classify the firms into 3 different types based on the main product, in value terms, that the firm produces. The classification is as follows:

Type 1 firm refers to firms that produce two-wheel tractors as the main product. Of the 35 firms 23 were in this group.

Type 2 firm refers to firms that produce four-wheel tractors as the main product. There were 7 firms in this group.

Type 3 firm refers to firms that produce threshing machines as the main product. These threshing machines are used mainly for corn and other legume. There were 5 firms in this group.

Eighty-six percent of the firms produced farm machinery as their main occupation and dealt with mechanical equipment as a repair shop or dealer of farm machinery, before they entered the business. Only one owner was found having a Bachelor degree in engineering. The rest started the business with their own experience or by hiring someone who knew how to do the work.

There are various sizes of firms, ranging from few workers to more than one hundred workers, in each type. Table 3 shows the number of firms classified by the number of workers and the operating period during the year. Nearly 50% of Type 1 firms employed less than 20 workers compared to 30% in Type 2 and 20% in Type 3 firms; in other words, most small firms produce two-wheel tractors and most of the large firms produce four-wheel tractors. As mentioned earlier, many small firms produce only to order or during a certain period. The survey shows that half of the firms produce throughout the year. Some firms may cut down workers during the off season, but still maintain some skilled laborers to produce the certain parts of tractors for stock.

Production process and cost of production of farm machinery.

Not all the parts of a small tractor are produced by the firm. The main components produced by the firms are the body parts such as wheels, engine housing, chasis and handle. Many parts, such as engine, chain and bearing, still have to be imported. At present, there are two companies producing diesel engines in Thailand. Machines used in the firm can be very simple, a small firm may need a welder, lathe, sprayer and acetylene cutter while a large firm may employ more labor saving machines such as hydraulic presser, shapers, steel roller, honing machine, electric power drive and sprocket wheel cutter (Pinthong, 1974).

Estimated costs of production of two-wheel and four-wheel tractors are shown in Table 4. Steel, which is the main input for two-wheel tractors accounts for 50% of the cost of production, excluding the diesel engine. The cost of an 8 h.p. diesel engine is around baht 15,050 (U.S.$752.5) but will vary depending on the brand. Total cost of a two-wheel tractor with engine is baht 19,512.80 (U.S.$ 975.64) compared to with baht 34,900 (U.S.$ 1,745) for an imported two-wheel tractor. However, the imported tractors are better built, lighter in weight and perform more functions than local machines.

A small four-wheel tractor, including 15 h.p. diesel engine, costs around baht 49,831 (U.S.$ 2,491.56). There is variation both in design and cost of the small four-wheel tractor among different manufacturing firms while there is little difference in design of the two-wheel tractors. The imported sale price of the small four-wheel tractor is around baht 84,500 (U.S.$ 4,225).

MARKETING SYSTEM OF FARM MACHINERY

Marketing of local farm machinery is the most important function of the business. Since there is a low degree of product differentiation among two-wheel tractors, firms have to use special techniques to gain popularity in the market. For local manufacturers located in other provinces outside the Bangkok Metropolitan Area, such as Chacheongsao, Nakhon Sawan, Chainat and Suphan Buri, the products are produced predominantly for local demand and sold directly to the consumers, rather than through dealers. The large firms in Bangkok and one firm in Prathum Thani, sold their products through dealers that were scattered throughout the country. Sale to dealers can be in cash or credit. These dealers are of crucial importance to the firms since they also provide useful information about design changes to suit consumer's needs in different locations. Usually, products from large firms are somewhat cheaper than average because of economies of scale in mass production. Smaller firms gain their market by having close contact with the customers, through prompt service or one year guarantee.

Small four-wheel tractors, produced mainly in Ayutthaya, vary in design from firm to firm and so do their costs. Each firm tries to improve its own design to attract customers. However, at the time of the study, there was no serious competition among the manufacturers since there was excess demand for small four-wheel tractors and each firm had to produce day and night to meet the demand. Most four-wheel tractors are sold directly to rice farmers, usually growing broadcast rice in the Central Plains. It was found that because of their weight, small four-wheel tractors, cannot perform as well as two-wheel tractors in the wet paddy fields. Therefore, farmers who transplant paddy tend to prefer two-wheel tractors.

The foreign market is the next step for large manufacturers. Some have sent their products to Indonesia for experimental use. Yet improvements are still necessary before they can be accepted internationally.

THE ROLE OF GOVERNMENT IN THE FARM MACHINERY INDUSTRY

There are two government agencies involved in industrial extension, which include the farm machinery industry (Mongkoltanatas, 1981). The Industrial Service Institute (ISI), Ministry of Industry, assists manufacturers in providing technical training and advisory services to owners and managers as well as workers. In addition to its extension work, ISI also organized the Forum of Tractor Manufacturers of Thailand in 1977. The objectives of the forum are to support local farm machinery manufacturers and to improve production techniques. At present there are 40 members, mostly located in the central region. The second agency is the Agricultural Engineering Division (AED) of the Ministry of Agriculture and Cooperatives, which assists manufacturing firms in testing and modifying new products. However, the survey shows only 40% of the firms received assistance from the government. This took the form of investment credit, machine design, tax exemption for equipment and management and technical training.

MAJOR PROBLEMS AND SUGGESTED SOLUTIONS

There are a number of problems facing the local farm machinery industry in Thailand. Major problems and solutions suggested by producers are listed as follows:

1. Financial problems. The survey showed 40% of the respondents, especially smaller firms, are confronting this problem. To obtain a low interest rate loan from the government is rather difficult. It is suggested that the government should encourage small firms by providing sufficient funds to help reduce the production cost of the firms and result in lower-priced machinery for the farmers.

2. Technological difficulties. Even though there is no patent law and the firms are free to copy any designs, technology is still one of the important problems to many producers. Proper training will assist producer to produce better quality machines.

3. Lack of labor and skilled labor. Most workers gain experience through on-job training. Many skilled workers were attracted by newly-opened firms and by high wage rates in the Middle East. Training for unskilled young workers is necessary.

4. Marketing problem. The demand for farm machinery is a derived demand which depends on product price. Since crop yield and price are uncertain, manufacturing firms have to be aware of crop yields. There is a large demand for farm machinery in following a good crop.

Besides these four major problems, there are minor problems such as the lack of proper equipment and unfair taxation (Industrial Service Institute, 1981) - i.e. imported materials are taxed higher than imported farm machinery (13.55% and 11.27% tax for local two-wheel and four-wheel tractors compared with 8.85% tax for imported machines).

In conclusion, the farm machinery industry in Thailand, was generated by private rather than government effort, but requires government assistance and protection to continue. If the goal of the government is to induce mechanization in Thailand, in order to intensity agriculture and raise yields per unit of land, it is most appropriate to support local farm machinery since the local farm machine is inexpensive, simple, and designed to fit local conditions. Standardization of farm machinery may be necessary for export demand. However, this will raise the cost of production to some extent. Taxation for imported machines and materials, should also be revised if the government wants to generate employment and reduce the trade deficit.

THE ROLE OF TRACTOR CONTRACTOR IN FARM MECHANIZATION IN THAILAND

The tractor contractors have paid an important tole in farm mechanization in Thailand. Owing to the fact that Thai farmers have a small land holdings (on the average 4 hectares per family), and the majority of farmers are low-income people, many farmers cannot afford to own any mechanical equipment and, therefore, have to use tractor contractor services. Tractor contractor services are used mainly for cultivation of upland crops and broadcasting rice where cultivation is done on dry land and full-size tractor becomes necessary.

At present, very few farms use bullocks for upland crop cultivation. Bullocks may be used for planting and weeding while plowing, transporting of products and threshing are performed by contractor services which are scattered throughout the country.

CHARACTERISTICS OF TRACTOR CONTRACTOR AND THEIR SERVICES

It is believed that almost all of the tractor owners do contract services. Some owners even travel more than 100 km. for plowing during the off-season. The contractor survey was carried out during April and May of 1980 in three locations namely: Phra Buddhabaht (area 1), Pak Chong (area 2) and Bang Pa IN (area 3). The first two areas are the major upland crop growing areas and the third area is the broadcast rice area where most contractors are located. Thirty-four contractors, who own 48 tractors were contacted. Of these 48 tractors, 22 were purchased brand new from the company. Most of the contractors are farmers, or at

least dealing with agricultural products. It was found that 76% of the contractors were rice and corn growers, 15% were upland crop middlemen and the rest were general merchants. The average land holding was 14 hectares. However, two contractors were found dealing only with contracting services.

Most contractors service neighbouring areas after finishing their own work. A contract is usually made directly by farmers and the custom rate determined by soil conditions and market price. It was also found that some contract arrangements were made through agents who looked for the customers in the nearby area and received a certain commission rate. At present, the number of tractor owners is increasing and there is competition in some areas. Therefore, some contractors have to travel in groups to other provinces to find new customers. Working in groups also reduces the probability of being robbed.

Fuel is the most important factor of contractor business. Rising fuel prices, and fuel shortages, increase operating cost and discourage contractors from travelling long distances for customers. Subject to the elasticity of demand for contractor services, a part of this rise in costs can be passed on to the farmers in higher custom rates.

THE AMOUNT OF WORK AND REVENUE FROM OWNING A TRACTOR

Contracting services can be provided both daytime and nightime. On average, one tractor plowed 176 hectares in 1979, 29 hectares or 17% of which was owned land and 147 hectares or 83% was contract (Table 5). The average working hours during the year were 432 hours or 56 working days. Contractors in Bang Pa In, which is a broadcast rice area, utilized their tractors more than in the other two areas. However, the total revenue per tractor was less than in the other two areas because custom rates for plowing paddy land were lower than for upland crops. This was due to soil condition and topography. The custom rate for plowing upland crops in 1979 was 500 baht per hectare compared to 247 baht for paddy land. During 1979 the contractors received an average total revenue of 70,771 baht of which 19% was derived from the use of the tractor in his owned land. Eighty-eight percent of this revenue was from plowing and the rest was from other activities such as threshing and transportation of farm produce which can be considered as a supplementary of income. In Phra Buddhabaht 96% of the revenue was from plowing alone.

COST OF OPERATION AND PROFITABILITY

The cost of operation can be divided into cash and non-cash costs. Cash costs refer to actual outlays such as fuel, oil, driver, maintenance etc. Cash costs accounted for 75% of the total cost (Table 6). Among these expenses, the cost of maintenance and repairs was largest, accounting for almost 40% of the total cost. This was because most tractors have already been operating for more than 5 years in poor soil conditions. The cost of fuel which varied with the amount of work done accounted for nearly 27% of the total cost. As mentioned earlier plowing land for broadcast rice is easier than for upland crops. The cost of operation of tractors, especially the cost of maintenance, was much lower in Bang Pa In than in the other two areas. Therefore, even though the revenue within the year was lower, the contractors in Bang Pa In made more profit than those in Phra Buddhabaht and Pak Chong.

BREAK-EVEN POINT ANALYSIS

In order to find out how many hectares each tractor has to plow within a year to cover its fixed cost, break-even point analysis was used as follows (Fordson, 1959):

$$\frac{FC+AVC}{X} = AR$$

where FC = Total fixed cost

X = Number of hectares to be plowed

AVC = Average variable cost for plowing one hectare

AR = Average revenue per hectare

hence $X = \frac{FC}{AR-AVC}$

The result of the analysis is shown in Table 7. The average break-even point was 116 hectares while the actual area plowed was 176 hectares. Therefore, the contractors were on average, making a profit from their operations.

CONCLUDING REMARKS

The tractor contractor has taken part in increasing agricultural productivity both by expanding new cultivated area and speeding up cultivation to permit multiple cropping. This is beneficial to both tractor owners and users since the user cannot justify his own tractor and the owner can fully utilize his tractor. At present, tractor owners are making profits. However, due to increasing competition and rising costs of operation, investment in tractor ownership may not be worthwhile in the future unless sufficient demand for contractor services can be assured. The increase in fuel price and automotive parts has generated high custom rates and therefore high cost of production. It is also expected that there will be a limited substitution of buffalo for machines as a result of increasing fuel prices since many poor farmers are able to pay such high custom rates without higher product prices. Therefore, if nothing can be done to cut down the cost of production, the only way the government can assist the poorer farmers is to raise the price of farm produce.

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Table 1 Number of farm tractors imported, locally produced during 1975-79

Item	1975	1976	1977	1978	1979
Imported farm tractors*	4,231	5,257	6,161	4,298	3,559
Small four-wheel tractors** (locally produced)	2,582	2,914	4,568	5,631	4,920
Two-wheel tractors** (locally produced)	27,860	31,766	49,722	52,281	54,124

Sources: *Department of Custom

**Estimated by Office of Agricultural Economics, Ministry of Agriculture and Cooperatives.

Table 2 Number of surveyed firms classified by type of machinery

Type of machinery	Number of firm	Percentage
Two-wheel tractor	12	34
Four-wheel tractor	1	3
Corn thresher	5	14
Both two-wheel and four-wheel tractor	7	20
Both two-wheel and rice thresher	7	20
Two-wheel, four-wheel and rice thresher	3	9
Total	35	100

Source: Field survey

Table 3 Number of firms classified by number of workers and operating periods

Item	Type 1		Type 2		Type 3		Total	
	No.of firm	%	No.of firm	%	No.of firm	%	No.of firm	%
Number of workers								
less than 20	11	48	2	29	1	20	14	40
20-39	5	22	1	14	3	60	9	26
40-100	6	26	1	14	1	20	8	23
more than 100	1	4	3	43	-	-	4	11
Total	23	100	7	100	5	100	35	100
Operating period								
throughout the year	13	57	6	86	-	-	19	54
by order	6	26	1	14	1	20	8	23
seasonal	4	17	-	-	4	80	8	23
Total	23	100	7	100	5	100	35	100

Source: Field survey

Table 4 Estimated Cost of production of two-wheel and four-wheel tractors

Item	Two-wheel tractor	% of sub-total	Four-wheel tractor	% of sub-total
	(baht)		(baht)	
Steel plate	1,528	34.24	3,849.	14.78
Steel rod	670	15.02	1,076	4.13
Cast iron	-	-	550	2.11
Cast aluminum	-	-	2,835	10.89
Lubricated oil	334	7.49	230	0.88
Bearing	358	8.02	1,400	5.38
Chains	392	8.78	840	3.23
Hydraulic pump	-	-	2,900	11.14
Other parts	544	12.19	5,370	20.62
Wage	250	5.60	2,000	7.68
Electricity and fuel	55	1.23	1,190	4.57
Depreciation	30	0.67	1,200	4.62
Other expense	150	3.36	1,600	6.15
Production tax	151.80	3.40	891	3.42
Tax on machinery	-	-	50	0.19
Sub-Total(without engine)	4,462	100	25,981	100
Diesel engine (8 h.p. and 15 h.p.)	15,050	-	23,850	-
Total cost	19,512.80	-	49,831.00	-

20 baht = 1 U.S.$

Source: Estimated by Industrial Service Institute 1981

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Table 5. Amount of work and revenue received from one tractor in 1979

Item	Phra Buddhabaht		Pak Chong		Bang Pa In		Average	
	Amount	%	Amount	%	Amount	%	Amount	%
Area plowed								
Owned land (ha)	25	13	25	21	40	17	29	17
Service (ha)	167	87	93	79	196	83	147	83
Total (ha)	192	100	117	100	237	100	176	100
Number of hours of plowing								
Owned land (hrs)	47	12	85	21	61	12	67	16
Service (hrs)	352	88	319	79	446	88	365	84
Total (hrs)	3339	100	404	100	506	100	432	100
Revenue from plowing								
Owned land (baht)	7981	11	13218	23	10725	18	10688	17
Service (baht)	61465	89	44458	77	47365	82	51269	83
Total (baht)	69447	100	57676	100	58091	100	61957	100
Revenue from other activities								
Owned land (baht)	1393	57	2542	15	4945	84	2786	32
Service (baht)	1043	43	14425	85	923	16	6029	68
Total (baht)	2436	100	16967	100	5868	100	8815	100
Total Revenue								
Owned land (baht)	9376	13	15759	21	15671	25	13474	19
Service (baht)	62509	87	58883	79	48288	75	57298	81
Total (baht)	71883	100	74643	100	63595	100	70772	100

Baht 20 = 1 US $

Source: Field Survey

Table 6. Average operating cost of tractors in 1979.

Item	Phra Buddhabaht		Pak Chong		Bang Pa In		Average	
	baht	%	Baht	%	Baht	%	Baht	%
Non-cash cost								
Depreciation	2759	3.9	7598	11.0	787	1.6	4040	6.3
Opportunity cost of investment (8%)	10828	15.4	10654	15.5	12179	24.0	11129	17.3
Opportunity cost of owner	667	0.9	929	1.4	1346	2.7	949	1.5
Sub-total	14252	20.3	19181	27.8	14313	28.2	16118	25.0
Cash cost								
Repairing & maintenance	29071	41.3	28556	41.4	15485	30.6	25198	39.1
Fuel	22626	32.3	14934	21.7	13640	26.9	17308	26.9
Oil	1411	2.0	2831	4.1	1857	3.7	2064	3.2
Driver	2552	3.6	3144	4.6	3708	7.3	3087	4.8
Others	329	0.5	269	0.4	1665	3.3	669	1.0
Sub-total	55989	79.9	49735	72.2	36354	71.7	48326	75.0
Total cost	70243	100.0	68915	100.0	50667	100.0	64443	100.0
Cash revenue	62509		58883		48288		57298	
Non-cash revenue	9374		15759		15671		13474	
Total revenue	71883		74643		63959		70772	
Net return over cash cost 1/	15894		24408		27605		22446	
Net profit 2/	1640		5727		13292		6328	
Net cash return over cash cost 3/	6520		9419		11934		8972	
Percentage of return from investment 4/	8.3		13.6		14.6		12.0	

1/ Net return over cash cost = Total revenue - Cash cost

2/ Net profit = Total revenue - Total cost

3/ Net cash return over cash cost = Cash revenue - Cash cost

4/ Percentage of return from investment = $\frac{\text{Net return over cash cost}}{\text{P.V. of tractor with implement + cash cost}} \times 100$

Table 7. Break-even point of using tractor in land preparation.

Location	Total fixed cost (FC)	Average variable cost (AVC)	Average revenue (AR)	Break-even (X)	Area actually plowed
	(baht)	(baht/ha)	(baht/ha)	(ha)	(ha)
Phra Buddhabaht	11,699	281	362	146	192
Pak chong	13,649	352	491	98	117
Bang Pa In	11,474	153	245	131	237
Average	11,369	254	352	116	176

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