

The Trend and Appropriate Structure of Small Tractors in Thailand - Investigation on the Power Tillers in Northeastern Thailand -

Kunio SATO*, Somnuk CHUSILP**, Makoto HOKI* and Vilas M. SALOKHE***

* Faculty of Bioresources, Mie University, 1515 Kamihama-cho, Tsu, Mie, 514-8507, Japan

** Faculty of Engineering, Khon Kaen University, 123 Friendship Highway, Khon Kaen 40002, Thailand

*** The School of Environment, Resources and Development, Asian Institute of Technology, Km. 42 Paholyothin Highway, Klong Luang, Pathumthani 12120, Thailand

Abstract

An investigation was conducted on the trend of power tillers in northeastern Thailand. The study revealed that the usage of power tillers increased by about 10 times from 1986 to 1995 in this region. The motivation for mechanization with power tillers among the small and medium scale farmers was found to be rather high in this region. At the same time, the rapid increase of light pickups has taken the place of conventional farm trucks. These changes are aimed at laborsaving and ease of use.

The future trend of small tractors in this region has been predicted. Because of limitations in owning large tractors privately, small power tillers are considered to be the fundamental private farm machinery for northeastern Thailand. On the assumption that the use or lease, and hiring type systems are established for large four-wheel tractors, the appropriate structure as well as a system for the practical application of small tractors are discussed.

Key Words : Northeastern Thailand • power tiller • appropriate structure • mechanization • steering handle

1. Introduction

According to the Agricultural Statistics of Thailand¹⁾, the number of walking type power tillers has increased from 750,542 to 1,135,742 and the number of riding tractors has increased from 57,739 to 98,096 during 1990-1994, respectively. In Japan, where mainly rice paddy type farms exist, the number of power tillers and four-wheel tractors are almost the same, since 1990, at 1,700,000 and 2,000,000 respectively²⁾. The mechanization and usage of farm machinery seem to have reached peak in Japan's conventional agricultural system. This comparison leads to the prediction that in Thailand the agricultural mechanization will stay in demand until the transfer to four-wheel tractors is fulfilled.

Considering the situation of Asia as a whole, many regions have common characteristics as they are densely populated, growing mainly paddy, and the agricultural mechanization has not been achieved yet

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* 三重大学生物資源学部 514-8507 津市上浜町1515

except in some regions like Malaysia and some parts of Thailand. The recent situation of the mechanization of these regions is investigated by Hoki³⁾ and Prempridi⁴⁾ from the point of traditional methods. According to these investigations, Thailand is passing through various stages of agricultural mechanization⁵⁾. Further, Thailand is located at the heart of the countries including Cambodia, Laos, Myanmar and Vietnam. These countries have a large population but enough agricultural production potential. Nonetheless, the mechanization is not developed yet due to various reasons^{6), 7)}.

In Thailand, there are districts where the land is fertile and agricultural mechanization is pervaded. In many other Asian countries, however, where the mechanization is not pervaded yet, small and medium scale farmers are following the same trend of use of tractors as those in northeastern Thailand. Therefore, in order to establish a sound agriculture in Asian countries, the effort of investigating the application of appropriate agricultural mechanization is desirable.

The following section discusses investigations made on the use of the small tractors and power tillers in northeastern Thailand. This study was compared to study conducted 10 years ago under another project⁸⁾.

2. Methodology

Field studies were made by visiting villages to interview with their representatives from July 17 to July 23, 1996. Some official statistics of 1995 fiscal year of the villages were collected for analysis. The study areas comprised of four provinces surrounding the Khon Kaen province in northeastern Thailand. In each province a pair of irrigated and non-irrigated villages (8 villages in total) were selected for study which were the same villages investigated in 1985 for a related project⁸⁾. In those villages, four villages had been divided into two each. However their category, whether irrigated or non-irrigated, had not changed for each village, therefore, the statistics of those villages were gathered according to the previous divisions of villages and the statistics from divided villages were added to make one data set.

3. Results and Discussion

3.1 Overall situation of the study area

The complete results from this study are given in Appendix Table A. In order to make comparisons, some items are accompanied by figures studied in 1985. Villages whose names are denoted by '+' refer to villages divided since the previous study, and the original names were used to indicate the present two villages. Although the areas were recorded in Thai traditional unit 'Rai', the figures were converted to 'ha'. Items listed as references, like the number of animals, motorcycles, television sets, pumps and the income for each household, are based on the memory or the conjecture of the representative of the village except in the case that the villages have accurate statistics. The demands indicated for four-wheel tractors are also the results of interviews. The income for each household and the demand for four-wheel tractors were similar among the villages studied. Therefore, it can be stated that the income amount and the demand for four-wheel tractors are likely to be common over the entire region.

The power tillers are important machinery for both tillage and transportation in each village. Buffalo and cattle used for agriculture are being replaced by cattle used for beef typically. The monetary income

from farming excluding cost of the crops used for self consumption is around 10,000-20,000 Baht annually. There were some farm households that had no monetary income from farm products. Some family members were found to often work in urban areas like Bangkok or abroad. Many other members also take seasonal work away from home during off seasons to earn extra income.

Table 1 shows the change of the population, farm area or size and the change in the total number of power tillers in the past 10 years (1986-1995). Tables 2 and 3 show the changes calculated for each group (irrigated and non-irrigated areas) respectively.

Although the overall number of households increased by 16%, members of each household in irrigated areas decreased by approximately 20% and even in non-irrigated areas they decreased by approximately

Table 1 Comparison of data for 1985 and 1995

	Total	Total ('95/'85)	Total/ Household	Total/H.h. ('95/'85)	Total/ Population	Total/Pop. ('95/'85)
Number of Households	1,632 (1,407)*	1.16 -	- -	- -	- -	- -
Population	8,324 (8,558)*	0.97 -	5.10 (6.08)*	0.84 -	- -	- -
Cultivated Area (ha)	5,623 (5,360)*	1.05 -	3.45 (3.81)*	0.90 -	0.68 (0.63)*	1.08 -
Irrigated Area (ha)	1,366 (1,425)*	0.96 -	0.84 (1.01)*	0.83 -	0.16 (0.17)*	0.99 -
Non-irrigated Area (ha)	4,257 (3,922)*	1.09 -	2.61 (2.79)*	0.94 -	0.51 (0.46)*	1.12 -
Paddy Field Area (ha)	3,270 (4,054)*	0.81 -	2.00 (2.88)*	0.70 -	0.39 (0.47)*	0.83 -
Non Paddy Field Area (ha)	2,353 (1,325)*	1.78 -	1.44 (0.94)*	1.53 -	0.28 (0.15)*	1.83 -
Number of Power Tillers	711 (69)*	10.30 -	0.44 (0.05)*	8.88 -	0.09 (0.01)*	10.59 -

* Numbers in parentheses indicate corresponding figures for 1985.

Table 2 Comparison of data for irrigated area

	Total	Total ('95/'85)	Total/ Household	Total/H.h. ('95/'85)	Total/ Population	Total/Pop. ('95/'85)
Number of Households	810 (693)*	1.17 -	- -	- -	- -	- -
Population	3,915 (4,254)*	0.92 -	4.83 (6.14)*	0.79 -	- -	- -
Cultivated Area (ha)	1,537 (1,696)*	0.91 -	1.90 (2.45)*	0.78 -	0.39 (0.40)*	0.99 -
Irrigated Area (ha)	1,366 (1,425)*	0.96 -	1.69 (2.06)*	0.82 -	0.35 (0.34)*	1.04 -
Non-irrigated Area (ha)	171 (257)*	0.66 -	0.21 (0.37)*	0.57 -	0.04 (0.06)*	0.72 -
Paddy Field Area (ha)	1,486 (1,449)*	1.03 -	1.83 (2.09)*	0.88 -	0.38 (0.34)*	1.11 -
Non Paddy Field Area (ha)	51 (266)*	0.19 -	0.06 (0.38)*	0.16 -	0.01 (0.06)*	0.21 -
Number of Power Tillers	355 (56)*	6.34 -	0.44 (0.08)*	5.42 -	0.09 (0.01)*	6.89 -

* Numbers in parentheses indicate corresponding figures for 1985.

Table 3 Comparison of data for non-irrigated area

	Total	Total (^{'95/'85})	Total/ Household	Total/H.h. (^{'95/'85})	Total/ Population	Total/Pop. (^{'95/'85})
Number of Households	822 (714)*	1.15 -	- -	- -	- -	- -
Population	4,409 (4,304)*	1.02 -	5.36 (6.03)*	0.89 -	- -	- -
Cultivated Area (ha)	4,085 (3,664)*	1.12 -	4.97 (5.13)*	0.97 -	0.93 (0.85)*	1.09 -
Irrigated Area (ha)	0 (0)*	- -	0.00 (0.00)*	- -	0.00 (0.00)*	- -
Non-irrigated Area (ha)	4,085 (3,664)*	1.12 -	4.97 (5.13)*	0.97 -	0.93 (0.85)*	1.09 -
Paddy Field Area (ha)	1,784 (2,604)*	0.68 -	2.17 (3.65)*	0.59 -	0.40 (0.61)*	0.67 -
Non Paddy Field Area (ha)	2,302 (1,059)*	2.17 -	2.80 (1.48)*	1.89 -	0.52 (0.25)*	2.12 -
Number of Power Tillers	356 (13)*	27.38 -	0.43 (0.02)*	23.79 -	0.08 (0.00)*	26.73 -

* Numbers in parentheses indicate corresponding figures for 1985.

10%. This indicates that more and more family members are working away from home in local urban areas.

It was found that the average cultivating area for each household decreased by approximately 10%. However, the average cultivating area for each person increased by approximately 8%.

In irrigated areas, although the cultivating area for each household decreased, the cultivating area for each person did not show a significant change. The change of farm land to rice paddies in these areas was promoted. During ten year span under the study, the number of power tillers increased by almost 7 folds.

On the contrary, in non-irrigated areas, although the cultivated area for each household did not change, the cultivating area for each person increased approximately by 10%. In this area, although the production of rice was found to decrease tremendously, the production of fruits and vegetables increased by more than two times. In addition, the number of power tillers per person increased as much as 27 times, although there was a fact that the number of power tillers compared was extremely few 10 years ago. The number of power tillers per person was 0.08, which is almost at the same level of 0.09 of irrigated areas. Ten years ago, rice was the main product in non-irrigated areas. At present, however, fruits and vegetables are getting an advantage over rice due to higher income from them.

The increase ratio of power tillers was remarkable. The ownership of 0.44 units per household was recorded. This is 10 times more than that recorded in 1985. The ownership of four-wheel tractors has not increased significantly as shown in Appendix Table A.

The ownership of power tillers differ from place to place. The ownership of power tillers is high in the province capital city, Khon Kaen. The number of owners decreases as you move away from the urban areas.

3.2 Appropriate Farm Mechanization for Small Scale Farmers

According to statistics provided by the Thai Ministry of Agriculture, the number of four-wheel tractors

is about one twelfth of that of power tillers¹⁾. In northeastern Thailand the small and middle scale farmers seldom own a four-wheel tractor individually. The number of four-wheel tractors used in the statistics also includes tractors that are owned by companies for rental or hiring operations. It is possible that tractors used for construction were also included in these statistics. Rental companies use tractors in both agriculture and construction.

Those farmers interviewed, responded that they could use a four-wheel tractor, however, they are too expensive to purchase. When a farmer purchases a power tiller, they usually borrow money from the Bank of Agriculture and Agricultural Cooperative. Table 4 shows the approximate tractor prices in the study area. Compared with annual incomes reported by farmers, (see Appendix Table A), it would be virtually impossible for individual farmers to purchase a four-wheel tractor. At present, a market for imported, used four-wheel tractors, commonly found in the central plains of Thailand, has not yet been formed in the northeastern regions.

Regarding the demand for four-wheel tractors, most villages included in their responses 'leveling' and 'primary tillage' of the land as necessary uses of four-wheel tractors. Primary tillage, however, is performed once a year and land leveling is only once every few years. Thus, these activities performed by tractors are not so frequent.

Many four-wheel tractors are inscribed in the statistics²⁾, however no four-wheel tractors were owned by individual farmers in this area. Three major reasons for this were revealed from the interviews. They are,

- a. The activities performed by four-wheel tractors are carried out through rental companies.
- b. Civil engineering and construction companies are entrusted to develop and manage the fields.
- c. Farmers from other provinces who own four-wheel tractors come as seasonal workers with their tractors.

The most effective way for mechanization in this particular situation seems to be the promotion of individual ownership of small tractors and the encouraged development of rental companies for large scale four-wheel tractors. These could be assisted by the following:

- a. Financial support for the individual ownership of small tractors.
- b. The establishment of organizations that rent large scale four-wheel tractors.

'Small tractors' mean multi-purpose small scale tractors that could be owned by each household and with which the farm families, that are considered to be the smallest units of management, could plan and perform the farm activities by themselves. Small tractors are expected to cover tillage, mowing, pump

Table 4 Approximate prices for power tillers and four-wheel tractors

Vehicle Category	Specifications	Price (Baht)*
Power Tiller	Body (with Disk Plow)	16,500 ~ 21,500
	Engine	24,000 (6.0kW) ~ 28,000 (7.1kW, 7.8Hp)
	Disk Plow only	2,200
Four-wheel Tractor	with Disk Plow and Four-wheel Drive System	770,000 (49.2kW) ~ 870,000 (58.2kW)
Pick Up (Ref.)	2,500 cc 67.1kW Diesel	307,000

* 1US\$ = @25 Baht (1995 conversion rate)

power, trailer transportation, etc.. Small tractors should be adapted to upland farming, which would result in significant savings to farmers. In northeastern Thailand, power tillers currently take the role of small tractors as discussed in the previous section. However, in more advanced areas like in the central plains of Thailand, especially in the upland farming areas, farmers are using small four-wheel tractors instead of power tillers.

In the area studied, four-wheel tractors will become popular in the future due to the demand for laborsavings and comfort. In some of the non-irrigated villages where rapid tillage should be done after rainfall, big four-wheel tractors are a must. A tractor dealer says that it will take 10 years before the four-wheel tractors will spread in to these districts.

On the other hand, the large scale four-wheel tractors in the forementioned policy refer for exclusive use of land operations like land leveling, deep tillage, and the like. From now on, the implements for the elimination of gravel and stones will be required as shown later. Large scale tractors could be used not only for farm preparation but also for construction purposes. Therefore, such tractors would be easier to be introduced in economically backward areas. If the construction businesses are to coexist with farm operations, the safety standard should be considered carefully.

3.3 Discussion on the Appropriate Design for Small Tractors

The demands for small and large scale tractors will continue to increase. Thus it is beneficial to re-look at the structure of small scale tractor usage, especially power tillers.

The length of steering handles of power tillers made in Thailand are considerably longer than those in other countries. Table 5 shows a comparison between the typical dimensions (Fig. 1) of Thai and

Table 5 Comparison between Thai and Japanese power tillers
(Average of three 9 Hp class tillers) (mm)

	L_1	L_2	L_3	L_4	L
Thai	280	790	-50	2,230	3,250
Japanese	240	550	30	1,300	2,120

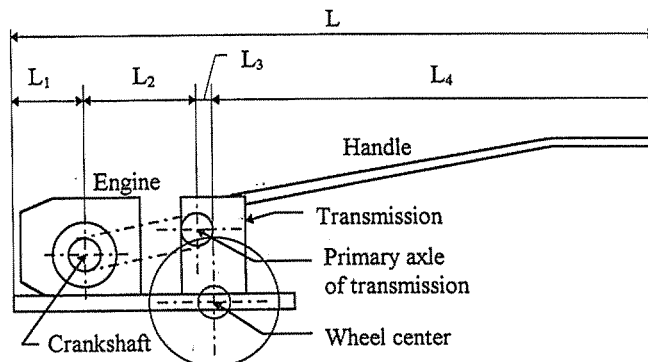


Fig. 1 Dimensions of power tiller

Japanese 6.7 kW class power tillers. The reasons for the longer steering handles on Thai power tillers are considered as follows;

1. Power tillers in Thailand did not have steering clutches at the beginning of 1960.
2. When engines are replaced, the distances from the engines to the primary axes of the tillers change and therefore to balance the weight, the positions of engines should also be changed. In this case the positions of the center of gravity of engines against the tiller bodies can not be minimized and consequently results in rather long lengths of steering handles.
3. In the poorly-drained paddy fields, the higher rotation torque around the axle of the tillers must be balanced with the effort of the operator.
4. In the irregular and stony fields, the operator must maintain control using the handles.
5. In the up-and-down fields, the operator must maintain control of the vehicle rotation around the axle using the long handles.
6. In Thailand, power tillers require such high power that the steering clutches tend to be heavy. Consequently the operator uses handles to steer and this needs certain length of the steering handles.

Item No. 1 above could be classified as a problem of continuity in the agricultural system. No. 2 is a problem in the dimensions of power tillers. Nos. 4 and 5 are problems closely related to each other and are a result of the regularity and leveling of fields. A detailed investigation of No. 6 leads to the uncomfortableness caused by change of engine noises in the irregular or up-and-down fields with small power engines. Therefore, the partial reason for demands for the larger power engines could be linked with the problems of the regularity and the leveling of fields.

On the contrary, the advantages of the short handles are listed as follows;

- a. The reasonable behavior of the operators can be expected when they are steering the power tillers for example in making a turn.
- b. The turning radius for a trailer, if attached to power tiller, could be shortened.
- c. The space needed for production, transportation and storage of such tiller could be reduced.
- d. The weight of power tillers would be reduced.
- e. The capability of small sharp turns while tilling could be enhanced.

If these advantages exceed the problem No.1 of continuity in the agricultural system, the shorter steering handles can be introduced to improve the tillers in many points. Under the condition of further mechanization and the consequent land preparation by the large scale tractors, the improvements of the structure of power tillers are proposed as follows;

1. The dimensions of engines and the bodies should be linked closely to shorten the horizontal distance between engines and primary axes of the tillers.
2. The steering clutches should be improved to be lighter and more reliable.
3. The plow should be improved to have the floatation controlling mechanisms to provide for the use in the poorly-drained paddy fields.
4. To shorten the length of the steering handles with the consequences of above improvements.
5. To develop the implements for the upland farming.

According to these countermeasures, the movement and the power required to the operation are expected to be reduced. With optimization of the system of agricultural mechanization and the structure of small scale tractors, the solutions for the comfortableness and geront-problem in agriculture can be achieved.

4. Conclusions

An investigation was conducted on the trend of use of power tillers in northeastern Thailand. There has been an increase in the usage of power tillers by about 10 times from 1986 to 1995 in this region. The motivation for mechanization with power tillers among the small and medium scale farmers was rather high in this region. The four-wheel tractors found in this region were typically not privately owned. Even though four-wheel tractors are in demand, the cost and lack of continuous need for such tractors prevent their extension.

Because of the difficulty in applying large tractors privately, small power tillers were considered to be the fundamental private farm machinery for northeastern Thailand. On the assumption that the use or lease and hiring type systems are established for large four-wheel tractors, the improvements of the structure of power tillers are proposed.

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Appendix Table A Compiled results of investigation

Village No.	1	2	3++	4	5	6	7++	8
Village Name	Saimool	Dong	Do+	Nonsaan	Kok Yai + Na Chan +	Na Chan +	Dong Singh+	Pra Tau Chai
Province Name	Khon Kaen	Khon Kaen	Maharakham	Maharakham	Kalasin	Kalasin	Roi Et	Roi Et
Category	Irrigated	Non-irr.	Irrigated	Non-irr.	Irrigated	Non-irr.	Irrigated	Non-irr.
Number of Households	184 (167)*	233 (200)*	177 (163)*	126 (97)*	294 (227)*	243 (234)*	155 (136)*	220 (183)*
Population	947 (1,127)*	1,143 (1,327)*	923 (885)*	833 (527)*	1,170 (1,506)*	1,238 (1,350)*	875 (736)*	1,195 (1,100)*
Cultivated Area (he)	256 (256)*	612 (432)*	449 (560)*	432 (432)*	592 (640)*	2,720 (2,400)*	240 (240)*	321 (400)*
Irrigated Area (ha)	205 (230)*	0 (0)*	449 (499)*	0 (0)*	592 (480)*	0 (0)*	120 (216)*	0 (0)*
Non-irrigated Area (ha)	51 (26)*	612 (432)*	0 (48)*	432 (432)*	0 (160)*	2,720 (2,400)*	120 (24)*	321 (400)*
Paddy Field Area (ha)	205 (230)*	366 (400)*	449 (499)*	208 (208)*	592 (480)*	912 (1,600)*	240 (240)*	298 (397)*
Non Paddy Field Area (ha)	51 (26)*	246 (32)*	0 (48)*	224 (224)*	0 (160)*	1,808 (800)*	0 (32)*	24 (3)*
Source of Irrigation Water	Dam (Dam)*	Rain (Rain)*	Canal (-)*	Rain (Rain)*	Canal (-)*	Rain (-)*	River (-)*	Rain (-)*
Number of Power Tillers	154 (42)*	163 (10)*	54 (8)*	32 (1)*	135 (4)*	149 (2)*	12 (2)*	12 (0)*
Popular kW of Power Tillers	6.0-7.1 (6.0-6.7)*	7.1 (7.5-8.2)*	6.0-7.1 (6.7-8.2)*	7.1-8.2 (3.7)*	- (5.2-6.7)*	7.1 (6)*	6.0-8.2 (5.2-6.7)*	7.1-8.2 (-)*
Number of Four-wheel Tractors	0 (0)*	0 (1)*	0 (0)*	0 (0)*	0 (0)*	0 (0)*	0 (0)*	1 (0)*
Number of Farm Tracks	6 (8)*	1 (0)*	0 (3)*	0 (1)*	2 (0)*	2 (0)*	0 (0)*	2 (1)*
Number of Pickups	7	13	17	4	28	10	10	25
Number of Trucks	2	19	3	2	16	11	2	3
Number of Vans	0	0	4	1	-	0	2	1
Number of Motorcycles	76	>233	<106	15	88	184	>40	130
Number of Television Sets	174	>233	177	96	282	219	84	163
Number of Animals (Buffalo+Ox)	-	a few	200+300	-	<10	60+90	60	55+0
Animal Use	-	Mowing	Sale	-	Sale	Mow&Meat	Cultivation	Cultivation
Annual Income (Baht)	15000	<15000	<20000	>10000	<15000	12000-13000	15000	few
Demand for Four-wheel Tractors	No	Leveling	Leveling	First Cultivation	Making Pond	Leveling	Leveling	Leveling & Cultivation

+ Those villages had been divided in to two villages.

++ Although those numbers do not add up by some reason, they were adopted as they are.

* Numbers in parenthes indicate corresponding figures for 1985.

タイにおける小型トラクタの動向と適正構造に関して —東北地方におけるパワーティラーに関する調査を中心として—

佐藤邦夫*, Somnuk CHUSILP**, 法貴 誠*, Vilas M. SALOKHE***

* 三重大学生物資源学部

** コンケン大学工学部

*** アジア工科大学院環境資源開発学部

タイ東北地方に位置するコンケン県とその周辺地域における小型トラクタ、特にパワーティラーの動向について調査した。

その結果、1986年から1995年の10年間でパワーティラーの台数の伸びがほぼ10倍に達し、この地域を形成する中小農民のパワーティラーによる機械化の意欲が非常に高まっていることが分かった。また同時に、従来よく使われていた農用トラックに替わり、小型ピックアップなどの所有台数が急速に増え、中小農民の生活形態が近代化、省力化の方向に向かっていることが示された。

次に、この地方の小型トラクタに関する将来の見通しについて考察した。大型トラクタを個人所有することが難しい現状では、タイ東北地方の個人農家における基本的な農業機械としては、小型のパワーティラーが想定される。

大型四輪トラクタに関しては共同所有、あるいは会社組織による賃貸・請負耕耘システムに組み込まれるという前提に立ち、個人農家のためのパワーティラーの構造と具体的な利用形態について考察した。