

Chapter 7

The Mechanization of Rice Production in Vietnam: An Analysis of Lifecycle of Agricultural Machinery

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Abstract:

This chapter illustrates the present status and characteristics of the mechanization of agriculture in Vietnam. The chapter particularly focuses on the ownership and use of tractors and combine harvesters for rice production. Several statistics indicate that the number of small tractors and combine harvesters has increased remarkably, the majority of which are comprised of imported secondhand tractors. The author's field survey found that agricultural machines are heavily used and replaced within a short period of time by the farm households that run custom hiring service businesses. This practice of machine use is economically beneficial for both machine owners and those who contract out agricultural work to the machine owners. However, concerns over the future sustainability of mechanized agriculture remain.

Keywords: combine harvester, mechanization of agriculture, tractor, Vietnam

1. Introduction

The mechanization of agriculture is commonly observed among emerging economies in which rapid industrialization is occurring, and Vietnam is no exception to this. One study estimates that 70% of the land preparation in Vietnam in 2010 is performed by tractors (Takeshima et. al. 2018). However, another study found that 100% of both land preparation and harvesting work was done by tractors and harvesters in the Mekong Delta region of Vietnam (the year of research was not indicated) (Reardon et. al. 2014).

The mechanization of agriculture in Vietnam is one of the consequences of a labor shortage in the agricultural sector. As Vietnam entered a period of rapid economic growth since the beginning of 2000s, the country experienced a drastic transformation of the labor force distribution towards the industrial and service sectors. The agriculture

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sector that had accounted for 62.5% of the total employed labor in 2000 was reduced to only 37.7% in 2018, while the agricultural land (planted area) of the country increased from 12.6 million hectares to 15.0 million hectares during the same period.²

Otsuka (2013) argues that the use of machines reduces the comparative advantages of smallholder farmers, i.e. zero or low costs to monitor employed labor, and larger farms thus become more efficient. As a result, lands are, theoretically, transferred from smallholder farmers to larger farmers. In Vietnam, in fact, at the national level, cultivation of small plots of land has reduced: the ratio of agricultural units (households, enterprises, and cooperatives) with less than 0.5 hectares of cultivated land has decreased by 13 points from 68.8% in 2006 to 55.0% in 2016 (GSO 2006; GSO 2018). At the same time, as will be discussed, the number of major agricultural machines such as tractors and combine harvesters has increased considerably.

Nonetheless, the same ratio in the Mekong Delta region, where the agricultural production scale is largest and the mechanization of agriculture is most advanced, reduced only by 5.8 points from 45.0% to 39.2% during the same period. Despite the diffusion of agricultural machineries, a large number of farmers in the Mekong Delta region still choose to be smallholders. This phenomenon can be attributed to the specific characteristics of the diffusion of agricultural machines.

Some previous studies have examined the factors which facilitate use of agricultural machines in Asia (and in Vietnam in particular by Liu et al. 2016 and Takeshima et. al. 2018). Nonetheless, current literature focuses exclusively on demand-side factors (non-agricultural wage, farm size, land productivities, education of household head, etc.), and lack analyses from the perspective of supply and usage of the machines. It is important to understand supply and usage of the machines to evaluate the potential market size and necessary policies to further facilitate the mechanization of agriculture in Vietnam.

The main objective of this chapter is to examine how agricultural machines, in particular tractors and combine harvesters, are owned and used by farmers in Vietnam. In the literature on “life cycle analysis” of agricultural machines in Europe, the effectiveness of machine replacement (Gaworski and Jozwiak 2012), and depreciation rates of machines (Ribera and Olmeda 2007; Wilson 2010, Lips and Burose 2012) are analyzed.³

² General Statistics Office (GSO) database (http://www.gso.gov.vn/Default_en.aspx?tabid=766, accessed January 31, 2020)

³ For example, the depreciation rates of tractors differ depending on the sizes (power of engine) and ages of machines in Spain (Ribera and Olmeta 2007), but are based on the hours of use per year in the UK (Wilson 2010). The average duration of lifetime use of tractors is 37 years in Switzerland, but farmers tend to replace tractors after a much shorter time because the

This paper aims to conduct similar analyses on tractors and combine harvesters for rice production based on the results of the author’s own surveys. This chapter is comprised of two parts. Section 2 introduces various statistics on the diffusion of tractors and combine harvesters in Vietnam. Section 3, using the results of the field surveys, the chapter attempts to analyze the life cycle and economic efficiencies of use of these machines.

2. Diffusion of major agricultural machines in Vietnam

2.1 Status of ownership of agricultural machinery in Vietnam

This section provides an overview of the status of ownership of major machines that supplement the shortage of agricultural labor in Vietnam. The results of the Rural, Agricultural, and Fishery Censuses (hereafter called “agricultural censuses”) of 2006, 2011, and 2016 indicate that the number of major agricultural machines (i.e., tractors, combine harvesters, and diesel/petrol engines) have increased, as illustrated in Table 7-1 and Table 7-2. The number of tractors of all kinds has increased by 82% in 10 years since 2006. In particular, the number and ownership ratio of small-sized tractors are increasing remarkably. In 2016, there were more than 700,000 tractors, of which 58% are small-sized tractors with less than 12 HP. Diesel or petrol engines are also among the machines that have diffused rapidly; the number increased by 61% between 2006 and 2016. Engines are adopted for a wide variety of uses, such as water pumps, outboard engines, and vehicle engines. As the use of combine harvesters has become popular in Vietnam since the early 2010s, the statistics on combine harvesters appeared in 2016 agricultural census results.

Table 7-1 Number of major machines

	2006	2011	2016
tractor 35HP <	24,380	17,206	28,193
tractor 35HP < > 12HP	105,180	221,445	270,722
tractor < 12HP	266,098	294,618	420,343
combine harvester			22,184
diesel/petrol engine	337,328	319,975	543,843

Source: GSO 2007; 2012; 2018.

maintenance costs increase as the period of use is extended (Lips and Burse 2012).

Table 7-2 Number of major machines per 100 units

	2006	2011	2016
tractor 35HP <	0.18	0.2	0.30
tractor 35HP < > 12HP	0.85	2.0	2.91
tractor < 12HP	2.30	2.7	4.52
combine harvester			0.24
diesel/petrol engine	2.83	2.7	5.85

Source: GSO 2007; 2012; 2018.

Policy measures have been an important factor in the diffusion of agricultural machineries in Vietnam. Among the recent influential policies is the Prime Minister's Decision No. 68 (68/2013/QĐ-TTg),⁴ which has helped farmers to purchase agricultural machines using bank loans. This decision stipulates that, when a farmer buys agricultural machines which are new and meet the quality standards set by the state, 100% of the interest of the bank loans is covered in the first two years, and 50% in the third year.

Despite such a rapid increase, the mechanization level in Vietnam is still below many of its neighboring Asian counterparts. As of 2013, the farm mechanization level, i.e., the total capacity of tractors (aggregated number by power of all kinds of tractors) was 1/3 that of Thailand, 1/4 of Korea, and 1/6 of China. The total capacity of a tractor per one hectare of cultivated land was 1.86HP/ha, which was lower than Japan (7 HP/ha) and South Korea (4.10 HP/ha), but higher than the Philippines (1.23 HP/ha), Pakistan (1.02 HP/ha) and India (1.0 HP/ha) (Nguyen Huy Bich et. al., 2016: 68).

2.2 Increasing supply of agricultural machines

During the planned economy era, and even after the economic reform began in the late 1980s, the agricultural machinery industry was one of the most heavily protected industries in Vietnam, and the state-owned enterprises (SOEs) were expected to lead the industry of manufacturing major machines in the 1990s. The power tillers and diesel engines manufactured by the SOEs like VIKYNO and VINAPRO were even exported at that time (Takeshima et. al. 2018). Since the beginning of 2000s, there was an attempt to design and produce locally manufactured small-sized combine harvesters, through the initiative of Nong Lam University of Ho Chi Minh City, and in fact VINAPRO could sell 90 units of them (Phan Hieu Hien et.al. 2007).

The agricultural machinery industry has become more liberalized since the mid-

⁴ Prime Minister's Decision on "Policy support to reduce losses in agriculture," dated on November 14, 2013.

2000s. Import of machines increased and production by foreign manufacturers started in the early 2010s.⁵ However, even today the SOEs, i.e., Vietnam Engine and Agricultural Machinery (VEAM) and its subsidiaries, are the major providers of agricultural machines among the local enterprises, with a total production capacity of 5,500 tractors per year.⁶ However, despite recent increasing demand, the capacities of local agricultural machine manufacturers in Vietnam are still limited. In rural Vietnam, one may observe more agricultural machines of foreign brands, predominantly Japanese ones (Kubota, Yanmar and Iseki). It is reported that the market share of local manufacturers is only 15-20% (Nguyen Huy Bich et. al. 2016).

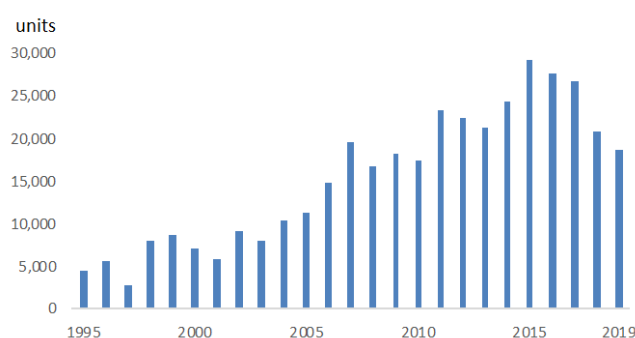
The diffusion of agricultural machines, in particular of tractors, has been enabled mostly by inflow of imported machines from Japan. As reliable trade data on tractors for Vietnam is not available,⁷ this section reviews the export data of Japan, the largest tractor exporting country to Vietnam. Japan started to export tractors to Vietnam in the late-1980s in informal manner (Sakata, forthcoming). The numbers of annual exported tractors in the 1990s were already more than annual production capacity of VEAM today. The export has continuously increased and the number exceeded 10,000 units in 2004, and 20,000 in 2011 (then reduced to less than 20,000 in 2019) (Figure 7-1). Many of the tractors exported to Vietnam are small-sized machines; in 2019, 54.8% of them are less than 18Kw (equivalent to 24 HP) ones, including two-wheel tractors. In addition, most of the exported tractors, both small- and large-sized ones, are secondhand machines (Table 7-3).

⁵ Kubota Vietnam was established in 2009, and started its knock down production of tractors in 2010, and combine harvesters in Vietnam in 2012 (<http://www.kubota.vn/>, accessed January 31, 2020).

⁶ VEAM web site: <http://veamcorp.com/> (accessed January 31, 2020).

⁷ For example, according to the Global Trade Atlas database, in 2017, 9,982 imported “tractors” (HS 8701: tractors, other than work trucks of heading 8709) from all over the world were recorded as imported to Vietnam. However, the number of Japan’s exports of agricultural tractors to Vietnam, 26,644, alone exceeds the number of total imports in Vietnam’s statistics.

Figure 7-1 Japan's export of tractors for agricultural use to Vietnam



Source: Global Trade Atlas database.⁸

Note: HS870190 from 1994 to 2016, HS870191-870195 from 2017 to 2019

Table 7-3 Japan's export of tractors and used tractors to Vietnam

HS code	Description	2017	2018	2019
870191	Tractors, Not Exceeding 18Kw	15,538	11,765	10,198
870191110	used	15,453	11,764	10,198
870192	Tractors, Exceeding 18 Kw But Not Exceeding 37 Kw	9,705	7,546	7,024
870192110	used	9,623	7,395	7,024
870193	Tractors Exceeding 37 Kw But Not Exceeding 75 Kw	1,367	1,483	1,353
870193110	used	1,367	1,483	1,353
870194	Tractors Exceeding 75 Kw But Not Exceeding 130 Kw	34	38	32
870194110	used	34	38	30

Source: Global Trade Atlas database.

3. Machine use for rice production in An Giang Province

3.1 Costs and benefits of machine use

The questionnaire surveys were conducted to 100 households in total that own either tractors or combine harvesters (or both), in January 2019 and in January 2020 in five districts of An Giang province, the second largest rice production province in the country.⁹ The surveys obtained information on farmers' purchase price, operated areas, and maintenance and repair costs of the tractors and combine harvesters during one year before the survey was conducted. In total, information on 122 tractors (both 2-wheel and

⁸ <https://www.gtis.com/gta/> (accessed January 31, 2020)

⁹ Kieng Giang province, neighboring An Giang province, was the largest rice production province, producing 4.26 million tons in 2018 (An Giang Province produced 3.89 million tons).

4-wheel tractors) and 38 combine harvesters that are currently used was collected.

Table 7-4 displays the period used and the operated areas of the tractors and combine harvesters currently owned by the surveyed households. The figures of mean and standard deviation of the periods of use suggest that tractors and combine harvesters were adopted by farmers relatively recently around the year 2010. Tractors are used for land preparation of more than 100 hectares of paddy fields per year, while the harvested areas that employed combine harvesters exceeded 260 hectares on average (and maximum operated areas of tractors and combine harvesters are both 700 hectares or more).¹⁰ The large difference in operated areas between tractors and combine harvesters indicates that a larger number of tractors are diffused than combine harvesters among farmers.

Table 7-4 Profiles of tractors and combine harvesters currently used by surveyed households

	period used (years)		operated areas (ha)	
	tractor	combine harvester	tractor	combine harvester
sample number	122	38	121*	38
mean	6.3	4.7	103.9	268.8
stdev	5.1	3.2	92.4	206.5
maximum	23	12	700.0	750.0
minimum	1	1	4.5	60.0

Source: Author's survey

Note: * Excluding one sample that was newly purchased and was not yet used.

Agricultural machines operate in relatively larger areas because firstly they are used for cropping of rice three times per year in the surveyed areas. Secondly, this is because they are used to cultivate the land of other households through the extension of custom hiring services of tractors for land preparation and combine harvesters for harvesting work (Takeshima et. al. 2018). Among the 100 surveyed households, 94 households run custom hiring services of their machines. 77 out of 84 households have tractors, and all of 25 households that have combine harvesters provide custom hiring services. Interestingly, custom hiring services seem specialized either to land preparation or to harvesting. 17 out of 25 households that have combine harvesters do not own tractors and contract out their land preparation work to other households that have tractors.

On the one hand, machine owners receive on average 1,161,000 VND per

¹⁰ In the literature on agricultural machine use in Europe and in Japan, usage is usually measured by working hours. However, in Vietnam, the operated area is commonly used to measure how much machines are used. Therefore, in this study the duration of use of machines is calculated with operated areas (hectares).

hectare of land for land preparation, and 1,966,400 VND for harvesting work. On the other hand, the average operation and maintenance/repair costs (of fuel, maintenance such as changing lubricant, and repairs of broken equipment) per hectare for tractors is 407,100 VND and for combine harvesters is 559,100 VND (there may be other costs of machine use such as operators' wages and transportation costs). A simple estimation by the author revealed that if the tractors are used in 100 hectares of paddy fields per year and combine harvesters 270 hectares, according to the calculations above, the owners of machines may be able to receive enough returns to pay off their investment in tractors within 5-7 years and in combine harvesters within 3-5 years.

3.2 Use of secondhand machines

The diffusion of agricultural machines in Vietnam is largely owing to the diffusion of less expensive secondhand machines. As Table 7-5 and Table 7-6 indicate, among the samples, 36.9% (45/122) of the tractors and 28.9% (11/38) of combine harvesters are secondhand machines that the surveyed households purchased. In Vietnam, more secondhand tractors are on the market than combine harvesters since more imported secondhand tractors are available.¹¹

The average prices of secondhand machines are far lower than new ones, while there is little difference, for both tractors and combine harvesters, in operation and maintenance/repair costs per hectare of operated areas. This implies that purchasing secondhand machines is an economically reasonable option. In contrast, purchasing new machines brings in more financial benefits since new machines can be operated for custom hiring services in more areas of paddy fields than secondhand machines.

Table 7-5 Profiles of tractors currently used by surveyed households

	purchased price (million VND)		period used (years)		operated area (ha)		costs of fuel, repairing/ maintenance (1000 VND)		costs of per hectare of use (1000 VND)	
	new	secondhand	new	secondhand	new	secondhand	new	secondhand	new	secondhand
sample number	77	45	77	45	76*	45	76*	45	76*	45
mean	336.6	106.7	4.3	9.6	122.2	72.9	41,403	23,557	396.4	425.3
stdev	97.8	74.0	2.6	6.5	99.2	70.5	29,198	25,691	217.6	402.2
maximum	605.0	318.0	13.0	23.0	700.0	300.0	140,600	146,000	1,162.0	1,906.7
minimum	20.0	10.0	1.0	1.0	10.0	4.5	5,400	2,200	40.0	123.2

Source: Author's survey.

Note: * Excluding one sample that was newly purchased and was not yet used.

¹¹ The secondhand combine harvesters, in particular those imported from Japan, cannot be used as they are, because Japanese combine harvesters are designed to harvest transplanted paddy (direct seeding, instead of transplanting is common practice in southern Vietnam).

Table 7-6 Profiles of combine harvesters currently used by surveyed households

	purchased price (million VND)		period used (years)		operated area (ha)		costs of fuel, repairing/ maintenance (1000 VND)		costs of per hectare of use (1000 VND)	
	new	secondhand	new	secondhand	new	secondhand	new	secondhand	new	secondhand
sample number	27	11	27	11	27	11	27	11	27	11
mean	565.4	238.6	5.5	2.7	321.5	139.6	180,076	87,791	554.9	569.4
stdev	81.2	138.1	3.3	1.7	222.3	58.7	144,678	57,546	233.7	200.0
maximum	760.0	600.0	12.0	6.0	750.0	215.6	474,300	208,000	950.0	964.7
minimum	420.0	90.0	1.0	1.0	60.0	60.0	18,000	11,000	220.0	183.3

Source: Author's survey.

Note: * Excluding one sample that was not used for more than one year before survey period.

3.3 Lifespan and depreciation of machines

To evaluate the lifespan of the machines, the survey also collected information on 44 tractors and 20 combine harvesters that used to be owned but were sold by the surveyed households. Many of the surveyed tractors (34/44) were secondhand when purchased, while more than half (12/20) were new among the surveyed combine harvesters. Considering the fact that the availability of machines on the market differs depending on the period, samples are divided into three groups, i.e. those sold in the 1990s or before (the period during which agricultural machines were still scarce), those sold in the 2000s (import of machines increased), and those sold in the 2010s (domestic production by foreign manufacturers increased) for comparison (Table 7-7).

Table 7-7 Profiles of tractors and combine harvesters that are already sold

	tractors			combine harvesters		
	sold before 2000	sold in 2000s	sold in 2010s	sold before 2000	sold in 2000s	sold in 2010s
number of sample	6	17	21	0	4	16
mean period of use (years)	7.8	7.2	8.6		3.0	4.7
mean purchasing price (mill.VND)	41.8	129.6	144.6		206.3	453.0
mean selling price (mill.VND)	19.3	74.2	73.4		87.5	106.6
value depreciated per year (mill.VND)	4.5	11.4	11.4		38.2	85.5

Source: Author's survey.

All surveyed tractors were sold within 10 years from their purchase. The significant difference between the prices of the tractors sold before and after 2000 could be the result of inflation. Moreover, the tractors sold in the 1990s or before must be quite old tractors compared to those sold after 2000. This group consisted of one Russian-made, one local brand, and four secondhand Japanese tractors imported in the 1980s and the

early 1990s¹².

Among the sample, there were no combine harvesters purchased or sold before 2000 (the oldest combine harvester was manufactured in 2008). Combine harvesters were replaced even within much shorter period of time than tractors. This could be attributed to the heavy use (larger operated areas) of the combine harvesters. While the combine harvesters sold after 2010 were used for a relatively longer period of time than those before 2010, the purchasing price and the average value depreciated per year are much higher. Custom hiring services of combine harvesters may need more profit to replace more high-priced machines within a shorter period of time.

4. Conclusion

This chapter illustrates how the mechanization of agriculture, especially of rice production, through diffusion of tractors and combine harvesters has occurred in Vietnam. Although the government has supported domestic production of machines by local SOEs since the planned economy era, the agricultural machines that actually diffused widely were those of foreign brands, including imported secondhand machines. This was due to the liberalization of import of foreign machines and domestic production by foreign manufacturers in Vietnam.

It could be assumed that the area one machine operates should be much larger in Vietnam than, for example, in Japan, where most of the secondhand tractors in Vietnam originate. Most Japanese farm households possess their own tractors and combine harvesters, and use them to cultivate their own agricultural land which are as small as two hectares on average. Conversely, in Vietnam tractors and combine harvesters are commonly used for custom hiring services for rice cropping of other farm households three times per year. This practice causes heavy use of machines, and as a result the machine owners tend to replace their machines within a quite short period of time. Many of these machines are repaired and customized by local workshops in rural areas and sold as secondhand machines (Sakata, forthcoming). The secondhand machine market, not only of imported machines but also of domestically manufactured machines, is also growing in Vietnam.

Custom hiring services must be beneficial for both machine owners and users of

¹² The lifespan of Vietnam's tractors seems to be much shorter than, for example, the result of a study on the use of 655 tractors in Switzerland. The average duration of use of the surveyed tractors was already 20 years at the time of survey.

the services. The owners seem to gain large returns from custom hiring service that are sufficient to replace their machines. By contracting out their agricultural work to those who own tractors or combine harvesters, smallholder farmers can maintain production on their own land instead of transferring them to large farmers, without investing a large sum of money in machinery.

However, it can be assumed that as the number of agricultural machines increases, the price of custom hiring service will decrease or the operated area per machine will be reduced (or both). As a result, practices of ownership and use of machine may change, and custom hiring service may become less profitable business. To promote the sustainable advance of the mechanization of agriculture, it would be crucial to create an environment or “ecosystem” that enables farm households’ sustainable machine use, consisting of new and secondhand machine markets, markets for spare parts, repairing services, and extension services for agricultural production.

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