Research Journal of Agriculture and Biological Sciences, 6(6): 778-784, 2010

Impacts of Rice Combine Harvesters on Economic and Social of Farmers in a village of the Tung Kula Ronghai Region.

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Abstract: The Tung Kula Ronghai (TKR) in Northeastern Thailand is often regarded as the best production area of Hom Mali Rice, giving the best quality of rice. More than 3.06 million tons from 9.19 million ton of exported rice in 2007 was produced from the TKR, accounted for 33%. Labor shortage problem changes farmer practice to adopted Combine Harvesters widespread in the TKR. The objectives of this research was to study the impacts of Combine Harvesters on Hom Mali rice agroecosystem in the TKR and describe the coping strategies farmers employ to cope with those impacts, in order to better understand agroecosystem impacts of Combine Harvesters in the TKR. The study area of this research is Roi-Et province, the province is one part of the TKR in the northeast Thailand, farmers conduct rainfed rice cultivation, the area chosen for the study is village No.1, Kukasing sub-district, Kaset Wisai district. The data were collected from both primary and secondary sources. The primary source included existing maps and publications whereas the secondary source was interview with relevant officials, Combine Harvester's brokers, Combine Harvester's owners and farmers. Semi-Structured interview used in this research. Results of the study indicated the impacts of Combine Harvester on Economic and social of TKR farmers included the net benefit of combine harvesting was about 30.3% higher compared to manual harvesting and threshing. After widespread using of combine harvesters, these absent household members no need to return home to help their family to harvest the paddy and then went back to their workplace after finished harvesting like before. 48% of household's absent member continues working in the city.

Key words: Tung Kula Ronghai, Combine Harvesters, impacts

INTRODUCTION

The Tung Kula Ronghai (TKR) in Northeastern Thailand is often regarded as the best production area of Hom Mali Rice, giving the best quality of rice. Approximately two-thirds of the total area producing Hom Mali is in the TKR[5]. Among the total rice exported by Thailand (9.19 million ton rice in 2007), more than 3.06 million tons was contributed from Hom Mali rice accounted for 33%[7].

Recently, rice harvesting became a problem for farmers due to shortage of labor and consequently, the increase of wages in the country. With the advent of industrialization, there has been a migration of labor from the agriculture sector to the industrial sector leaving limited numbers in the later sector to do the labor-intensive farming activities like harvesting[4].

Consequently, one type of mechanical equipment that has grown rapidly in popularity is Combine Harvesters. It is a technology that combines harvesting, threshing, cleaning, and in some instances, bagging, in one operation. One series of surveys in the TKR showed that use of Combine Harvesters increased rapidly between 1996 and 2006 (from preliminary field study). Fully mechanized harvesting systems have replaced the conventional systems using human labor with sickles in harvesting operations in TKR. The main advantage of mechanizes harvesting systems are reducing the production costs and improving labor efficiency. However, operating the combine harvesting machines has great potential to cause negative impacts to economic of farmers, especially social impacts. What are the impacts of Combine Harvesters on economic and social of farmers in the TKR will be the research question in this study.

Research Methods: This study examines impacts of Combine Harvesters on economic and social of farmers in the TKR, and the coping strategies of farmers who are involved with those impacts. The research methods used include Rapid Rural Appraisal (RRA) methods, as well as semi-structured interviews, questionnaires and a review of secondary data.

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The village No.1 in Kukasingh sub-district, Kaset Wisai district, Roi-Et was selected for detailed study because it has very large proportion of lowland paddy fields, where previously manual harvesting was the primary a harvesting method, but now more than 90 percent of farm households in this village currently have adopted combine harvesting methods.

Data Collection: Data collection was conducted at the provincial, district, village, and household levels. Both primary data and secondary data were collected. The preliminary study was conducted by Semi- Structured Interview (SSI). The whole process of data collection took 4 weeks in harvesting season of year 2007 and 8 weeks in harvesting season of year 2008 to complete. Table 1 is the approach followed in collecting data.

Data Analysis: Both quantitative and qualitative data were obtained from the field research. The quantitative data was processed using simple statistical analysis in Microsoft Excel, such as calculation of percentages and constructing graphs and figures. Such quantitative analysis provides support to the qualitative data. Some contradictory and unclear information were discovered during the analysis. Therefore, re-interviewing for 23 Households was conducted whenever data and information were found to be incomplete.

RESULTS AND DISCUSSION

1. Economic Impacts:

1.1 Current Rice Harvesting and Threshing Methods in the Study Village: Two methods of harvesting and threshing were commonly used in village No.1. The traditional method is manual harvesting. Combine harvesting was introduced in the early 1990s. At the time of this study, about 87 % of farmers in village No.1 used a combine harvester for some or all of their rice fields while 21 % manually harvested all of their paddy fields (Table 2).

1.1.1 Manual Harvesting: Manual harvesting and threshing is labor intensive. About 13.1 % of farmers in village No.1 manually harvested all of their paddy fields and another 7.9 % of farmers manually harvested some of their paddy fields and harvested the remainder using a combine. During manual harvesting, farmers use hand sickles to cut the panicles. The panicles are made into bundles which are usually stacked on the field until the farmer has finished harvesting all of his other fields. After a certain period the paddy bundles are transported to the threshing plot for threshing with a mechanical threshing machine. Human labor may be used to transport the paddy bundles from the field to the threshing plot. Once at the threshing plot, the paddy is threshed immediately or heaped for a certain period depending on the weather or household grain requirement. Prior to threshing, the plot is cleared of grass. The grain is then threshing, winnowed, measured, and transported to storage.

Table 3 shows the timing of harvesting and threshing and the method of transporting paddy in village No.1. Harvesting begins at the end of September in village No.1; however, November is the peak manual harvesting time, when about 56.6% of farmers are harvested. From the study, the average number of man days per rai required 1.1 man-days / rai to complete harvesting in village No.1. Studies by Gavian and Gemechu[3] found that it took 2.72 man-day/rai to complete harvesting in Philippines. This suggests that the data from village No.1 underestimate the labor requirement for harvesting. Moreover, informal discussions with farmers in the area indicated that it took 2.0-3.0 man-days / rai, depending on crop density. For this reason, the value of 2.5 man-days / rai was used in the profitability analysis for village No.1.

Most of farmers in the study area left their paddy heaped in the field after harvesting until they had finished harvesting other crops. Then they transported the crop to the threshing plot where it was heaped again. In village no.1, the first heaping took 0.05 man-days/rai. Also, farmers in village No.1 needed time 0.05 man-days / rai to heap their paddy at the threshing plot. In village No.1, about 0.4 man-days / rai were required to transport the rice bundles to the threshing plot. Three main factors affected the amount of labor required to transport the paddy bundles: distance from the field to the threshing plot, utilization of rice straw, and mode of transport. In village No.1, farmers used the rice straw for animal feed and thus threshed near the homestead; however, some farmers did not use the straw for animal feed and hence threshed near the paddy field. The method of transportation used in the study area also influenced the amount of labor required. Most farmers (53.3 %) in village No.1 used iron buffalo (tiller) and trailer to transport paddy from the field to the threshing plot, while some farmers used pick-up truck to transport rice bundles. Pick-up truck is usually able to transport more paddy bundles at a time than a trailer.

Although some farmers started threshing in October, the majority of farmers in both localities threshed in November. About 0.9 man-days / rai were used for threshing in village No.1, while the average number of vehicle days used was about 4.9 days/rai in village No.1. Once the grain was threshed and separated from the straw, it was winnowed to clean the seed. This process took about 0.2 man-days / rai in village No.1 (see Table 4)

Table 1: Source of data

	n	Method	Coverage of Sample
Farmers	229	Questionnaires	All Farm households of village No.1
CHs owners in the village	8	SSI	All owners in Village No.1
Visiting CHs owners	28	SSI	Unknown share
Combine Harvester Brokers	7	SSI	all of Brokers in village No.1 (2) Others in Sub-District
Private, Cooperative Rice Millers	5	SSI	All private rice millers in village No.1 (1)
Local collectors			2 others private rice millers in Sub-District 1 Cooperative Rice Millers in Kaset-Wisai District 1 Cooperative Rice Millers in Suwanaphum District All local collectors in village No.1 (1) 2 others local collectors in Sub-district
Village chiefs	3	SSI	1 village chief in village No.1 2 from other village in Sub-District
Government officers	2	SSI	1 from Sub-District Ag. Extension Dept. 1 from Livestock Dept.

Table 2: Rice harvesting methods in village No.1

Methods	small (n=62)	medium(n=104)	large (n=63)	Total(n=229)
Manual Harvesting	38.7% (24)	5.8 % (6)	0% (0)	13.1% (30)
Combine Harvesting	51.6% (32)	86.5% (90)	93.6% (59)	79.0% (181)
Both	9.6% (6)	7.6% (8)	6.3 % (4)	7.9% (18)

Table 3: Timing of manual harvesting and threshing and method of transporting rice in village No.1

Time of harvesting	small (n=24)	medium (n=6)	large (n=0)	Total(n=30)
October	4	1	0	16.6%(5)
November	14	3	0	56.6%(17)
December	6	2	0	26.6%(8)
Method of transport				
Power Tiller	14	2	0	53.3%(16)
Pickup truck	10	4	0	46.6%(14)
Commencement of threshing				
October	2	1	0	10.0%(3)
November	15	4	0	63.3%(19)
December	7	1	0	26.6%(8)
Method of harvesting and threshing				
Power thresher	24	6	0	100.0%(30)

Table 4: Labor (day/rai) required for rice operations in village No.1

Rice operation	Type of labor	Village No.1	
Harvesting	Human	1.1[a]	(20)[b]
Heaping in the field	Human	0.05	(18)
Heaping at threshing plot	Human	0.05	(9)
Transportation	Human	0.42	(19)
Transportation	Power Tiller	0.33	(19)
threshing	human	0.90	(20)
threshing	Thresher	4.86	(20)
Winnowing	Human	0.24	(4)

[a] Average working time per day is 8 h for humans
[b] Number of farmer

1.1.2 Harvesting with Combine Harvesters: In the study area, the Combine Harvester has substantially reduced the labor requirement for rice production. About 87% of farmers used the Combine Harvesters in at least one of their paddy fields. A Combine Harvesters was used to harvest about 83% of total paddy field areas in village No.1. It may be misleading to extrapolate these figures to represent this study area in general, however, since the topography, infrastructure, and proximity to repair and maintenance services in the study area are more suited to combine harvesting than most other regions in Northeastern Thailand.

Most farmers in village No.1 (96.0%) rented a Combine Harvesters from a private owner. Most farmers in village No.1 (48.7%) used a Combine Harvester during late October (Table 5).

Farmers could easily gain access to a Combine Harvester. Some farmers accessed a machine directly with the machine's owners but most farmers contact the Combine Harvester's brokers to obtain the service of a combine harvester. This was mainly due to economies of scale, since a large and continuous field is required to achieve maximum combining efficiency, and also partly due to a shortage of machines. Currently, the number of Combines in the area increased and the latter explanation became less important.

Farmers in village No.1 used pickup truck or trailers with power tillers to transport paddy to their homestead. Pickup trucks were hired per transports trip or according to the distance to homestead or mills. Farmers were familiar to rent the car from their relative. The average cost of transporting paddy, was 400 baht per one trip.

1.2 Comparison of Yields by Harvesting and Threshing Method: The rice yield is somewhat higher for farmers using Combine Harvesters than it is for those doing manual harvesting. The average yield for combine harvesters is 0.35 ton/rai compared to 0.32 ton / rai for manual harvesting. Thus, the yield difference between combine harvesting (as measured by the combine operator) and manual harvesting in village No.1 was 10.0%. As described previously, rice management practices (excluding land preparation and variety selection) are not significantly linked to method of harvesting. With regards to land preparation, the proportion of fields plowed by tractor was insignificant hence its effect on overall yield may not be statistically significant. Moreover, KDML 105, which was mostly used by Combine Harvesting farmers, did not produce significantly different yields to other varieties, except where there was a location effect. Thus, the difference in yield was mainly attributed to harvesting method.

According to Choun-udom[2], yield loss due to manual harvesting and threshing relative to combining was 10.0 %, which is in agreement with the results from village No.1. The yield difference between the harvesting and threshing methods is due to a number of factors, with the most important being:

Yield loss which occurs during manual sickling, collecting, transporting, threshing (e.g., animals feeding whilst trampling over rice bundles), and untimely harvesting and threshing. The major economic incentive for adopting the Combine Harvester is to avoid these losses.

Purity of the harvest, particularly in village No.1where the weed population is very high. Combine operators will not adjust the cleaner to effectively separate weeds from grain. The high proportion of farmers that winnow after combine harvesting confirms this. Yield (ton) is estimated by volume-to-weight ratio. A given volume will have a standard weight labeled on the container. Where there is a high level of weed seeds, the container is filled before the correct weight of grain is achieved, thus resulting in substantial discrepancies. To avoid yield bias, the yield measured by the farmer was used in the profitability analysis.

1.3 Financial Profitability Analysis: Partial budgeting was used to compare the profitability of manual and combine harvesting and threshing of paddy in the study area. The partial budget is a way of analyzing the profitability of two or more competing enterprises or technologies by considering the costs and benefits that vary between/ among the technologies (Table 6).

The benefits were calculated by multiplying yield and price. The yield from Combine Harvesting plots in village No.1 (0.35 ton/rai) ($t=3.9$; $p<0.01$) and yields from MH plots in village No.1 (0.32 ton /rai) ($t = 5.1$: $p<0.01$)

The labor requirements for manual harvesting are higher than combine harvesters. Costing of human labor for manual harvesting and threshing was determined according to field survey.

These material requirements for manual harvesting can be either purchased or made at home but all have a market value. Material costs were determined by first using the price per unit and then calculating the cost in baht/rai. It was expected that, on average, the materials have different service lives.

The costs of Combine Harvesting include the service charge, which is based on the current price of fuel (Diesel) and the broker's fee (30 Baht/rai). In the study area, the average charge was 550 Baht/rai including the brokers fee, however this varied with the condition of the combine - the new series with big grain tank charged 600 Baht/rai, while old series charged 500 Baht/rai. This was used in the analysis.

Table 5: Source of Combine Harvester and timing of harvesting for farmers in village No.1

	Village No.1			n=199
	Small(n=38)	Medium(n=98)	Large(n=63)	Percent of farmers
Source of Combine Harvesters				
Owned Combine Harvesters	1	3	4	4.0
Hired Combine harvesters	37	95	59	96.0
Time of harvesting				
October	19	43	35	48.7
November	11	31	22	32.2
December	8	24	6	19.1

Table 6: Financial profitability (Baht/rai) of rice harvesting and threshing in village No.1

	Village No.1	
	Manual harvesting	Combine harvesting
Yield (ton/rai)	0.32	0.35
Gross return [a]	3,200	3,500
Costs of manual harvesting		
Labor [b]	-	-
Harvesting [c]	500	-
Heaping [c]	100	-
Transportation [c]	400	-
Threshing [d]	200	-
Storage [e]	100	-
Food	250	-
Cost of combine harvesting		
Hire of combine harvester	-	550
Transport with pick up car	-	400
Storage	-	50
Labor	-	50
Food	-	100
Total costs that vary	1,550	1,350
Net income	1,650	2,150

[a] Price of rice in Kaset Wisai District = 10,000 Baht/ton (average Febuary'07 – April '07)
[b] Labor for manual harvesting is taken from table 3
[c] Labor cost for harvesting, heaping, and transportation = 900 Baht/day (Field study 2007)
[d] Labor cost for threshing = 20Baht/1sacks(30kg) (Field study 2007)
[e] Storage cost = 100 Baht / day

Table 7: Alternates used of labor time saved by using Combine Harvesters

	Village No.1			
	small (n=62)	medium (n=104)	large (n=63)	Total (n=229)
Working in the city	62.9% (39)	52.8% (55)	23.8% (15)	48% (109)
Maintenance of farmstead	35.4% (22)	20.1% (21)	22.2% (14)	25% (57)
Childcare and education	22.5% (14)	13.4% (14)	34.9% (22)	22% (50)
Relaxation and entertainment	6.4% (4)	6.7% (7)	3.2% (2)	5% (13)

Most Combine Harvester farmers (58%) were charged 300 to 500 Baht transport their grain using a pickup truck. The transport cost was calculated using the distance of the fields to homestead or to the mills.

Another cost associated the food the farmers provided to Combine Harvester's driver and his workers (50 to 100 Baht / day).

Labor costs incurred by farmer were grain cleaning. Farmers in village No.1 worked for about 0.1 days/rai to clean their harvest. Results of the partial budget analysis are shown in Table 6.7. The cost per rai of manual harvesting and threshing was higher Combine Harvesting (200 Baht/rai).

It can be seen that manual harvesting has higher costs (1,550 baht/rai) and lower gross returns (3,200 baht/rai) than using a Combine Harvester which costs 1,350 baht/rai and gives a gross return of 3,500 baht/rai. Therefore, the net benefit of using the Combine Harvester is 2,150 baht/rai compared to 1,650 baht/rai for manual harvesting. In village No.1, the net benefit of combine harvesting was about 30.3% higher compared to manual harvesting and threshing. Thus, the adoption of the Combine Harvester significantly increased in every year.

2. Social Impacts of Combine Harvesters:

2.1 Impacts of Combine Harvester on Employment of Labor: The adoption of combine harvesters in the study area since the last decade has brought about revolutionary change in Hom Mali Rice Production. The total labor requirement is also reduced. The displaced labor may of course be absorbed in the other alternatives created by the increased mechanization such as manufacturing, repair and service shops and the sale services. Thus, it only results in the shifting of the labor from one vocation to the other. As production increases with mechanization of the farm operations, it creates a good scope for commercialization of agriculture. The use of farm mechanization enlarges the employment opportunities, both on farms and in nonfarm sectors through increase in area under plough, multiple cropping, development of agro-industries and related services. On the other hand, displacement of human labor does take place and demand for semiskilled labor in place of unskilled labor is increased such as mechanic for farm machine maintenance.

Aggarwal and Mehra[1] reported an estimated displacement of casual labor by cost of combine harvester in Ludhiana district to the extent of 9 man days per acre. Rao[8] studied the relative cost of traditional and mechanical methods of harvesting and threshing wheat in India. It was reported that harvester combine displaces labor, but in situation of this study, it may not be that Combine Harvesters displaces labor but CH gains opportunity of displaced agricultural labor by other causes, on a large scale and was costliest from social point of view. Mishra and Sundram[6] assessed the cost and benefits of harvester combines in Punjab, India. It was estimated that the use of harvester combine resulted in saving of about 15 man-days of unskilled labor per acre.

From the study in village No.1, Farmers were asked about the number of household member living outside of the home area. Generally, before the using of combine harvesters, when the harvesting time come up, these absent household members returned home to help their family to harvest the paddy and then went back to their workplace after finished harvesting. Currently, after widespread using of combine harvesters, 48% of household's absent member continues working in the city. When farmers were asked about the activities they did during harvesting by Combine Harvester. It was found that the farmers were all genuinely interested to get some time for the maintenance of farmstead (25 percent), about 22 percent of the farmers said that they used their saved work load for their children and their education and about 5 percent said that they used it for relaxation and entertainment respectively. (Table 7).

3. Farmer's Coping Strategies with Labor Impacts: The servicing and maintenance of farm machinery is very important for farmers and owners of combine harvesters. In village No.1, the number of hired combine harvesters and locally-owned combine harvesters are increasing significantly in every year. One of necessary services that Combine Harvester's owner needed is garage or repair unit in the village. As the using of combine harvester become popular in this area, the lack of spare parts and skilled labor such as Combine Harvester mechanic causes losses in income to the owners in harvesting season. Many laborers have begun practicing repair and maintain the machine. There are many local garages to provide services for the visiting Combine Harvesters. The spare part was ordered from the central regions to sell to combine harvester's owners. Young men in the village learn about the mechanical maintenances. Their knowledge can also apply to maintain other farm machine and vehicles in the village. Fathers and uncles teach their kids maintaining the farm machine when available from farm works, and then the maintenance skill would be transferred to the next generation. The villagers said the kids are familiar with machine because almost every household in village No.1 own at least one power tiller. Therefore they are interesting to learn mechanical skill. The income from maintenance services is depended on their skill and their experience.

ACKNOWLEDGMENT

I would like to express my greatest appreciation to my respondents, all of the farmers in village No.1 , Kukasing sub-district for responding me without hesitation, warmly regards and kindly helped me throughout when I staying in the village and collecting data.

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