



Economic Performance of Using Combine Harvesters in Rice Cultivation in Northwest Cambodia

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Abstract Labor scarcity is the most common problem for Cambodian farmers during harvesting season since they commonly harvest rice manually. To reduce harvesting loss, expenses and time, a well-designed combine harvester is gaining popularity. This study aims to evaluate the economic performance of using combine harvesters in rice cultivation. Specifically, this study aims to (1) clarify the reasons farmers adopted the use of combine harvesters, and (2) compare the profitability of rice farming between combine harvester owner-farmer and non-owner-farmer. This study was conducted in Banan district, Battambang province, where utilization of combine harvesters is prevalent. A total of 68 respondents who use combine harvesters were randomly selected and interviewed using a questionnaire and further categorized into 34 combine harvester owner-farmers and 34 non-owner-farmers. The study has four main findings. First, most farmers started using combine harvesters in 2010 due to labor shortage and high wages. Combine harvester owner-farmers spent lesser total production cost compared to non-owner-farmers. Second, the total production cost of both farmer types varied mainly on the variable cost since the non-owner-farmers spent more on rice harvesting fee, while combine harvester owner-farmers spent only on the cost of diesel, depreciation, and driver. Third, combine harvester owner-farmers received the higher profitability compared with the other. Fourth, the three main reasons for adopting the use of combine harvester were labor shortage during peak harvesting season, convenient harvesting on time, and opportunity to provide custom service to other farmers.

Keywords combine harvester, custom service, cost and return analysis

INTRODUCTION

Rice is the traditional source of income for rural Cambodian people and the essential staple food of the country and other Asian countries (World Bank, 2014). In general, rice cropping cycle takes about three months to seven months, depending on the geographical and climate conditions, and rice varieties (CARDI, 2013). Harvesting is an important operation to maintain the productivity and quality of rice which require about labor input of 150-200 man-hours/ha (Salassi and Deliberto, 2010). With the advent of industrialization, many agricultural laborers have been moved to industrial and service sectors or migrated to neighboring countries (Chhim et al., 2015; MAFF Cambodia, 2016).

Recently, rice harvesting became a relevant issue for farmers due to labor scarcity. Combine harvesters (CH) have become useful and popular to address the problem of labor shortage in manual harvesting practices. CH can perform several operations such as harvesting, threshing, cleaning, and discharging grain into a bulk wagon or directly into a bag. Paraweewongwuthi et al. (2010) and Samaraweera (2012) mentioned that net profit of CH was about 30.3% higher compared

to manual harvesting and threshing, and there was a significant difference between the average production costs of CH and manual harvesting methods. Although only limited farmers can afford to purchase one, many farmers tend to rent CH from other farmers, districts or provinces.

OBJECTIVE

In order to evaluate the economic performance of using CH in rice cultivation, this study aims to (1) clarify the reasons farmers adopted the use of CHs, and (2) compare the profitability of rice farming between CH owner-farmers and non-owner-farmers.

METHODOLOGY

This study was conducted in Banan district, Battambang province. Located 28 km away from Battambang city, this district is known as the second largest rice-growing area in the province. There is also a significantly large number of farmers using combine harvesters. The total area of the district is 789 sq. km., of which paddy fields occupy about 43,969 ha (approximately 62% of total agricultural land) (Banan District, 2016).

Primary data were collected through farm questionnaire survey of randomly selected 68 farmer-respondents and series of key-informant interviews (e.g. district administrator) in August and September 2017 in three communes of the district. The farmer-respondents were identified to be CH users during the time of field survey. They were further equally categorized into 34 CH owner-farmers and 34 CH non-owner-farmers. Non-owner-farmers refer to those who avail custom service or rent CH.

Simple descriptive methods and cost and return analysis were utilized.

RESULTS AND DISCUSSION

Characteristics of the Farmer-Respondents

Table 1 General characteristics of farmer-respondents

| | CH owner-farmers | CH non-owner-farmers |
|------------------------------------|------------------|----------------------|
| N | 34 | 34 |
| Average family size (persons) | 4 | 4 |
| Average age (year old) | 43.6 | 44.0 |
| Average educational level (years) | 7.6 | 6.2 |
| Average farming experience (years) | 16.2 | 13.5 |
| Average planted land per HH | | |
| Wet season rice (ha) | 4.4 | 2.6 |
| Dry Season rice (ha) | 5.9 | 2.4 |

Source: Field Survey, 2017

In the study, most farmers mentioned that they have engaged in rice farming since they were young and have made decisions and improvements based on their own experience and knowledge shared by their ancestors. Although average age of both types was 44 years old, the average education level and years of farming experience of CH owner-farmers were higher than CH non-owner-farmers. Moreover, with regards to average planted area, CH owner-farmers had larger size for both wet (4.4 ha) and dry season rice (5.9 ha) than CH non-owner-farmers.

The Reasons for Using Combine Harvester in the Study Area

In relation to CH adoption, field survey revealed that farmers started using CH in 2010 due to labor shortages during the harvesting period. Moreover, around 90% of the 34 CH owner-farmers purchased Kubota brand because of its light-weight body, suitability for harvesting rice in both wet

and dry seasons, and affordability. In addition, roughly 25% of CH owner-farmers owned two or three machines depending on their land size and budget.

Table 2 Main reasons for using combine harvesters

| Reason of using CH | CH owner-farmer (n=34) | CH non-owner- farmer (n=34) | Total |
|---|---------------------------|--------------------------------|-----------|
| Have difficulty in securing hired labor | 9 | 10 | 19 |
| Conveniently harvest on time | 7 | 11 | 18 |
| Can provide custom service | 10 | 2 | 12 |
| Have large farm area | 5 | 3 | 8 |
| Used by many farmers | 2 | 4 | 6 |
| Millers do not buy rice harvested by hand | 1 | 4 | 5 |
| Total | 34 | 34 | 68 |

Source: Field Survey, 2017

Table 2 shows the reasons for using CH. The following three main reasons were identified: (1) have difficulty in securing hired labor during peak harvesting season, (2) conveniently harvest on time, and (3) can provide custom service to other farms. Furthermore, according to interviewed farmers, family factor highly influenced their decision to purchase or use combine harvesters. The level of living condition of farmers in rural areas and educational attainment of farmers were low. Thus, many young people tend to move from rural to urban areas and work in garment factories and/or other industries or migrate to other countries. Only elderly farmers were left to farm. CH owner-farmers added that CH was preferred for reducing harvest losses and maintaining rice quality and quantity. In general, both group farmers showed satisfaction in CH usage.

Rice Production Cost of Studied Farmers in Wet and Dry Seasons

Table 3 Rice production cost of selected farmers in wet season

| Items | Wet season (early maturity, 2016) | | | | | | | |
|------------------------------------|-----------------------------------|---------------|---------------|---------------|----------------------|---------------|---------------|---------------|
| | CH owner-farmers | | | | CH non-owner-farmers | | | |
| Land size | Small | Medium | Large | Extra-large | Small | Medium | Large | Extra-large |
| Number of HH | 2 | 5 | 6 | 5 | 10 | 5 | 4 | 2 |
| Equipment ⁽¹⁾ | 17.97 | 12.81 | 12.25 | 11.60 | 17.52 | 11.73 | 12.13 | 12.16 |
| Hand tractor | 66.00 | 40.32 | 38.34 | 33.70 | 104.52 | 80.93 | 66.49 | 65.53 |
| Tractor | 0.00 | 69.11 | 63.29 | 61.28 | 0.00 | 58.96 | 53.07 | 48.08 |
| Pumping pipe | 11.91 | 5.82 | 4.12 | 3.08 | 12.49 | 8.85 | 6.96 | 6.67 |
| Tractor trailer | 0.00 | 16.39 | 14.22 | 13.64 | 0 | 0 | 0 | 0 |
| Combine harvester | 62.67 | 48.02 | 45.30 | 39.73 | 0 | 0 | 0 | 0 |
| Total fixed cost | 158.55 | 192.47 | 177.52 | 163.03 | 134.53 | 160.47 | 138.66 | 132.44 |
| Cost of seed | 39.36 | 44.95 | 49.09 | 49.46 | 44.45 | 44.55 | 48.14 | 49.01 |
| Fertilizing | 85.27 | 90.54 | 97.96 | 106.53 | 88.70 | 90.10 | 100.73 | 107.98 |
| Herbicide | 9.90 | 11.14 | 12.38 | 13.86 | 10.80 | 13.61 | 12.38 | 12.38 |
| Pesticide | 9.90 | 10.02 | 11.21 | 12.45 | 9.41 | 9.90 | 10.56 | 12.38 |
| Land preparation fee | 27.23 | 0.00 | 0.00 | 0.00 | 25.68 | 0.00 | 0.00 | 0.00 |
| Land preparation (fuel) | 4.97 | 20.36 | 17.15 | 15.89 | 4.84 | 24.36 | 23.17 | 21.13 |
| Material input cost ⁽²⁾ | 7.02 | 8.61 | 9.60 | 10.94 | 5.29 | 8.94 | 10.94 | 13.95 |
| Harvesting cost ⁽³⁾ | 20.38 | 19.84 | 19.58 | 19.46 | 100.98 | 103.34 | 102.10 | 100.56 |
| Family labor cost | 37.13 | 24.94 | 18.54 | 13.71 | 30.40 | 21.66 | 19.59 | 17.82 |
| Hired labor cost | 15.10 | 31.19 | 43.49 | 57.10 | 25.12 | 34.90 | 47.65 | 52.54 |
| Total variable cost | 256.26 | 261.60 | 279.00 | 299.40 | 345.67 | 351.36 | 375.26 | 387.74 |
| Total production cost | 414.81 | 454.07 | 456.52 | 462.43 | 480.20 | 511.83 | 513.92 | 520.18 |

Source: Field Survey, 2017

Unit = USD/ha

Note 1) Equipment included blue-sheet, sprayer, sickle and sack.

2) Material input cost included cost of pumping water and transportation.

3) Harvesting cost refer to fuel cost of CH owner; harvesting fee of CH non-owner-farmer.

Production cost for early maturity rice and irrigated type rice was calculated by season, farmer type and operated land size (e.g. small 0.1 to 2.9 ha; medium 3 to 5.9 ha; large 6 to 9.9 ha; extra-large 10 ha and above).

Looking at the rice production cost during wet season by farmer type and operated land size, production costs of both farm types were correlated with the increase in operated land size (Table 3). For example, extra-large CH owner-farmers spent the most, amounting to 462.43 USD/ha, followed by large CH owner-farmers (456.52 USD/ha), medium (454.07 USD/ha) and small (414.81 USD/ha).

However, CH non-owner-farmers seemed to spend more compared to CH owner-farmers. The significant difference can be attributed to the higher spending of CH non-owner-farmer on harvesting fee (about 100 USD/ha), while CH owner-farmers spent on diesel, depreciation and driver fee only.

Table 4 Rice production cost of selected farmers in dry season

| Items | Dry season (irrigated type, 2017) | | | | | | | |
|------------------------------------|-----------------------------------|---------------|---------------|---------------|----------------------|---------------|---------------|-------------|
| | CH owner-farmers | | | | CH non-owner-farmers | | | |
| Land size | Small | Medium | Large | Extra-large | Small | Medium | Large | Extra-large |
| Number of HH | 3 | 11 | 9 | 6 | 9 | 10 | 4 | 0 |
| Equipment cost ⁽¹⁾ | 12.78 | 13.25 | 13.06 | 13.22 | 14.91 | 14.53 | 13.76 | - |
| Hand tractor | 44.64 | 38.66 | 37.43 | 37.04 | 77.93 | 74.44 | 67.75 | - |
| Tractor | 50.04 | 45.30 | 38.31 | 30.76 | 61.09 | 52.94 | 52.12 | - |
| Pumping pipe | 6.96 | 5.97 | 4.11 | 3.43 | 9.80 | 8.75 | 7.41 | - |
| Tractor trailer | 19.10 | 18.45 | 18.06 | 16.63 | 0.00 | 0.00 | 0.00 | - |
| Combine harvester | 55.13 | 51.74 | 44.79 | 41.64 | 0.00 | 0.00 | 0.00 | - |
| Total fixed cost | 188.66 | 173.36 | 155.76 | 142.73 | 163.73 | 150.66 | 141.05 | - |
| Cost of seed | 44.78 | 47.65 | 48.57 | 51.98 | 49.79 | 50.00 | 50.31 | - |
| Fertilizing | 112.62 | 116.58 | 122.28 | 124.50 | 107.82 | 111.14 | 110.10 | - |
| Herbicide | 9.90 | 12.38 | 13.00 | 14.85 | 12.38 | 14.85 | 21.35 | - |
| Pesticide | 9.90 | 10.15 | 12.38 | 13.61 | 12.38 | 13.61 | 20.11 | - |
| Ploughing (fuel) | 19.81 | 19.36 | 18.51 | 17.48 | 22.24 | 21.39 | 19.28 | - |
| Material input cost ⁽²⁾ | 10.43 | 11.62 | 13.58 | 15.39 | 9.95 | 11.15 | 15.30 | - |
| Harvesting cost ⁽³⁾ | 19.77 | 19.53 | 19.27 | 19.05 | 74.94 | 72.40 | 72.52 | - |
| Family labor cost | 28.96 | 20.85 | 16.24 | 11.26 | 32.80 | 23.39 | 18.56 | - |
| Hired labor cost | 26.61 | 41.34 | 62.38 | 75.50 | 26.83 | 44.62 | 58.17 | - |
| Total variable cost | 282.79 | 299.45 | 326.19 | 343.62 | 349.13 | 362.55 | 385.71 | - |
| Total production cost | 471.45 | 472.81 | 481.95 | 486.35 | 512.86 | 513.21 | 526.75 | - |

Source: Field Survey, 2017

Unit = USD/ha

Note 1) Equipment cost included blue-sheet, sprayer, sickle and sack.

2) Material input cost included cost of pumping water and transportation.

3) Harvesting cost refer to fuel cost of CH owner; harvesting fee of CH non-owner-farmer.

Table 4 shows that production cost in dry season rice seemed to be higher than wet season rice varieties in both farmer type due to shorter cropping duration (only 3 to 4 months) than wet season rice varieties. In order to achieve higher yield, both farmer types from small to extra-large farm needed to input more material and labor inputs. Furthermore, farmers who did rice farming with these varieties spend more diesel cost because they did not do harrowing, but they commonly plowed twice before direct-seeding. Looking at the labor cost, both farmer types who owned large and extra-large farms seemed to spend on hired labor cost than small farms, who were likely to do by themselves. CH non-owner-farmers had higher rice production cost than CH owner-farmers in each category because of the high harvesting fee (around 72 USD/ha).

Rice Farming Profitability of Combine Harvester Owner-Farmers and Non-Owner-Farmers

Net profit of CH owner-farmers and non-owner-farmers in wet season are presented in Table 5. Average paddy yield of both farmer type ranged from 2.90 ton/ ha to 3.75 ton/ha. The result also found that extra-large CH owner-farmer gained the highest gross revenue (906 USD/ha) and followed by large, small and medium farm. Similarly, extra-large CH non-owner-farmers also received the highest revenue amounting to 872.90 USD/ha and followed by large (816.60 USD/ha), small (714.57 USD/ha) and medium farm (689.11 USD/ha), respectively.

Looking at the net profit of CH owner-farmers, extra-large farm had the highest amounting to 443.65 USD/ha; and small farm received the lowest profit at 412.47 USD/ha. In addition, small CH owner-farmer earned almost twice profit than small CH non-owner-farmer.

Table 5 Net profit by type of selected farmers in wet season

| Items | CH owner-farmers | | | | CH non-owner-farmers | | | |
|----------------------|------------------|---------------|---------------|---------------|----------------------|---------------|---------------|---------------|
| | Small | Medium | Large | Extra-large | Small | Medium | Large | Extra-large |
| Land size | | | | | | | | |
| Number of HH | 2 | 5 | 6 | 5 | 10 | 5 | 4 | 2 |
| Paddy yield(ton/ha) | 3.75 | 3.30 | 3.55 | 3.60 | 3.10 | 2.90 | 3.37 | 3.75 |
| Price (USD/ton) | 220.61 | 242.57 | 249.21 | 251.69 | 230.51 | 237.62 | 241.96 | 232.77 |
| Total cash expense | 338.32 | 384.18 | 388.89 | 399.26 | 405.35 | 445.62 | 446.19 | 453.35 |
| Total expense | 414.81 | 454.07 | 456.52 | 462.43 | 480.20 | 511.83 | 513.92 | 520.18 |
| Gross revenue | 827.27 | 800.50 | 883.57 | 906.08 | 714.57 | 689.11 | 816.60 | 872.90 |
| Gross margin | 488.95 | 416.31 | 494.69 | 506.82 | 309.22 | 243.49 | 370.41 | 419.55 |
| Net Profit | 412.47 | 346.42 | 427.05 | 443.65 | 234.37 | 177.28 | 302.68 | 352.71 |

Source: Field Survey, 2017

Unit = USD/ha

Table 6 shows the net profit of CH owner-farmers and non-owner-farmers in dry season. Even, the group of CH owner-farmers in extra-large farm and large farm seemed likely to spend the highest amount on total rice production cost than other medium and small farm, but they remained the highest profit after calculation. Similarly, the group of CH non-owner-farmers in large farm received 424.53 USD/ha; and followed by medium and small farm. As mentioned earlier, in average net profit of CH owner-farmer received the highest profitable compared to net profit of another group in each category.

Table 6 Net Profit by type of selected farmers in dry season

| Items | CH Owner-Farmers | | | | CH Non-Owner-Farmers | | | |
|----------------------|------------------|---------------|----------------|----------------|----------------------|---------------|---------------|-------------|
| | Small | Medium | Large | Extra-Large | Small | Medium | Large | Extra-Large |
| Land size | | | | | | | | |
| Number of HH | 3 | 11 | 9 | 6 | 9 | 10 | 4 | 0 |
| Paddy yield (ton/ha) | 3.33 | 4.00 | 4.24 | 4.67 | 3.19 | 3.90 | 4.00 | - |
| Price (USD/ton) | 232.05 | 235.15 | 242.78 | 247.03 | 237.28 | 230.82 | 237.82 | - |
| Total cash expense | 397.71 | 404.31 | 417.14 | 423.11 | 430.27 | 439.82 | 457.88 | - |
| Total Expense | 471.45 | 472.81 | 481.95 | 486.35 | 512.86 | 513.21 | 526.75 | - |
| Gross revenue | 773.51 | 940.59 | 1030.47 | 1152.81 | 756.92 | 900.19 | 951.29 | - |
| Gross margin | 375.80 | 536.28 | 613.33 | 729.69 | 326.65 | 460.37 | 493.41 | - |
| Net Profit | 302.07 | 467.78 | 548.52 | 666.45 | 244.06 | 386.97 | 424.53 | - |

Source: Field Survey, 2017

Unit = USD/ha

In general, in terms of season, farmers who cultivated irrigated rice varieties in dry season tend to spend higher on total expense than farmers who cultivated wet season rice varieties. However, irrigated rice varieties had higher yield than other varieties. Moreover, CH non-owner-farmers had higher rice production cost than CH owner-farmers in each category.

CONCLUSION

Field survey revealed that farmers started using CH in 2010. Kubota was the main CH brand used in Battambang Province which had an affordable price and was suitable for harvesting during both

wet and dry seasons. The main reasons for CH adoption were (1) have difficulty in securing hired labor during peak harvesting season, (2) conveniently harvest on time, and (3) can provide custom service to other farms. Cost and return analysis revealed that it is more profitable to use CH for both CH owner-farmers and non-owner-farmers in the study area. Besides, CH owner-farmers received higher profit in comparison to the non-owner-farmers.

This study recommends that farmers shift to CH usage for rice harvesting in order to address labor shortage, reduce production cost as well as gain more profit. For further study, there is a need to conduct a detailed study on CH custom services and its social impact on rice farmers' livelihood.

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