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Effects of Rice Combine Harvester on Postproduction Losses and Production Costs: The Case of Luzon, Philippines

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ABSTRACT - This study quantified the effects of rice combine harvester (RCH) on rice output particularly on harvesting-threshing losses and production costs. The postproduction losses using different models of RCH were established following a randomized complete block design with two replications and these were compared with the traditional method of harvesting and threshing rice. Partial budget analysis was employed to determine the benefits derived by farmer-adopters using the data gathered from a one-shot cross sectional survey involving 448 respondents. Results of the field experiments revealed that postproduction losses with the three models of RCH did not differ significantly, ranging from 1.19% to 1.76% of the total yield. Comparing the harvesting-threshing losses in using RCH and the traditional method, the use of RCH significantly reduced harvesting-threshing losses by 1.02 percentage points. Prevention of postharvest loss was more pronounced during the wet season harvest at 1.54 percent. From the point of view of the farmer-adopters, the use of RCH lowered harvesting costs by PhP 3,908.60/ha/ and gained additional PhP 718.40/ha for losses prevented by using RCH. Thus the farmer-adopter could potentially gains additional benefit of PhP 4,627.00/ha/cropping season. With these, the use of RCH has the potential to enhance rice competitiveness by lowering the production cost and preventing paddy loss by PhP1.12/kg or 9.56% of the current production cost.

Keywords: Postproduction losses, Production cost**,** Rice combine harvester

1. INTRODUCTION

Rice has been the most important crop in the Philippines, being the staple food for vast majority of the population and a significant source of income and employment in the rural areas. For these reasons, rice remains at the forefront of government development efforts. While the country ranks 8th in terms of global rice production, Philippines is also the 5th largest importer as local supply could not keep up with the growing population (FAOSTAT). To address this concern, the Department of Agriculture (DA) launched the Food Staples Sufficiency Program in 2011, with agricultural mechanization as one of the key strategies adopted. Aside from addressing the food self-sufficiency agenda, mechanization also aims to boost farm income through increased production, reduced costs and losses and consequently modernize the rice industry, in particular, and the agriculture sector, in general.

Mechanization of agriculture is often used as a development strategy in transforming agricultural economies of most developing countries. Mechanization in the Philippines started as early as 1960s, with the extension of government credit programs, promotion of high yielding varieties and development of farm machines such as power tiller by the International Rice Research Institute (Tan, 1981). Power-intensive operations such as land preparation, threshing and milling were successfully mechanized but early attempts to mechanize the labor-intensive operations such as planting and harvesting was unsuccessful because of the introduction of inappropriate machines not suited to local conditions and the surplus agricultural labor during that period.

With the launching of the government facility assistance program in 2011, the adoption of RCH, machines aimed to supplant one of the most labor intensive farm operations in rice production started to gain acceptance. The provision of government subsidies allowed farmers to collectively own facilities and the promotion of lower capacity machineries made it more affordable for enterprising individuals to invest in these facilities. Moreover, the shrinking rural labor supply due to urban migration and rapid ageing of local farm labor rationalized the need for labor-replacing technologies while the growing concern on climatic variability enable farmers to recognize the importance of such machineries in safeguarding their produce from adverse effects of climate risks.

While development projects such as mechanization can bring enormous societal benefits, there are serious equity consequences often borne by the replaced or marginalized poor who are negatively affected. The government advocates selective mechanization but the aggressive efforts of enterprising private individuals lead to proliferation of RCH which poses threat to the landless farm workers in remaining areas with surplus labor.

Harvesting is one of the most labor-intensive operations in rice production. In general, manual harvesting (cutting, gathering and piling) and mechanical threshing require 14.69 and 4.50 person-days/ha, respectively or a total of 19.19 person-days/ha for the two operations Malanon et al., (2018). Manual harvesting and threshing operations give a total loss of 4.29 percent (Savador et al., 2010). These losses consisted of uncut or un-harvested and shattered or fallen grains, losses from the blower and separator parts of the mechanical thresher, and other factors such as handling. The quantified loss in the traditional method is higher compared to the 3 percent loss in combine harvester-thresher based on the test results of Agricultural Machinery Testing and Evaluation Center (AMTEC).

There are already literatures describing technical, economic and socio-anthropological studies quantifying the impact of mechanizing harvesting on farm output, employment and income distribution (Mahrouf and Rafeek, 2003; Alizadeh and Allameh, 2013; Sattar et al., 2015;) but studies on the effects of harvesting mechanization technologies in the Philippines are still lacking.

This research study aimed to determine the effects of using RCH in reducing harvesting losses and assessed the financial benefits derived from using and operating the technology. Eventually, recommendations were formulated to enhance the program on mechanization.

2. MATERIALS AND METHODS

2.1 Project Framework

Figure 1 shows the project framework indicating the pathway towards attaining the objectives of the project in relation to the country's goal of agricultural mechanization. The lack of empirical studies on the potential effects of RCH needs a research study to determine whether the goals of the program in mechanization are achievable and identify areas for further improvement. This will provide vital information for policy makers and program implementers to enhance mechanization and identify/address problems, issues and concern arising from mechanization of harvesting operations. Two studies were conducted to meet the objectives of the project.

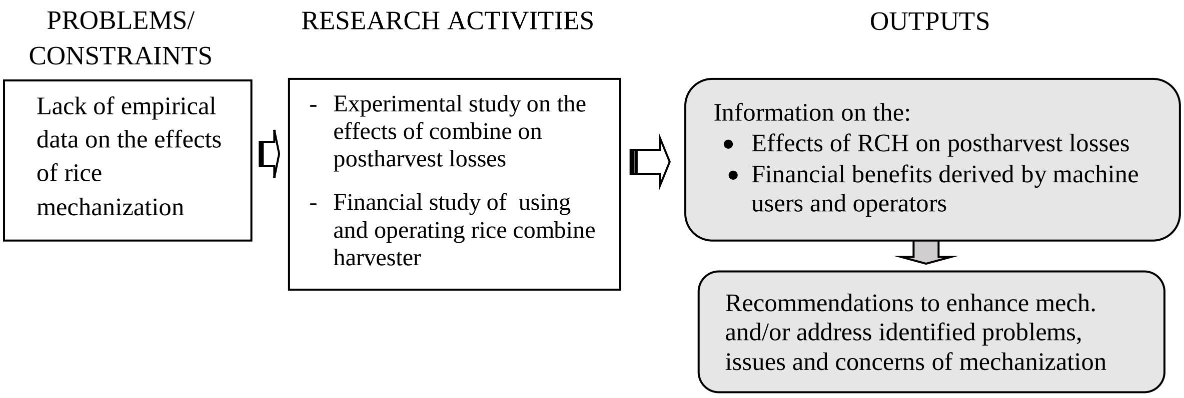

Figure 1. Paradigm showing the envisioned pathway in attaining the objectives of the project

Study 1: Assessment of Losses in Harvesting and Threshing Paddy using the Traditional Method versus RCH

2.2 Selection of study sites

The study was conducted in Tarlac and Pangasinan where the three most popular models of RCH (Kubota DC-60, Ford 4LZ-2.0 and Agri-70) were predominant. These three popular RCH models were the most common types provided through the Department of Agriculture-Rice Mechanization Program.

2.3 Research design

The study used single-factor experiment following the randomized complete block design with two replications represented by the two locations. The following experimental treatments on harvesting/threshing methods were evaluated: (a) manual harvesting and piling + mechanical thresher and, (b) combine harvester using Agri-70, Ford 4LZ-2.0 and Kubota DC-60 models.

2.3.1 Treatment specifications

The traditional method involved manual cutting using scythe, bundling and piling in strategically located place for easy access of a mechanical thresher and then threshing using a mechanical rice thresher. Fully-mechanized harvesting and threshing were done using the RCH.

The harvesting loss for each type of RCH was evaluated in at least two farms. Since the three types of RCH were difficult to pool in one place for evaluation, the three RCH were evaluated in their actual location of operation but ensured that the three models harvested the same variety and maturity of paddy. From each experimental area, six observation plots measuring 1m x 1m were marked, four observation plots from the two outer sides and two from the central part of the experimental plots. For each of the three locations identified, the same set-up was established.

2.5 Data gathered

Loss assessment

Losses in terms of grains spilled, unharvested/unthreshed panicles, filled grains blown out from the hay outlet of the machines were recorded. Spillage along the path of combine path were also collected. The sources of losses in the traditional method of harvesting and threshing by manual cutting and piling and threshing using mechanical thresher were identified and the quantity of losses were calculated following the methodology adopted by Maranan *et al*., (1996) and Salvador *et al.*, (2010) and the standard methods of test for mechanical rice thresher specified in PNS/PAES 205:2015.

Similarly, the postharvest losses from the use of combine harvester were determined following the methods of test specified in PNS/PAES 225:2015.

2.2.4 Data analyses

Analysis of variance (ANOVA) was used to compare the different RCH models and differences among treatment means were analyzed using Tukey's HSD Post Hoc Test. On the other hand the difference on postharvest loss between RCH and the traditional method was determined using the t-test. The level of significance was set at 5%.

Study 2. Production Cost, Farm Income, and Financial Viability of Using and/or Operating RCH

Study methods

Survey of rice farmers who used combine harvesters was conducted. The number of respondents sampled was determined applying the Slovin's formula:

$$n = \frac{N}{1+Ne^2} \quad \text{(Equation 1)}$$

Where n = number of machine operators drawn
N = total number of operator of combine harvester
e = the allowed probability of committing an error in selecting the representatives of the population, mostly ranging from 1-10%. In this study e was set at 5%

The total number of respondents was purposively sampled from the provinces where the available combines are situated. Respondents were identified following a multi-stage sampling. The first stage of sampling was the identification of regions where combine harvester are available and widely used. Samples were randomly selected from each region, pro-rating the number based on the total number of machines in each region. The list of combines was obtained from the Agri-Fishery Infrastructure Coordinating Unit (AICU) of PHilMech. The distribution of respondents by region was as follows: Region 1 (39), Region 2 (217), Region 3 (103), and Region 4b (89) with a total respondents of 448.

A multiple-subject survey was conducted using face-to-face interview. Both the owner and the operators of the machines were interviewed using structured questionnaire. Actual observation and/or measurement were done to complete and/or validate the information generated from the interview. The list of machine owner-operators was validated from the available list of the Department of Agriculture-Regional Field Offices and the local government office of the provinces and municipalities.

Data analysis

The change in production cost with the use of RCH was calculated based on the total cost of labor and harvesting/threshing fee paid to machine service provider and the reduction in postharvest loss. The postharvest loss prevented by the use of RCH would increase the quantity of paddy that could be derived from a given area while the reduced cost of labor would in effect reduce the total production cost. With reduced postharvest loss and reduced production cost, the unit cost of producing paddy would decrease. The benchmark information on the cost of producing one kilogram of paddy was derived from the average costs and returns of rice for 2013-2017 from the Philippine Statistics Authority-Bureau of Agricultural Statistics (PSA-BAS).

Partial budget analysis was employed to determine the effect on income of farmers adopting the RCH compared with the traditional system of rice harvesting. The adoption of RCH by farmers was considered a change in postproduction practice and was compared with the traditional postproduction system previously adopted or currently employed by other farmers. Sections within the partial budget include added returns and reduced costs (which increases the net financial gain from adoption of RCH), as well as reduced returns and added costs (which decreases the net financial gain from adopting RCH). Net effect was calculated to determine the financial gain or loss from adopting the services offered by the facility. A positive change in income indicates a net financial gain to farmer-adopter of RCH. The assumptions were based on actual data generated from the farm survey.

3. RESULTS AND DISCUSSION

RCH and harvesting losses

The specifications of the three most popular combine harvesters in the country are shown in Table 1. RCH Model B has the highest engine rating and highest capacity at 0.72 ha/h. It is also the most compact, hence, faster to maneuver and there is lesser concern on the effect on the sinking of hard pan. Because of smaller size, it is the most suitable model farms with small paddies and problematic road access.

Table 1. Specifications of combine harvesters evaluated

Specifications	Combine Harvester		
	Model A	Model B	Model C
Engine Rating, hp	70	75	60
Field Capacity, Actual, ha/hr	0.56 (4.48 ha/day)	0.72 (5.75 ha/day)	0.50 (3-5 ha/day)
Cutting Width, m	2000	2000	1905
Weight, kg	2760	2350	2450
Dimension			
Length, mm	4950	4550	4800
Width, mm	2580	2350	2175
Height, mm	2060	2300	2800

Loss assessment revealed that the three models of RCH did not differ statistically in terms of the total harvesting and threshing losses (Table 2). However, Model B appeared to be relatively more efficient in cutting and gathering the rice panicles, recording a harvesting loss of 0.15%. This feature indicates that this model is more effective in harvesting lodged crop in wet or muddy fields. Model B was also more compact so it was more effective working in paddy fields with high soil moisture and soft texture. On the other hand, Model A, being the most bulky and heaviest model and incurring numerically higher harvesting loss was the least effective for lodged crop and muddy rice fields. Among the three models, Model C emerged to be more efficient in threshing, registering the lowest threshing loss at 0.87%. This explains why most farmers prefer this combine model over the other models available.

Grains harvested by Models B and C had the cleanest outputs among the three types of RCH evaluated. The outputs of Models C and B were statistically higher compared to the output of Model A. Nevertheless, the outputs of all combine models in terms of grain purity were comparable with the output of rice thresher. It should be noted that the rice threshers evaluated were newly-acquired units, not the old, inefficient facilities generally used by most rice farmers.

The average losses recorded using manual harvesting and mechanical threshing was 3.67% during the first or wet season (Table 3). Using RCH during the same period resulted to 2.13% harvesting-threshing losses. This shows that harvesting-threshing losses are potentially reduced by 1.54 percentage points by using RCH during the wet season. For the dry season trials, manual harvesting and mechanical threshing yielded 1.97% losses compared to RCH which recorded 1.47% losses. This implies that the use of RCH is more crucial during the wet season as losses are generally higher during the period. Although losses incurred from RCH were also higher during the same period, the percentage reduction during the wet season was higher. Higher losses were incurred during the wet season because of the wet condition of the field and rice plant and the prevalence of lodged crop which affect the overall efficiency of harvesting and/or threshing machines. Similar results on the advantage of RCH in reducing postharvest losses were obtained by other researchers (Mahrouf and Rafeek, 2003; Alizadeh and Allameh, 2013; Sattar *et al.*, 2015).

Table 2. Performance of different models of combine harvester in terms of harvesting-threshing losses and grain output

Item	Mechanical Thresher	Combine Harvester Model		
		Model A	Model B	Model C
Total Losses, %		1.76a	1.47a	1.19a
Harvesting		0.35	0.15	0.22
Conveying		0.14	0.06	0.10
Threshing		1.27	1.26	0.87
Purity, %	94.40 ab	93.82a	96.18b	96.57b

Means followed by the same letter(s) within each row are not statistically different at 5% level ($p > 0.05$), ANOVA, Tukey's HSD Post Hoc Tests

Table 3. Comparison of harvesting-threshing losses using conventional manual harvesting + mechanical threshing and RCH, % of potential yield, dry basis

Losses/Season	Harvesting-Threshing Method		Difference
	Manual Reaping/ Mechanical Threshing	RCH	
Harvesting			
Wet Season	2.35	0.97	
Dry Season	1.50	0.24	
Piling			
Wet Season	-	-	
Dry Season	0.10	-	
Conveying			
Wet Season	-	0.05	
Dry Season	-	0.10	
Threshing			
Wet Season	1.32	1.11	
Dry Season	0.37	1.13	
Total Harvesting-Threshing	2.82	1.80	1.02*
Wet Season	3.67	2.13	1.54
Dry Season	1.97	1.47	0.50

*statistically significant based on t-test, $p = 0.019$

Potential benefits of farmer-adopter

The financial advantages of using RCH compared with the traditional method of harvesting and threshing are shown in Tables 4 to 9. Reduced costs include harvesting, threshing meals/snacks and bundles. Other farmers were able to avail additional savings for free sacks, ties and hauling offered by some RCH operators. This was especially observed in areas where combines were already prevalent and operators were charging lower or more competitive custom fees. On the other hand, additional cost ranging from 8-14% of output was incurred by using RCH. At custom service charge of 8% in some areas, the rate was almost equivalent to the harvesting or threshing fee usually incurred in traditional practice. This demonstrated that farmers in some areas could already save the cost of harvesting or threshing by using RCH. Moreover, the value of prevented losses provided additional income for farmers. For the dry season, the total value of reduced costs was PhP 11,618.52 per ha while total added cost amounted to PhP 7,691.00/ha, depending on service fee charged by the combine operator (Table 4). The net effect amounted to PhP 3,927.52/ha and additional income increased to PhP 4,283.520/ha if the value of loss prevented is taken into account (Table 5). Cost reduction was lower during the wet season because of the lower yield. However, loss reduction wag higher during the season so the net effect was higher at PhP 4,966.48/ha during the period (Table 7). For both seasons, the total cost and loss reduction effects amounted to PhP 4,627.00/ha (Table 9).

Table 4. Partial budget of using RCH versus the traditional manual harvesting and mechanical threshing method, dry season (no reduced losses)

Positive Effects (A)		Negative Effects (B)	
Added Returns	0	**Added Costs**	
		Combine harvester rental per ha	PhP 7,691.00
Total Added Returns	0	**Total Added Costs**	PhP 7,691.00
Reduced Costs		**Reduced Returns**	0
Sacks/Bundles/Ties	800.00		
Harvesting	4,894.26		
Threshing	4,894.26		
Hauling	430.00		
Meals/Snacks	600.00		
Total Reduced Costs	PhP 11,618.52	**Total Reduced Returns**	0
Total Added Returns and Reduced Costs	PhP 11,618.52	**Total Added Costs and Reduced Returns**	PhP 7,691.00
Net Effect (A-B)		**PhP 3,927.52/ha**	

* Based on national average yield 2013-2017 from PSA and price reported by rice farmers (3,928 kg/ha x PhP 17.80/kg = PhP 69,918.00)

Table 5. Partial budget of using RCH versus the traditional manual harvesting and mechanical threshing method, dry season (reduced harvesting and threshing losses)

Positive Effects (A)		Negative Effects (B)	
Added Returns		**Added Costs**	
Loss prevented (20 kg @ PhP 17.80/kg)	Php356.00	Combine harvester rental per ha	PhP 7,691.00
Total Added Returns	PhP 356.00	**Total Added Costs**	PhP 7,691.00
Reduced Costs		**Reduced Returns**	0
Sacks/Bundles/Ties	800.00		
Harvesting	4,894.26		
Threshing	4,894.26		
Hauling	430.00		
Meals/Snacks	600.00		
Total Reduced Costs	PhP 11,618.52	**Total Reduced Returns**	0
Total Added Returns and Reduced Costs	PhP 11,974.52	**Total Added Costs and Reduced Returns**	PhP 7,691.00
Net Effect (A-B)		**PhP 4,283.52/ha**	

* Based on national average yield 2013-2017 from PSA and price reported by rice farmers (3,928 kg/ha x PhP 17.80/kg = PhP 69,918.00); Additional benefits of using RCH are: timely harvesting which reduces risk of further quantity and quality losses especially during the wet season, no cash required to pay laborers, hauling and other related cost

Table 6. Partial budget of using RCH versus the traditional manual harvesting and mechanical threshing method, wet season (no reduced losses)

Positive Effects (A)		Negative Effects (B)	
Added Returns	0	**Added Costs**	
		Combine harvester rental per ha	PhP 7,580.00
Total Added Returns	0	**Total Added Costs**	PhP 7,580.00
Reduced Costs		**Reduced Returns**	0
Sacks/Bundles/Ties	800.00		
Harvesting	4,823.70		
Threshing	4,823.70		
Hauling	430.00		
Meals/Snacks	600.00		
Total Reduced Costs	PhP 11,477.40	**Total Reduced Returns**	0
Total Added Returns and Reduced Costs	PhP 11,477.40	**Total Added Costs and Reduced Returns**	PhP 7,580.00
Net Effect (A-B)		**PhP 3,897.00/ha**	

* Based on national average yield 2013-2017 from PSA and price reported by rice farmers (3,803 kg/ha x PhP 18.12/kg = PhP 68,910.00)

Table 7. Partial budget of using RCH versus the traditional manual harvesting and mechanical threshing method, wet season (reduced harvesting and threshing losses)

Positive Effects (A)		Negative Effects (B)	
Added Returns		**Added Costs**	
Loss prevented (59 kg @ Php18.12/kg)	PhP 1,069.00	Combine harvester rental per ha	PhP 7,580.00
Total Added Returns	PhP 1,069.00	**Total Added Costs**	PhP 7,580.00
Reduced Costs		**Reduced Returns**	0
Sacks/Bundles/Ties	800.00		
Harvesting	4,823.70		
Threshing	4,823.70		
Hauling	430.00		
Meals/Snacks	600.00		
Total Reduced Costs	PhP 11,477.40	**Total Reduced Returns**	0
Total Added Returns and Reduced Costs	PhP 12,546.48	**Total Added Costs and Reduced Returns**	PhP 7,622.00
Net Effect (A-B)		**PhP 4,966.48/ha**	

* Based on national average yield 2013-2017 from PSA and price reported by rice farmers (3,803 kg/ha x PhP 18.12/kg = PhP 68,910.00); Additional benefits of using RCH are: timely harvesting which reduces risk of further quantity and quality losses especially during the wet season, no cash required to pay laborers, hauling and other related cost

Table 8. Partial budget of using RCH versus the traditional manual harvesting and mechanical threshing method, both seasons (no reduced losses)

Positive Effects (A)		Negative Effects (B)	
Added Returns	0	**Added Costs**	
		Combine harvester rental per ha	PhP 7,622.00
Total Added Returns	0	**Total Added Costs**	PhP 7,622.00
Reduced Costs		**Reduced Returns**	0
Sacks/Bundles/Ties	800.00		
Harvesting	4,850.30		
Threshing	4,850.30		
Hauling	430.00		
Meals/Snacks	600.00		
Total Reduced Costs	PhP 11,530.60	**Total Reduced Returns**	0
Total Added Returns and Reduced Costs	PhP 11,530.60	**Total Added Costs and Reduced Returns**	PhP 7,622.00
Net Effect (A-B)		**PhP 3,908.60/ha**	

* Based on national average yield 2013-2017 from PSA and price reported by rice farmers (3,858 kg/ha x PhP 17.96/kg = PhP 69,290.00)

Table 9. Partial budget of using RCH versus the traditional manual harvesting and mechanical threshing method, both seasons (reduced harvesting and threshing losses)

Positive Effects (A)		Negative Effects (B)	
Added Returns		**Added Costs**	
Loss prevented (40 kg @ Php17.96/kg)	PhP 718.40	Combine harvester rental per ha	PhP 7,622.00
Total Added Returns	PhP 718.40	**Total Added Costs**	PhP 7,622.00
Reduced Costs		**Reduced Returns**	0
Sacks/Bundles/Ties	800.00		
Harvesting	4,850.30		
Threshing	4,850.30		
Hauling	4300.00		
Meals/Snacks	600.00		
Total Reduced Costs	PhP 11,530.60	**Total Reduced Returns**	0
Total Added Returns and Reduced Costs	PhP 12,249.00	**Total Added Costs and Reduced Returns**	PhP 7,622.00
Net Effect (A-B)		**PhP 4,627.00/ha**	

* Based on national average yield 2013-2017 from PSA and price reported by rice farmers (3,858 kg/ha x PhP 17.96/kg = PhP 69,290.00); Additional benefits of using RCH are: timely harvesting which reduces risk of further quantity and quality losses especially during the wet season, no cash required to pay laborers, hauling and other related cost

Potential effect of mechanizing harvesting on production cost

The potential effect of mechanizing the harvesting operations on the production cost is displayed in Table 10. Obtaining the average costs and returns of rice for 2013-2017 from the Philippine Statistics Authority (PSA), the production cost per kilogram was re-computed to reflect the changes in costs and yield attributed to RCH. For the five year period, the average production cost per kilogram of rice was PhP 11.23/kg during the dry season and PhP 12.12/kg for the wet season, with an average of PhP 11.71 /kg for both seasons. These included all cash costs, non-cash costs and imputed costs.

With RCH, production cost was lower by PhP 3,927.52/ha during the dry season which could result to reduced production cost from PhP 11.23/kg to PhP 10.18/kg. For the wet season, the use of RCH reduced costs by PhP 3,897.00/ha and this results to decreased production costs from PhP 12.12/kg to PhP 11.109/kg. For both seasons, cost reduction due to RCH was calculated at PhP 3,908.60/ha and this translates to reduction of production costs from PhP 11.71/kg to PhP 10.70/kg.

The effect of RCH on harvesting and threshing losses further reduce the production cost per kilogram as output is potentially increased by 20 kg and 59 kg during the dry season and wet season, respectively. Adding up the loss reduction to the cost reduction effect attributed to RCH, production cost per kg is potentially reduced to PhP 10.18/kg, PhP 10.92/kg and PhP 10.59/kg during the dry season, wet season and both seasons, respectively. With the RCH, production cost per kg is reduced by PhP 1.05 and PhP 1.20 during the dry season and wet season, respectively. This is equivalent to 9.35% to 9.90% reduction in production costs.

Table 10. Effect of RCH in reducing production cost of paddy

ITEMS	SEASON		
	DRY	WET	BOTH
Production cost, Php/ha			
Cash Costs	20,422.60	20,539.20	20,498.20
Non-Cash Costs			
Harvester and thresher share	6,772.80	7,602.20	7,272.00
Other non-cash costs	6,936.60	6,953.80	6,890.40
Imputed Costs	9,969.60	10,976.00	10,508.20
Total Cost, PhP/ha	44,101.60	46,071.20	45,168.80
Yield, kg/ha	3,927.80	3,802.60	3,857.60
Cost of producing paddy, PhP/kg	**11.23**	**12.12**	**11.71**
Cost effect of RCH			
Cost reduction due to RCH, PhP/ha	3,927.52	3,897.00	3,908.60
Adjusted Total Cost, PhP/ha	40,174.08	42,174.20	41,259.40
Adjusted Cost, PhP/kg	10.23	11.09	**10.70**
Cost effect + Loss effect of RCH			
Adjusted Total Cost, PhP/ha	40,174.08	42,174.20	41,259.40
Prevented Losses due to RCH	20	59	40
Adjusted yield with RCH, kg/ha	3,947.80	3,861.60	3,897.60
Cost, PhP/kg	**10.18**	**10.92**	**10.59**
Change in Production Cost, PhP/kg	***1.05***	***1.20***	***1.12***
Change in Production Cost, %	9.35	9.90	9.56

Major rice exporting countries such as Vietnam, India and Thailand have unit costs of PhP 6.07/kg, PhP 8.26/kg and PhP 8.73/kg, respectively (Bordey *et al.*, 2016)

4. CONCLUSION AND RECOMMENDATIONS

The potential effects of RCH on rice productivity, postharvest losses and farm income as well as its potential effect on enhancing rice competitiveness were investigated. The study used both experimental and survey methods of research. Three types of RCH were compared in terms of postharvest losses. Similarly, postharvest loss incurred with the use of RCH and the use of the traditional method of harvesting-threshing was compared. Four hundred forty-nine respondents were interviewed to gather information used in the partial budget analyses of using RCH over the traditional method of harvesting-threshing.

The total postharvest loss was significantly lower with the use of RCH compared to the traditional method. The average reduction in postharvest loss with the use of RCH was 1.02 percentage points, with more losses prevented during the wet season harvest (1.54 percentage points) than during the dry season harvest (0.50 percentage points). The results imply that the benefits of using RCH would be relatively higher during the wet season harvest. Inclement weather is prevalent during the wet season harvest and timely operation is needed to insure that harvestable paddy are harvested, threshed and taken out of the field as fast as possible. Faster harvesting-threshing operation which is possible with RCH could prevent the risk of damage from continuous rains. The three models of RCH had postharvest losses that did not differ significantly from each other at the range of 1.19-1.76% of the projected dry paddy yield. However, the paddy harvested by Model B and C were significantly cleaner than those produced by Model A.

The farmer-adopter of RCH could gain additional benefits of PhP 4,283.52/ha and PhP 4,966.48/ha during the dry season and wet season, respectively. These represent the lower harvesting-threshing cost and the additional value of paddy saved due to reduced loss. Because of reduced harvesting-threshing cost and more paddy available due to reduced loss, the use of RCH has the potential to reduce the unit cost of producing paddy by PhP 1.12/kg, a 9.56% reduction from the current production cost of PhP 11.71/kg.

The use of RCH proved to be an important means to improve rice production efficiency in terms of reducing losses and production cost. Moreover, the timely completion of harvesting and threshing activities minimizes the exposure of crop to weather risk, thereby securing the produce and income of rice farmers. This contributes significantly in attaining the goal of the government in improving farm income and enhancing rice competitiveness. While there are already private investments in RCH, the government can still provide facilities in less favorable areas particularly the non-irrigated and high risk areas as private involvement in these areas is still limited.

5. ACKNOWLEDGEMENT

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