

Factors affecting corn combine harvester adoption

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Abstract: Increasing mechanization in the corn sector is central to realizing corn sufficiency in the Philippines, as it reduces labor cost and, consequently, lowers the price of the commodity. Use of a corn combine harvester has been identified as among the machines that can help boost mechanization efforts in the sector. The study was conducted in Tabuk, Kalinga, a major corn-producing area where mechanization is gradually being introduced. However, the use of combine harvesters is resisted by several quarters, making manual harvesting the dominant practice. Hence, this study aims to examine the factors that affect the adoption of corn combine harvester among corn farmers in Tabuk. Among the significant factors influencing corn combine harvester adoption were farm size, membership in organizations, and access to CCH. On the other hand, barriers to adoption include perceptions and attitudes regarding the externalities of CCH, such as the effect of labor displacement. Addressing these externalities could mean a more sustainable adoption of this machine.

Keywords: technology adoption, adoption of corn combine harvester, corn farmers

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1 Introduction

Despite the identified benefits of mechanizing operations in the corn sector, such as significant reduction in manual labor and timely operations, advocating for mechanization remains a challenging task (Cariaga, 2006). A survey by the Philippine Centre for Mechanization and Development (PHilMech) finds only 12% of yellow corn farmers used combine harvesters. The survey was conducted in the provinces of Bukidnon, Iloilo, Isabela, Pangasinan, and South Cotabato. Manual harvesting remains the dominant practice, and it requires about 23 man-machine to harvest a hectare in a day; corn combine harvester only needs about 2 man-machine per day (Rodulfo et al., 2021).

A dismal mechanization rate is the key reason the Philippine corn industry lags behind other corn-producing countries. In the past, in general, adoption of new technologies, not just machines, can result in yield increases, such as in the case of yellow maize production. In 2001, yellow maize yields were relatively low in comparison to those of other Asian countries (Gonzales and Lapiña, 2003). Corn farmers in the Philippines recognize that there are opportunities to enhance the productivity of their maize crops and cite various factors contributing to the yield gap. These gaps encompass issues such as pest incidence, inadequate access to technical information or technology for farmers, and suboptimal crop management practices (Gerpacio et al., 2004). Indonesia was the most productive corn grower in

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Southeast Asia in 2020, with a yield of 5.69 mt ha⁻¹. Corn yields in the Philippines, Myanmar, Thailand, and Vietnam fall somewhere between 3.18 and 4.85 metric tons per hectare (FAOSTAT, 2021). Salazar et al. (2021) noted that the sector's improving productivity could mean that prospects for export loom, which means increased income for farmers. Moving in this direction necessitates that farmers consolidate their production to achieve the necessary volume and quality standards. Currently, farmers are unable to meet production requirements due to insufficient postharvest facilities. The research indicated that it would be highly advantageous for corn farmers if pertinent agencies could enhance these support services; failing to do so may result in continued poverty for farmers and an ongoing reliance on corn imports in the Philippines.

There is some evidence showing uptake in CCH adoption, such as the case in Isabela province. For example, the Office of the Provincial Agriculturist reports that about 80% of corn farmers in the City of Ilagan, the corn capital of the Philippines, have embraced corn combine harvesting. The same could not be said of its neighboring provinces. One such province is Ifugao, the leading producer of yellow corn in Cordillera. The Provincial Agriculturist Office in Ifugao reports that less than 10% of the farmers in Alfonso Lista, the town that produces the largest volume of yellow corn, are using CCH owing to its rolling topography. Another province is Kalinga, known as among the corn corridors and the second largest producer of yellow corn in the Cordillera region, which also reports low CCH adoption. On the other hand, adoption of rice combine harvester is high in Kalinga at 65%. Kalinga is also the rice granary in the Cordillera.

While there are some reports of low use and adoption of CCH in other parts of the country, there remains a dearth of studies that explain these phenomena. In general, there are few studies on farm machine adoption in the country, not just in corn. Additionally, again, while there are some studies about

the factors affecting the adoption of farm machines in rice cultivation in the Philippines (Mariano et al., 2012; Francisco et al., 2018), the same could not be said of the corn machines, especially the CCH.

This study aimed to identify the factors influencing the adoption of CCH among corn farmers in Tabuk, Kalinga in the Philippines. This study specifically sought to determine the reasons behind the adoption and non-adoption of CCH, as well as the factors influencing the decision to plan or not plan for its use in the upcoming cropping season.

Although there are many studies on the acceptance of farm machines in rice farming in the Philippines (Mariano et al., 2012; Francisco et al., 2018), there is a clear research void about the adoption of corn combine harvesters (CCH), especially in the corn sector. This study focuses on the under-researched corn sector, particularly the adoption of CCH in Tabuk, Kalinga, which is a major corn-producing province, to help close this disparity. This makes the research both timely and regionally relevant since current studies fall short in sufficiently addressing the mechanization dynamics in corn production, particularly in geographically separate regions like Kalinga.

Also, unlike the few national polls that offer just basic descriptive statistics on CCH usage, this paper explores more the particular socio-economic and contextual elements influencing adoption, including farm size, organization membership, and opinions of externalities like labor displacement. Focusing on both drivers and obstacles to CCH adoption helps this study to provide more complete knowledge necessary for developing localized policy interventions. Finally, the attention paid to the varied topography of the Cordillera region offers a special viewpoint on how environmental and geographical elements affect mechanization. As Alfonso Lista, Ifugao, notes, the terrain of the area presents different difficulties for machine use—something that is not well-documented in past research on farm technology acceptance. This regional emphasis enables the research to address an underappreciated aspect of mechanization in the

Philippines, supporting academic debate as well as pragmatic policy consequences.

2 Methodology

This study used an exploratory research approach to unpack the reasons surrounding the adoption and non-adoption of CCH. A survey was conducted to respond to the questions set forth for this study. The province of Kalinga was chosen as the research site because it provides a good area to compare the use and non-use of the machine. Owing to time and mobility constraints, the study was conducted only in the town of Tabuk. Tabuk, Kalinga (17°28' N, 121°18' E; 125 m a.s.l.) is one of the leading municipalities in corn production and features the flattest terrain, which is ideal for CCH. It also has a significant number of yellow corn farmers who practice both corn combine and manual harvesting. Primary data were collected from November to December 2022, during the peak corn harvest season and under COVID-19 mobility restrictions, while the research was initiated in 2022 and concluded in 2023.

The respondents of the study were purposively sampled. Purposive sampling was employed because the study aimed to focus specifically on corn farmers who had relevant experience with either using or not using corn combine harvesters (CCH). This method ensured that only those farmers who could offer useful information regarding the adoption and non-adoption of CCH were included in the study. By selecting respondents from the list of corn farmers provided by the City Agriculturist Office, the study was able to target individuals who were knowledgeable about both manual and mechanized harvesting practices, thus providing richer and more relevant data for analysis. This approach was particularly suited to the exploratory nature of the study, which sought to understand the contextual and socio-economic factors influencing CCH adoption in Tabuk, Kalinga. The sample size was determined using Cochran's formula for proportions with finite population correction, which is widely applied in social sciences and agricultural research when the total population (N) is

known (Cochran, 1997). The formula is expressed as:

$$n = \frac{z_a^2(0.25N)}{N\varepsilon^2 + 0.25z_a^2} \text{ where } z_a^2 = \begin{cases} 2.575, & \text{if } \alpha = 0.01 \\ 1.96, & \text{if } \alpha = 0.05 \\ 1.645, & \text{if } \alpha = 0.10 \end{cases}$$

Where,

n = sample size

α = significance level

N = total population of yellow corn farmers

ε = tolerable error

Z = Z-score

A confidence level of 95% was employed. The formula indicated a significance level (α) of 0.05, accompanied by a tolerable error (ε) also set at 0.05. Based on a total population size (N) of 1,377, it was determined that the study would include 117 yellow corn farmers as respondents. In Tabuk, there are a total of 2,800 corn farmers; however, merely 46 of these cultivate white corn. The remainder cultivate yellow corn. Among the 2,754 yellow corn farmers, 50% cultivate their crops on flat terrain, whereas the remaining 50% operate on rolling terrain. Only those who engage in farming on flat land were regarded as members of the overall population. This study categorizes non-adopters as farmers who have not utilized combine harvesting services at any point and have only used combine harvesters at least once during the wet season of 2021 through the dry season of 2022. In contrast, adopters were farmers who utilized CCH during both the wet season, from July to December 2021, and the dry season, from January to June 2022.

The study utilized primary data collected through a survey conducted during the wet harvest season of 2021 and the dry harvest season of 2022. The questionnaire for the survey underwent a pre-testing phase. The survey encompassed inquiries related to socioeconomic characteristics, harvesting techniques, costs and returns, and participation in combine harvester seminars or on-farm trials, as well as questions addressing perceptions, attitudes, and challenges faced in the decision-making process regarding the adoption of CCH. Furthermore, interviews with key informants were carried out

involving barangay officials from the Committee on Agriculture as well as local CCH service providers.

2.1 Data analysis

2.1.1 Descriptive analysis

Descriptive analysis was conducted to ascertain the frequencies and means of all identified input variables. The focus of this study was on the socioeconomic characteristics of the farmers, institutional factors, and technical and physical aspects, as well as their perceptions and attitudes towards the adoption of technology. Additionally, it examined the challenges and constraints faced in relation to the adoption of CCH.

2.1.2 Logistic regression analysis

A binary choice model was employed to identify the hypothesized factors that significantly impacted farmers' decision-making processes concerning the adoption of CCH. Economic decision-makers utilize these models when faced with the choice between two mutually exclusive outcomes (Hill et al., 2008). In this research, the harvesting technique selected by the farmer is indicated by the dummy variable: the harvesting method chosen by the farmer is represented by the dummy variable:

$z = \{1 \text{ farmer adopts combine } 0 \text{ farmer practices manual harvesting}\}$

The probability that a farmer adopts combine harvesting can be expressed through the subsequent equation:

$$P[z = 1] = P_i$$

From this equation, it can be inferred that the probability of the farmer engaging in manual harvesting is expressed as:

$$P[z = 0] = 1 - P_i$$

The logistic regression analysis, also known as the logit model, was the particular binary choice model utilized. This model employs the cumulative logistic probability as referenced by Gujarati (2003) which was cited in Tolentino (2017)'s work. This model delineates the probability P_i that a farmer will choose to adopt combine harvesting in the following manner:

$$P_i = P(z) = f\left(\beta_0 \sum_{i=1}^N \beta_i X_i\right) = \frac{1}{1 + e^{-z}}$$

$$P_i = \frac{1}{1 + e^{(\beta_0 \sum_{i=1}^N \beta_i X_i)}}$$

Where,

P_i = probability of adopting CCH

z = measure of the total contribution of all the independent variables used in the model

β_0 = constant value

N = number of independent variables

β_1 = coefficients associated with the independent variables

X_1 = independent variables (factors that affect combine harvesting adoption)

e = base of the natural logarithm

This equation can also be expressed as:

$$P_i = \frac{e^{(z_i)}}{1 + e^{(z_i)}}$$

$$z_i = \beta_0 + \sum_{i=1}^N \beta_i X_i$$

Both sides are then multiplied by $1 + e^{(Z_i)}$,

$$P_i + e^{(Z_i)} P_i = e^{(Z_i)}$$

The factor $e^{(Z_i)} P_i$ is then transposed, and distribution is performed,

$$P_i = e^{(Z_i)} + e^{(Z_i)} P_i = (1 - P_i) e^{(Z_i)}$$

Which equates to,

$$\frac{P_i}{1 - P_i} = e^{(Z_i)}$$

The natural logarithm of both sides is then taken,

$$\ln \frac{P_i}{1 - P_i} = Z_i$$

The logarithm of the probability associated with the specific decision serves as the dependent variable within the formula. P_i signifies the probability of a farmer adopting a combine harvester, and $1 - P_i$ indicates the probability of relying on manual harvesting. The odds ratio, therefore, plays a crucial role in assessing the farmer's decision to adopt combine harvesting. If P_i is equal to zero, then $\frac{P_i}{1 - P_i}$ would also equal to zero.

The regression probability can be expressed as follows:

$$\ln \frac{P_i}{1 - P_i} = z = b_0 + b_1X_1 + b_2X_2 + \dots + b_nX_n$$

In this study, the variable z will be defined as follows:

$$z = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 \\ + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} \\ + \beta_{11}X_{11} + \beta_{12}X_{12} + \beta_{13}X_{13} + \varepsilon$$

Where,

z = adoption of combine harvester (1 = using combine harvester, 0 = not using combine harvester);

X_1 = farmer's age (in years);

X_2 = farmer's education (in years);

X_3 = farmer's household size;

X_4 = non-corn income (in PhP/annum);

X_5 = farm size (in hectares);

X_6 = land tenure (1 = owned/partly owned, 0 = wholly rented);

X_7 = membership in cooperatives/associations (1 = yes, 0 = no);

X_8 = participation in combine harvester seminars or on-farm trials (1 = yes, 0 = no);

X_9 = Perception of the benefits of combine harvesting (total number of responses for each question);

X_{10} = Perception towards the technical characteristics of combine harvesting (total number of responses for each question);

X_{11} = Attitude toward the labor displacement caused by combine harvesters (total number of responses for each question);

X_{12} = Perception of the skill of manual harvester-laborers (total number of responses for each question);

ε = disturbance term.

The model excluded accessibility, as nearly all farms involved in the study were deemed accessible for combine harvesters.

3 Results and discussion

This section presents the key findings in this study. The presentation flows from the reasons for adopting CCH, followed by the reasons for not using CCH, the reasons for planning and not planning to use a corn combine harvester in the next cropping, and the factors

influencing the adoption of CCH.

3.1 Reason for adopting the corn combine harvester

The top two reasons farmers adopt CCH are that it reduces the overall cost in corn cultivation (35.78%) and its overall efficiency in performing the task (33.94%). Use of CCH means farmers are able to reduce the cost associated with hiring people. This means that some savings is incurred in the process. Compared with manual harvesting, use of CCH is far more efficient, as it only requires 4 hours to finish a hectare. In addition, the speed with which combine harvesters can harvest corn allows farmers to take advantage of favorable market conditions, especially in relation to price and weather. Additionally, the time saved enables farmers to reduce the risk of yield losses and grants them greater operational flexibility (Table 1). Use of CCH is also less labor-intensive (17.43%) compared with manual harvesting, which requires a larger workforce. Furthermore, use of CCH means reduced reliance on laborers (7.24%). Reduced reliance on farm laborers is particularly important in areas and in times when hired labor is scarce and when it proves difficult to supervise farm laborers. Use of CCH means that farmers can streamline their operations. There are also farmers who think that using CCH reduces waste and loss (4.59%). In general, it can be said that there is a feeling of satisfaction over the machine's performance and a wide understanding of how it can transform farm operations.

3.2 Reason for not using corn combine harvester

The most cited reasons for not using CCH were higher losses (27.84%) compared with manual harvesting and unavailability (26.80%) (Table 2). Farmers expressed apprehension that using the CCH could lead to greater post-harvest losses, which may negatively impact their overall yield and profitability. Some respondents had prior experience with CCH, where they noticed higher losses due to improper calibration of the machine and lack of training in using it efficiently. Among those who used the combine harvester only once during the dry season, perceived losses averaged 2.00 percent. However, for those who

used the machine only once during the wet season, the perceived loss was higher, averaging 3.38 percent. Others have heard about these issues from fellow farmers, influencing their perception. Additionally, the absence of the CCH in their area hindered their ability to access and use the technology. The belief that the

CCH displaces landless manual harvesters was cited by 12.37% of respondents. This result indicates concern about potential job losses for manual laborers whose primary source of income is manual harvesting. Farmers think that it is not ethical to adopt CCH if people were to be jobless.

Table 1 Reason for adopting the corn combine harvester

Response*	Count	%
Less costly	39	35.78
Shorten harvesting time	37	33.94
Less labor-intensive	19	17.43
Harvester-laborers not available	8	7.34
Less waste/losses	5	4.59
Satisfaction with its performance	1	0.92
Total	109	100.00

Note: *multiple responses

Other minor reasons were the non-applicability of the CCH in the area, the availability of a comparable machine (sheller service), and the small size of cornfields. Farmers think CCH may be hard to use in areas with unpaved roads and faraway service providers. It was also noted that there is a sheller service in the area, which employs laborers. Hence,

consistent with their view of looking after the welfare of farm laborers, they opt to patronize the sheller over the CCH. Lastly, the small size of the cornfield discourages them from using the CCH. Farmers believe that manual harvesters are more suitable for smaller fields, allowing for better control and efficient harvesting.

Table 2 Reason for not using corn combine harvester

Response*	Count	%
More losses than manual	27	27.84
No available CCH	26	26.80
Manual harvester will be displaced	16	16.49
Not applicable in the area	12	12.37
Availability of sheller	4	4.12
Small area	3	3.09
Expensive rate	2	2.06
Additional payment for picking up the corn on cobs	2	2.06
Manual has better output/uncleaned output	2	2.06
Lack of knowledge	1	1.03
Damages the field	1	1.03
No contact with service providers	1	1.03
Total	97	100.00

Note: *multiple responses

3.3 Reason for planning and not planning to use the corn combine harvester next cropping

In terms of willingness to continue using the CCH, 100 percent of adopters intend to do so (Table 3). This indicates that the adopters possess a significant degree of satisfaction with the benefits and effectiveness of CCH in their harvesting operations. The collective agreement to persist with the use of the CCH indicates that users have encountered favorable results and are

inclined to integrate the technology into their forthcoming agricultural practices. Conversely, 8.33 percent of non-adopters express an intention to experiment with the contemporary harvesting method by employing the CCH in the upcoming cropping season. This suggests that individuals who have not adopted the CCH show limited interest and willingness to explore its potential benefits. Several factors contribute to their reluctance, including concerns, a preference for traditional methods, and perceived

barriers to adoption. A significant proportion of non-adopters, specifically 91.67 percent, do not plan to utilize the CCH in the upcoming season. This finding indicates that a significant number of non-adopters have chosen not to integrate the CCH into their agricultural practices. The observed disinterest can be attributed to several factors, including perceived drawbacks, concerns regarding operational costs, incompatibility with existing farming systems, and a preference for traditional manual harvesting techniques.

The most common reason cited by adopters and non-adopters for planning to use the CCH in the upcoming cropping is its time efficiency (Table 4). About 42.86 percent of adopters and 44.44 percent of non-adopters recognize the CCH's capacity to reduce harvesting time. This implies that respondents value the CCH's ability to streamline their operations and make harvesting more efficient. The second most prevalent reason cited by respondents is the potential cost savings and increased profitability associated with using the CCH. About 30.48 percent of adopters and 22.22 percent of non-adopters believe that the CCH can help them save money and increase profits. This emphasizes the economic advantages respondents anticipate gaining from adopting the technology.

Another factor influencing the adoption of the CCH is the decrease in labor needs. About 14.29 percent of adopters and 11.11 percent of non-adopters acknowledge that the CCH can reduce the need for manual labor during harvesting. This indicates that respondents view technology as a means to address labor issues and reduce labor costs. A notable percentage of respondents, 7.62 percent of adopters and 11.11 percent of non-adopters, are attracted to the convenience offered by the CCH. This referred to the ease of operation, increased ease of managing the harvesting process, or the overall convenience of using mechanical harvesting technology compared to manual methods. Among adopters, 4.78 percent mentioned the lack of available shellers as a factor influencing their decision to use the CCH in the upcoming season. This indicates that the unavailability or limited accessibility of alternative harvesting options pushed them towards adopting the CCH as a viable solution. For 11.11 percent of non-adopters, their decision to try mechanical harvesting using the CCH is contingent upon its applicability to their specific farming situation and the availability of the machine. This indicates that non-adopters are willing to explore the technology if it aligns with their needs and if they have access to the necessary resources.

Table 3 Willingness to use the CCH for the next cropping

Response	Adopter		Non-Adopter	
	Count	%	Count	%
No	0	0	66	91.67
Yes	45	100.00	6	8.33
Total	45	100.00	72	100.00

Table 4 Reason for planning to use next cropping

Response*	Adopter		Non-Adopter	
	Count	%	Count	%
Time-efficient	45	42.86	4	44.44
Save cost/more profitable	32	30.48	2	22.22
Reduced labor requirement	15	14.29	1	11.11
Convenient	8	7.62	1	11.11
Unavailability of sheller	5	4.78	0	0
Applicable and available	0	0	1	11.11
Total	105	100.00	9	100.00

Note: *multiple responses

The reasons cited by non-adopters for their refusal to participate in mechanical harvesting are detailed in Table 5. The most prevalent reason cited by more than

30 percent of non-adopters is the concern that mechanical harvesting using the CCH will negatively impact manual laborers. These respondents prioritize

preserving employment opportunities for laborers who rely on manual harvesting methods. According to 24.74 percent of respondents, the lack of CCH availability in their area prevents them from considering its use. This indicates that access to the technology is limited, which inhibits its adoption by non-adopters. For 18.56 percent of respondents, the perceived issue of low harvest quality and quantity discourages the use of mechanical harvesting like CCH. They are concerned about the machine's performance in delivering satisfactory outcomes compared to manual harvesting methods. The presence of a sheller service in their area is cited by around 16.49 percent of respondents as a reason for not intending to use the CCH. Instead of relying on mechanical harvesting, these farmers have chosen to utilize the existing sheller

service. Poor road conditions leading to their farms are a barrier to CCH adoption for 3.09 percent of farmers. This impedes service providers and CCH access to their farms, rendering the technology impractical or inapplicable in their particular circumstances. About 2.06 percent of farmers express concerns that the CCH could potentially harm their fields and result in greater losses compared to manual harvesting methods. The concerns expressed by these respondents about the adverse impacts of mechanical harvesting surpass any possible advantages. A limited area of cornfields and a specific season restrict 1.03 percent of farmers from utilizing CCH. The limited size of the farm allows for the use of manual harvesters, while the CCH is employed solely during the wet season to facilitate harvesting ahead of the impending rain.

Table 5 Reason for not planning to use next cropping

Response*	Count	%
Affects manual laborers	30	30.93
Unavailability of CCH	24	24.74
Low quality and quantity of harvest	18	18.56
Availability of shellers	16	16.49
Not applicable in all areas	3	3.09
Damage the field	2	2.06
More losses than manual	2	2.06
Small cornfield area	1	1.03
For wet season only	1	1.03
Total	97	100.00

Note: *multiple responses

3.4 Factors influencing adoption of corn combine harvester

The analysis of a farmer's decision to adopt a technology is based on the assumption that it is influenced by a set of attributes. Various factors, including socioeconomic, institutional, and physical/technical characteristics of the sampled population, influence the likelihood of a farmer embracing a resource-conserving technology, such as CCH. Additionally, the advantages of the technology in conserving resources, such as labor, along with the perceptions and attitudes of the farmers towards its adoption, play a significant role in this decision-making process.

The logistic regression model employed these variables to elucidate their impact on the adoption of CCH. The results of the analysis are displayed in Table

6. The model demonstrated a high level of significance, as indicated by the likelihood ratio chi-square value of 68.2. Out of the fifteen independent variables examined, four were identified as significant at the 5% and 1% levels, respectively.

At a confidence level of 95%, farmers with larger farm sizes were found to be more likely to adopt practices, with odds of 1.558, compared to their counterparts with smaller farm sizes. The increase in farm size results in more labor-intensive and costly harvesting processes; therefore, the implementation of labor-saving and cost-reducing technologies emerges as a viable solution. The implementation of corn combine harvesters has led to considerable long-term cost reductions for farmers operating larger agricultural enterprises. Through the reduction of labor costs and the enhancement of productivity, combine

harvesters have played a significant role in optimizing the harvesting process and improving overall profitability. Farmers operating larger farms are likely to experience greater advantages from these cost-saving effects, owing to their increased production volumes. The results align with earlier research conducted by Ghosh (2010), Akudugu et al. (2012), Mariano et al. (2012), and Francisco et al. (2018), all of which emphasized the significance of farm size in the adoption of technology.

Participation in organizations like cooperatives may enhance farmers' readiness to adopt new practices. At a confidence level of 95%, individuals who are members of cooperatives exhibited odds of adopting CCH that were more than nine times (9.59) greater than those of non-members. This phenomenon can be ascribed to the exchange of information and the sharing of knowledge that cooperatives promote. Cooperatives often provide a platform for farmers to exchange information and knowledge about emerging technologies. Members of the cooperative have the opportunity to gain insights into the benefits and uses of emerging technologies through a series of regular meetings, workshops, and training sessions. Access to information reduces uncertainty and enhances understanding and confidence in the adoption of new technologies. The findings presented here are consistent with the results of Francisco et al. (2018) study regarding the socio-economic aspects of adopting and utilizing combine harvesters in the Philippines. This study illustrated the importance of organizational membership in facilitating technology adoption among rice farmers.

Furthermore, the presence of the machine within the community is likely to enhance the farmers' inclination to adopt the new equipment. The findings indicate that the presence of new technology within a locality significantly increases the likelihood of farmers adopting CCH, with a three-and-a-half times greater probability compared to situations where such machines are unavailable. The effect demonstrated a significant impact, achieving a confidence level of 95%. The credibility of this outcome can be attributed

to the farmers' understanding of the technology's characteristics, which enhances their awareness of its potential advantages, thereby allowing them to make well-informed decisions. The provision of combined contracting services has also yielded financial advantages for farmers. Through the utilization of these services, farmers are able to make effective use of combine harvesters without the necessity of direct ownership, thereby minimizing their initial investment expenses. The accessibility and cost-effectiveness of combined services have created new avenues for farmers to improve their harvesting processes, boost efficiency, and possibly elevate their financial outcomes. This finding is consistent with the research carried out by Malanon and Pabuayon (2022), who examined the factors affecting the full adoption of rice combine harvesters in Isabela, Philippines. The study demonstrated a significant yet moderate effect, as indicated by an odds ratio of less than one. This suggests that the availability of adequate facilities has a marginally negative impact on the likelihood of adoption, resulting in a decrease in the odds by approximately one percent during both the rice dry and wet seasons. Additionally, this study bears resemblance to the research conducted by Xangsayasane et al. (2019), which investigated the efficiency of combine harvesting in rice fields and its implications for the adoption of combine contracting services in Central Laos. The research indicated a swift rise in the accessibility of combine contracting services in specific provinces, including Khammouan and Bolikhamxay.

The availability of combines in these regions has increased, suggesting an expanding market for these services. The rise of various service providers has contributed to heightened competition, resulting in more economical combined service fees. The results point out the role of the local availability and accessibility of corn combine harvesters in influencing adoption rates. The introduction of this technology within the community fosters awareness among farmers, enabling them to observe directly the benefits and advantages associated with the use of combine

harvesters. Furthermore, the expansion of combined contracting services provides farmers with additional resources and support.

The study examined the perceptions and attitudes associated with the use of CCH to assess their impact on farmers' decisions to adopt this practice. To evaluate the hypothesis regarding their impact, the model incorporated binary variables that reflect the advantages of CCH, the technical attributes of CCH, the quality of corn harvested manually, and the displacement of labor towards CCH. However, three

out of the four variables were analyzed statistically, but they showed no significant impact.

The claim that the implementation of CCH resulted in a labor-displacing effect was the sole factor that significantly impacted the probability of adoption, achieving a confidence level of 99.9%. The likelihood of adoption for individuals who believed that the implementation of CCH displaces labor was 0.16 times that of individuals who did not share this perception, indicating an 84 percent decrease in the odds of adoption.

Table 6 Factors that influence adoption of corn combine harvesters

Variables	Coeff	Odds Ratio	Std Err	z	Pr> z
Sociodemographic variables					
Age (yr)	0.010	1.010	0.024	0.412	0.680
Educational attainment (yr)	-0.120	0.887	0.090	-1.326	0.185
Household size	-0.096	0.908	0.158	-0.607	0.544
Non-corn income (Php yr-1)	0.000	1.000	0.000	-0.212	0.832
Farm size (ha)	0.444	1.558	0.218	2.039	0.041
Institutional variables					
Land tenure (1=owned)	-0.863	0.422	0.705	-1.225	0.221
Membership in FCA (1=yes)	2.260	9.587	0.769	2.939	0.003
Attended seminar (1=yes)	-0.104	0.901	0.678	-0.153	0.878
Access to advice/extension (1=yes)	0.782	2.186	0.722	1.083	0.279
Access to credit (1=yes)	0.238	1.269	1.058	0.225	0.822
Physical/Technical variables					
Availability	1.250	3.490	0.434	2.881	0.004
Perception/Attitude variables					
Benefits of CCH	-0.475	0.622	0.412	-1.154	0.249
Technical characteristics of CCH	-0.257	0.773	0.386	-0.667	0.505
Quality of manually harvested corn	-0.434	0.648	0.471	-0.921	0.357
Labor displacement towards CCH	-1.843	0.158	0.467	-3.950	0.000
Log likelihood: -43.869		LR Chi2(15): 68.2			
Pseudo R2: 0.437		Prob > Chi : 0.00			

4 Conclusion

The adoption and non-adoption of Corn Combine Harvesters (CCH) by farmers are influenced by various factors, including cost considerations, the availability of labor, the extent of post-harvest losses, local employment dynamics, logistical challenges, and the quality of output. Farmers take into account particular conditions when utilizing CCH, a factor that policymakers and stakeholders must comprehend to promote its adoption. This underscores the significance of tackling labor availability, enhancing

time efficiency, and advancing infrastructure development to promote mechanized harvesting within the agricultural sector. Individuals who have embraced CCH report a high level of satisfaction and intend to maintain its use moving forward. A number of non-adopters express intentions to utilize CCH; however, the majority remain hesitant, citing concerns, established preferences, and perceived obstacles as significant factors influencing their decision-making process. Gaining insight into these factors can facilitate the removal of barriers to the adoption of mechanized harvesting technologies, thereby

encouraging their broader implementation in the agricultural sector.

This study presents empirical findings regarding the determinants that affect the adoption and utilization of corn combine harvesters (CCH) in Tabuk, Kalinga. The findings from the logistic regression analysis detailed and examined the impact of a range of socioeconomic and institutional factors, physical and technical aspects, as well as farmers' perceptions and attitudes on the probability of adopting and utilizing CCH. The analysis revealed that farm size constitutes a significant socioeconomic factor. This factor has a positive influence on the probability of CCH adoption. Membership in organizations, including cooperatives and associations, emerged as a significant institutional factor affecting the likelihood of CCH adoption and utilization. The accessibility of community members to CCHs represents a crucial physical and technical factor that greatly impacts the probability of adopting and utilizing CCHs. Conversely, obstacles to adoption encompass perceptions and attitudes related to the externalities of CCH, including concerns about labor displacement. It is essential to take into account the perceptions and observations related to the adoption and utilization of CCH while also offering practical solutions for the impacted sector, specifically the manual harvesting laborers. Addressing these challenges can enhance the advantages of implementing and utilizing CCH. Although the recognized impact may necessitate farmers bearing extra costs, it can ultimately result in reduced production expenses and increased overall income. Generally, promotion strategies and the dissemination of technology may not have succeeded in fostering widespread adoption, as certain factors may have been neglected. It is essential to acknowledge that these factors must be considered in the promotion of technology to enhance adoption rates.

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