

# Determinants of Corn Combine Harvester Technology Adoption: The Case of Corn Farmers in Tabuk, Kalinga

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**Abstract**—This study examined the issues and determinants of adoption of corn combine harvesters (CCH) in Tabuk, Kalinga, in an effort to promote their increased use. The survey of 117 corn farmers was supplemented by interviews with key informants from nine corn-producing barangays within the municipality of Tabuk. Results showed that socioeconomic factors can inform strategies for promoting technology adoption and advancing agricultural development. The institutional characteristics shed light on the importance of land ownership, collective participation, knowledge dissemination, and financial support in influencing combine harvester adoption among corn farmers whereas physical/technical characteristics of CCH highlight the importance of infrastructure development and availability of combine harvesters in promoting their adoption among corn farmers. In addition, the study examined the perceptions and attitudes of farmers regarding combine harvesting in relation to various aspects, including the advantages of combine harvesting, the technical characteristics of combine harvesters, the quality of manually harvested corn, and the displacement of labor caused by combine harvesters. The findings provide valuable insights into the perceptions and attitudes of farmers regarding combine harvesting, highlighting both consensus and divergent perspectives among adopters and non-adopters. The adoption of CCH offers advantages such as time efficiency, cost reduction, labor optimization, convenience, increased market price, and improved corn quality. However, there are challenges to consider, including high postharvest losses, inapplicability to small farm areas or rough roads, negative effects on manual harvesters and sheller operators, additional costs for collecting cobs, potential harvest delays, field damage, and concerns about unclean output. To convince corn farmers to use the CCH, there is a need to address accessibility issues, reduce post-harvest losses, and maintain farm-to-market roads in order to facilitate the effective use of the CCH.

**Keywords**— Technology adoption, adoption determinants, logistic regression, corn combine harvester.

## I. INTRODUCTION

In the Philippines, Corn (*Zea mays L.*) holds significant agricultural importance as the second most crucial crop. Yellow corn constitutes approximately 70 percent of the country's corn production and plays a vital role in livestock mixed feeds. On the other hand, white corn, comprising the remaining 30 percent, serves as the main staple food for around 12 million Filipinos (PSA, 2014).

The level of agricultural mechanization varies across Asian countries, with different stages of mechanization observed in different regions. Soni and Ou (2010) highlighted the initial

stages of mechanization, involving plowing, land preparation, and threshing using small-scale machines with simple configurations. This level of mechanization is commonly observed in countries like the Philippines, where farming households are the primary units responsible for agricultural activities.

The literature has identified various factors that influence technology adoption. This includes age (Owombo et al., 2012; Howley, O'Donoghue, & Heanue, 2012; Ghosh, 2010; Akudugu et al., 2012), education (Thi, 2008; Uaiene, Arndt, & Masters, 2009; Adebisi & Okunlola, 2013), household size (Mwangi & Kariuki, 2015; Mlenga & Maseko, 2015; Mariano et al., 2012), farm size (Ghosh, 2010; Akudugu et al., 2012; Mariano, 2012; Uaiene et al., 2009), off-farm income (Diuro, 2009; Ellis & Freeman, 2004), land ownership (Zeng et al., 2018; Juma, 2009), extension services (Yaron, Voet, & Dinar, 1992; Mwangi & Kariuki, 2015; Mlenga & Maseko, 2015; Caswell et al., 2001; Akudugu et al., 2012), credit (Simtowe & Zeller, 2006; Akudugu et al., 2012), accessibility of information (Bonabana-Wabbi, 2002), social groups (Uaiene et al., 2009; Bandiera & Rasul, 2006), and technology characteristics (Mwangi & Kariuki, 2015; Mignouna et al., 2011; Akudugu, Guo, & Dadzie, 2012), and access to farm power and machinery (Sims & Kienzle, 2016).

This study hypothesizes that socio-economic factors, which include household-specific and economic, institutional, and technical/physical factors, as well as perception and attitude towards the technology, are among the factors that influence technology adoption.

Although there is information regarding the increase in adoption rates of CCH in some provinces and the low adoption rates in some regions of the country, there is very little information regarding their causes. In general, research on the adoption of agricultural machinery in the country is scarce. Although some research has been conducted on the factors influencing the adoption of rice agricultural technologies in the Philippines (Mariano, Villano, & Fleming, 2012; Francisco, Navarro, & Apaga, 2018; Malananon & Pabuayon, 2022), very little research has been conducted on corn mechanization, especially corn combine harvesters.

## Objectives of the Study

This study aimed to discuss the determinants of adoption of the corn combine harvesters among corn farmers in Tabuk, Kalinga. Specifically, this study tried to: describe the socioeconomic profile and institutional characteristics of corn farmers, and physical characteristics of corn combine harvester; describe the perception and attitude that influence the adoption among corn farmers; and identify the problems that constrain corn farmers from the adoption of combine harvesters.

## II. METHODOLOGY

### Research Design

This study used an exploratory research approach, specifically descriptive analysis, to determine frequencies and means. The exploratory research approach was used to further discover the gap between the CCH adopters and non-adopters in terms of the different characteristics. Furthermore, this exploratory research would serve as a base-line for future studies and for continuous improvement of the technology adoption.

The exploratory research design was conducted using survey questions to explore the perception and attitude of corn farmers towards CCH adoption as perceived by both adopters and non-adopters.

### Study Sites

The province of Kalinga was chosen as the area of study because combine and non-combine harvesting of corn were practiced. However, due to the covid-19 pandemic and time constraints, the study was limited to the city of Tabuk. Moreover, this municipality was chosen because it is one of the top corn-producing municipalities with mostly flat terrain, and it has a relatively good number of yellow corn farmers who practice both corn combine and manual harvesting.

### Respondents and Data Collections

The respondents of the study were selected using purposive sampling. The reason for adopting a purposive sampling strategy is based on the assumption that, given the aims and objectives of the study, specific types of individuals may hold different and significant perspectives on the ideas and issues at hand and, thus, should be included in the sample (Mason, 2002). Restrictions on technology adoption were imposed by study-specific factors, such as the accessibility of potential participant's corn farms to roads. The primary selection criteria were familiarity with combine harvesters and current cultivation of a corn farm on a flat terrain. The respondents were taken from the list of corn farmers provided by the City Agriculturist Office. The sample size was computed using the following formula:

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

where:

n = sample size

$\alpha$  = significance level

N = total population of yellow corn farmers

$\epsilon$  = tolerable error

Z = Z-score

A 95 percent level of confidence with a 5 percent error margin was utilized. This was represented in the formula by a significance level ( $\alpha$ ) of 0.05 and a tolerable error ( $\epsilon$ ) of 0.05. From a total population size (N) of 1,377, it was calculated that 117 yellow corn farmers would participate in the study. Out of the 2,800 corn farmers in Tabuk, only 46 of them grow white corn, while the rest cultivate yellow corn. Half of the 2,754 yellow corn farmers farm on flat terrain, while the other half farm on rolling terrain. Those who farm on plain terrain were the only ones considered as part of the total population. In this study, non-adopters were classified as farmers who have never availed combine harvesting services and who have utilized combine harvesters at least once between the wet season of 2021 and the dry season of 2022, whereas adopters were classified as farmers who have used combine harvester for the last two harvesting seasons.

### Ethical Consideration

Ethical considerations were taken into account by obtaining consent from the participants prior to accessing the questionnaire and ensuring the confidential storage of their responses.

### Instrument Used

This study examined the factors influencing the adoption of CCH among farmers in Tabuk, Kalinga, using survey questionnaires. The farmer-respondents were covered by a single questionnaire set. In addition, a guide questionnaire for the Key Informant Interview was created.

The developed survey questionnaire used for the corn farmers consisted of four parts: socioeconomic characteristics, institutional factors, technical/physical characteristics of combine harvester, and, perception and attitude of farmers. The socio-demographic characteristics included age, education, gender, civil status, farming experience, household size, farm family worker, total area of yellow corn production, and off-farm income.

In addition, the questions on the perception of corn farmers towards the benefits of CCH, technical characteristics of CCH, quality of manually harvested corn, and labor displacement caused by the CCH was answered based on a 5-point Likert scale from 1 being strongly disagree to 5 being strongly agree. These statements were answered by the respondents by checking on the desired scale column. Lastly, an open-ended question asking the problems, issues and areas that need improvement on the corn combine harvester adoption was asked.

### Data Analysis

Descriptive analysis was undertaken to determine the frequencies and mean values of all the identified input variables as presented in the conceptual paradigm of the study. Therefore, descriptive analysis was used to describe the socioeconomic characteristics of the farmers, institutional factors, technical/physical, perception and attitude towards technology adoption, and the problems and constraints they encountered in relation to the adoption of the machinery.

### *Attitudes and Perception*

Farmers' attitudes and opinions were interviewed about integrated harvesters. Attitudes and perceptions were hypothesized to influence their decision-making process regarding the adoption of this machinery.

The attitudes and the perceptions of the farmer-respondents were measured through the use of a Likert scale test composed of questions about their perception of the benefits and technical characteristics of combine harvesters, perception towards the quality of manually harvested corn, and attitude towards labor displacement caused by combine harvesters. This study used a 5-point Likert scale, a psychological response method that allows respondents to simply answer questions and indicate their agreement on a 5-point scale.

The 5-point Likert scale includes the following points: (1) strongly disagree, (2) disagree, (3) neither concur nor disagree, (4) agree, and (5) strongly agree. Joshi et al. (2015) explained that the construction of the Likert scale is determined by the research objectives. In some cases, the purpose of research is to comprehend the opinions/perceptions of participants regarding a single 'latent' variable (phenomenon of interest).

Four questions were devised for category 1 regarding the perception of combine harvester benefits. Each question carries 5 points, the lowest score is 4 and the highest score is 20. Regarding the perception of the technical characteristics of combine harvesters, category 2 was comprised of three questions. With each question worth 5 points, the minimum and maximum attainable scores are 3 and 15, respectively. Two questions concerning the perception of the quality of manually harvested corn were developed for category 3. With each question worth 5 points, the minimum and maximum possible scores are 2 and 10, respectively. Finally, a fourth section deals with attitudes towards job losses due to mergers. Similar to category 1, which has four questions with each question worth 5 points, the minimum possible score is 4 and the maximum possible score is 20. After combining the scores for each category, the total score were ranked from lowest to highest across five ranges.

### III. RESULTS AND DISCUSSION

This chapter discusses the treatment of the results from the survey instruments in accordance with the set objectives of this research.

The section is comprised of eight parts, including sociodemographic, institutional, and technical/physical characteristics, as well as the perception and attitude of corn farmers toward the adoption of corn harvesters, and statements on the benefits and drawbacks of corn combine harvester.

#### *Socioeconomic Characteristics of the Corn Farmer-respondents*

The majority of the adopters interviewed were between 50 and 59 years old, with a mean age of 48.80. This shows that farmers in this age group were more inclined to adopt the technology. On the other hand, non-adopters were between 40 and 49 years old, with a mean age of 45.28. This indicates that farmers in this age range were less likely to adopt the

technology. Akudugu et al. studied modern agricultural production technologies in Ghana in 2012 and found that due to financial constraints, young farmers may struggle to adopt certain technologies. However, leasing or cooperative arrangements may allow young farmers to acquire or access combine harvesters. Moreover, according to Salvador et al. (2019), the average age of corn farmers in the Philippines was 51 years old. This means that the Tabuk farmers who participated in this study were younger than the average age of maize farmers in the country.

In terms of education, among the adopters, 37.78 percent of them had either entered college or obtained a college degree. This implies that a significant proportion of the adopters have received higher education, which potentially contribute to their understanding and openness towards adopting new technologies in agriculture. On the other hand, among the non-adopters, 36.11 percent d attended and/or completed elementary and college education. The data indicates that the majority of the respondents in the study were male. Among the CCH adopters, males accounted for 64.44 percent of the respondents, while among the non-adopters, males comprised 54.17 percent of the respondents. These results highlight a gender disparity in the sample population, with males being more represented in both the adopter and non-adopter groups. This indicates that men are more actively involved in farming activities and decision-making processes related to technology adoption in the specific context of corn combine harvesters. The research conducted by Mignouna et al. (2011) found that gender affects agricultural technology adoption. The study shows that men, who make farming decisions, have more production resources than women. Their resource allocation and decision-making affect agricultural technology adoption. The data reveals that a significant majority of both adopters and non-adopters were married. Among the adopters of corn combine harvesters, 86.67 percent of the respondents were married. Similarly, among the non-adopters, 88.89 percent of the respondents were married. These percentages indicate a high prevalence of married individuals in both groups, implying that marriage is a common characteristic among farmers in the study area.

The data indicates that CCH adopters have significantly more farming experience compared to non-adopters, with an average difference of over 7 years. This implies that farmers who have been involved in agricultural practices of corn for a longer period of time are more inclined to adopt the use of combine harvesters. Their extensive experience in farming contribute to their willingness to explore and adopt mechanized techniques like CCH, recognizing the potential benefits it offers in terms of efficiency, cost-effectiveness, and labor-saving. Moreover, according to the provided data, the average household size of adopters of corn combine harvesters was 4.78, while for non-adopters, it was slightly higher at 4.97. This indicates that both groups have relatively similar household sizes, with non-adopters having a slightly larger average household size. Household size plays a role in technology adoption decisions, as larger households have more labor resources available to support agricultural activities. However, it is important to note that the difference



in average household size between adopters and non-adopters is relatively small and not significant factor influencing the adoption of corn combine harvesters. The data reveals that the average farm size of CCH adopters was 2.53 hectares, whereas non-adopters had an average farm size of 1.55 hectares dedicated to corn production. This indicates that CCH adopters tend to have larger farm sizes compared to non-adopters. Farm size plays a role in the adoption of corn combine harvesters as larger farms have a greater need for efficient mechanized equipment to manage larger areas of crop cultivation. Generally, corn fields were rain-fed. Furthermore, the average off-farm income of CCH adopters was reported as Php 62,913, while non-adopters had an average off-farm income of Php 49,398. This indicates that CCH adopters tend to have higher off-farm income compared to non-adopters. Off-farm income refers to the income generated from sources other than agricultural activities, such as employment in non-agricultural sectors or other business ventures. A higher off-farm income indicates better financial capacity and resources for CCH adoption, as well as potential diversification of income sources.

#### *Institutional Characteristics of the Corn Farmer-respondents*

The majority of the farmers interviewed own the land they till with 71.11 percent of the CCH adopters and 87.67% of the non-adopters. The remaining were lessee, those who amortize and lease the land they managed, tenants, and those who borrowed their farm for free from their relatives.

Among the CCH adopters, a significant majority of 66.67 percent were members of a farming organization, indicating their active involvement in collective agricultural activities. On the other hand, more than half of the non-adopters (56.94 percent) did not belong to any farming organization, suggesting a relatively lower level of collective participation among this group. Furthermore, among those who confirmed their membership, the majority of both adopters and non-adopters were members of a cooperative. This indicates that cooperatives play a significant role in organizing and representing the interests of farmers in the community. Additionally, a smaller percentage of respondents, both adopters (10.00%) and non-adopters (77.42%), were members of farmers' associations. This implies that there is a diversity of farming organizations in the community, catering to different needs and interests of farmers.

Regarding the farmers' participation in seminars, more than half of the adopters (53.33%) reported attending farming-related seminars. In contrast, a lower percentage of non-adopters (36.11%) had attended such seminars. The most common seminar topic for both adopters and non-adopters among those who attended was corn production and machinery. This implies that farmers, regardless of their adoption status, recognize the importance of staying updated on the latest advancements and knowledge in their field of work.

As regards farmers' access to credit and extension services, it indicates that a high percentage of both CCH adopters (91.11%) and non-adopters (83.33%) had access to credit. This means that the majority of farmers in the study area have

some form of financial support available to them for their agricultural activities. However, it is important to note that having access to credit does not necessarily mean that they have loans for every cropping season. The data indicates that most respondents used their own funds to finance their corn production, indicating a level of self-reliance in funding their farming operations. Among those with credit access, more than half of both adopters and non-adopters reported having access to loans from cooperatives and private individuals. This highlights the significance of cooperative institutions and informal lending networks in providing financial assistance to farmers in the community. Furthermore, the data reveals that a significant percentage of adopters (more than half) had access to corn-related advice from technicians or extension services. This indicates that adopters have the opportunity to seek professional guidance and expertise in relation to corn farming practices. In contrast, a lower percentage of non-adopters (26.39%) reported having no access to extension services, suggesting a potential gap in accessing specialized agricultural advice and knowledge for this group.

#### *Physical/Technical Characteristics of Corn Combine Harvester*

All of the adopters confirmed that their farms were accessible, suggesting that they did not face significant challenges in terms of transportation and road conditions. On the other hand, a small percentage of non-adopters (4.17%) reported that their farms were inaccessible due to rough roads. These unpaved roads pose a barrier to the transportation of combine harvesters, as service providers are reluctant to risk moving heavy machinery on such roads. According to the farmers' accounts, the roads leading to their farms are generally passable, but the unpaved condition makes it impractical or risky for service providers to transport combine harvesters. The absence of proper road infrastructure can limit the availability and utilization of agricultural machinery in certain areas. This can be attributed to the time-consuming nature of travel on these roads, making it more convenient for farmers to prefer farms that are closer to accessible roads.

Furthermore, more than half of the adopters (58.18%) reported the availability of combine harvesters within their barangay. This suggests that a significant portion of adopters have convenient access to combine harvesters in their immediate vicinity. On the other hand, among non-adopters, 30.26 percent reported seeing combine harvesters around the barangay, indicating a lesser presence compared to adopters. The majority of non-adopters (64.47%) reported seeing combine harvesters within the municipality. This indicates that while the availability of combine harvesters may extend beyond the barangay level, they are still relatively more common within the broader municipal area. Moreover, a smaller percentage of adopters (23.64%) mentioned the availability of a combine harvester within the municipality, indicating that access to these machines is more widespread within the municipality compared to the immediate barangay. In terms of broader availability, 12.73 percent of adopters reported the presence of a combine harvester within the province. This indicates that while access may extend beyond

the municipality, it is still primarily limited to the province level. Similarly, 3.95 percent of non-adopters reported the availability of combine harvesters in other municipalities outside their own province, indicating some level of accessibility beyond their immediate area. Outside the province, the availability of combine harvesters becomes less common. Only 5.45 percent of adopters and 1.32 percent of non-adopters reported the presence of combine harvesters in locations outside their province. This indicates that access to combine harvesters may significantly decrease when considering areas beyond their own province.

It can also be observed that among adopters, 40.00 percent reported the availability of one combine harvester within their barangay, while 31.11 percent mentioned the presence of two combine harvesters. This indicates that a significant portion of adopters have access to at least one combine harvester within their immediate vicinity. However, it is worth noting that 28.89 percent of adopters stated that there were no available combine harvesters within their barangay. This implies that the combine harvesters they utilized came from outside their local area, possibly from neighboring barangays or municipalities.

In contrast, a larger proportion of non-adopters (68.06%) reported that there were no available combine harvesters in their community. This means that the majority of non-adopters do not have convenient access to combine harvesters within their immediate vicinity. However, a smaller percentage of non-adopters (19.44%) acknowledged the presence of one unit of combine harvester in their barangay, while 12.50 percent reported the availability of two units. This indicates that some non-adopters may still have limited access to combine harvesters within their local area, although it is less prevalent compared to adopters.

#### *Perception and Attitude of Corn Farmer-respondents*

There are 14 questions that were grouped to determine the corn farmer-respondents' perception on the benefits of combine harvesting, perception on the technical characteristics of combine harvesting, perception towards the quality of manually harvested corn, and attitude towards labor displacement caused by combine harvesters. To quantify the overall perception for each of the categories, total perception scores for each of them were calculated.

Responses of both adopters and non-adopters regarding their perceptions of the corn combine harvester (CCH) were compared to manual harvesting. The findings provide insights into the general consensus among users and non-users regarding the speed, cost, yield, losses, and transportation cost associated with the CCH. The majority of adopters agreed or strongly agreed that the CCH is faster than the manual harvesting method. This indicates that adopters perceive the CCH as an efficient technology that significantly reduces the time required for harvesting compared to manual labor. This perception aligns with the time-efficiency aspect previously mentioned as a reason for recommending the CCH to other farmers.

Similarly, most adopters strongly agreed that the CCH is less costly than manual harvesting. This implies that adopters

recognize the cost-saving potential associated with mechanized harvesting, which can result in reduced labor expenses and improved overall cost-effectiveness. Non-adopters, on the other hand, showed disagreement on this aspect, suggesting a slightly less pronounced belief in the cost advantages of the CCH.

Interestingly, there was a significant difference between adopters and non-adopters in terms of their perceptions of yield and losses associated with the CCH. More non-adopters believed that the CCH had higher yield and lesser losses compared to manual harvesting. This implies that non-adopters, who might have limited or no firsthand experience with the CCH, perceive it as a technology with the potential to enhance agricultural outcomes in terms of crop yield and losses. Adopters, however, responded with a more neutral stance, as more than half neither agreed nor disagreed, indicating a level of uncertainty or variability in their observations.

Both adopters and non-adopters agreed that the CCH reduces transportation costs. This implies that both groups recognize the potential transportation cost savings associated with the use of the CCH, which can be attributed to its ability to harvest and transport crops simultaneously. However, it is worth noting that a small percentage of adopters (20%) strongly disagreed and disagreed (11%) with the reduction of transportation costs, suggesting that there might be specific cases or contexts where transportation expenses associated with the CCH could be higher.

Regarding the technical characteristics of corn combine harvesters (CCH), the findings shed light on the respondents' views regarding the ability of CCH to harvest flattened corn, the cleanliness of CCH-harvested corn compared to manually shelled corn, and the presence of chaff and husk in combine-harvested corn. More than half of both adopters and non-adopters agreed that combine harvesters cannot effectively harvest corn that has been flattened. This consensus indicates that respondents recognize a limitation of CCH in handling flattened corn, which is a common occurrence in certain agricultural circumstances. The agreement on this aspect indicates an understanding that manual harvesting might still be necessary in such situations. As regards the cleanliness of CCH-harvested corn compared to manually shelled corn, the majority of both adopters and non-adopters responded with a neutral stance. Sixty percent of adopters and fifty-six percent of non-adopters neither agreed nor disagreed that CCH-harvested corn is cleaner than manually shelled corn. The cleanliness of the harvested corn is influenced by various factors, including the specific CCH used, age of the CCH, as well as the operating conditions and environment.

In terms of the presence of chaff and husk in combine-harvested corn, the percentage of non-adopters (21%) who believed that all combine-harvested corn contained small amounts of chaff and husk was slightly lower compared to adopters (22%). This indicates that there is a similar perception among both groups that some level of chaff and husk can be present in combine-harvested corn. The relatively small difference between adopters and non-adopters on this aspect implies a general understanding that a certain amount

of chaff and husk is unavoidable during the combine harvesting process.

In terms of perceived efficiency and effectiveness of manual harvesting methods, the majority of both adopters and non-adopters were aware of the efficiency of manual harvesters, indicating a common understanding among farmers that manual harvesting can be an effective method for harvesting corn. This perception is supported by the fact that only a small percentage of adopters (2%) and non-adopters (1%) strongly disagreed with the efficiency of manual harvesters.

Furthermore, a significant proportion of adopters (39%) and non-adopters (53%) neither agreed nor disagreed that hired laborers have left behind a large quantity of corn on the cob in the field after manual harvesting. However, a notable percentage of adopters (20%) and non-adopters (38%) believed that a significant amount of corn on the cobs remained in the field after manual harvesting was completed. This indicates a perception among these respondents that manual harvesting resulted in some level of loss or inefficiency in terms of fully collecting all the corn on the cobs.

As regards the attitudes of respondents towards labor displacement caused by corn combine harvesters, both adopters and non-adopters believed that mechanized harvesting has an impact on manual laborers and their livelihoods. The majority of farmers, regardless of whether they were adopters or non-adopters of corn combine harvesters, expressed a belief that they were responsible for the livelihoods of manual laborers. This sentiment was particularly strong among non-adopters, with 95 percent of them sharing this belief. Adopters also overwhelmingly agreed with this statement, with 96 percent expressing the same view. This indicates that farmers, regardless of their adoption status, feel a sense of responsibility towards the well-being of manual laborers and recognize the potential impact of mechanization on their livelihoods.

There was also a notable divergence of opinions between adopters and non-adopters when it comes to using corn combine harvesters. Adopters were more divided, with 40 percent disagreeing and 13 percent strongly disagreeing that it is better not to use the CCH when corn is healthy to prevent labor displacement. In contrast, non-adopters showed a higher level of agreement with this statement, with only 15 percent disagreeing and 6 percent strongly disagreeing. This implies that non-adopters are more inclined to believe that using the corn combine harvester should be limited or avoided to protect the employment of manual laborers, even when the corn crop is healthy.

Additionally, there was disagreement among farmers regarding the circumstances under which combine harvesters should be used. Non-adopters were more likely to agree that combine harvesters should only be utilized when no harvester-laborers can be found or when a storm is approaching. Forty-three percent of non-adopters agreed with this statement, while 26 percent strongly agreed. In comparison, only 20 percent of adopters agreed and a mere 2 percent strongly agreed. This indicates that non-adopters are more inclined to prioritize

manual labor employment and view mechanized harvesting as a last resort or for specific weather-related circumstances.

Furthermore, a higher proportion of non-adopters believed that as corn farmers, it was more important to protect the livelihoods of manual harvester-laborers than to increase their own incomes. This perspective was shared by 42 percent of non-adopters, while only 29 percent of adopters held the same belief. It is worth noting that there were more neither agree nor disagree responses among adopters for this particular question, implying that adopters are more undecided or uncertain about the necessity of prioritizing the livelihoods of manual laborers over their own income generation.

#### *Advantages and Disadvantages of Corn Combine Harvester*

The information demonstrates that the adoption of a CCH provides numerous benefits, including time efficiency, cost reduction, labor optimization, convenience, an increase in market price, and the preservation of corn quality (Table 12). Adopters reported an average harvesting time of 3.6 hours per hectare, which was also acknowledged by non-adopters. This implies that the technology significantly reduces the time required for harvesting. For adopters, this benefit was cited by 39.47 percent, while for non-adopters, it was mentioned by 50.38 percent. Both adopters and non-adopters recognized the potential for cost savings, in addition to the time savings. About 32.46 percent of adopters and 27.82 percent of non-adopters believed that utilizing the CCH could result in reduced costs and expenses. This indicates that the technology may contribute to overall harvesting cost savings. A further advantage of the CCH is the reduction in labor requirements. When using combines, users reported only 5 man-days per hectare versus 23 man-days per hectare for manual harvesting. This labor savings was recognized by 16.67 percent of adopters and 17.29 percent of non-adopters. Utilizing the CCH permits a more efficient allocation of labor resources, potentially freeing up labor for other farm tasks or reducing the need for additional hired labor. Also highlighted as a benefit of combine harvesters was their convenience. Around 7.89 percent of adopters and 3.76 percent of non-adopters mentioned the technology's convenience, which streamlines and simplifies the harvesting process. In addition, some respondents highlighted the benefits of using a CCH in terms of obtaining a higher price for the harvested crop and preserving the quality of the corn, particularly in the face of typhoons. About 3.51 percent of adopters and 0.75 percent of non-adopters cited these factors. By rapidly harvesting the crop with a CCH, farmers are able to deliver their produce promptly, which may result in a higher market price. In addition, this technology helps reduce storm damage, ensuring grain quality and market value.

Meanwhile the disadvantages associated with the use of a Corn Combine Harvester (CCH) included high postharvest losses, inapplicability to small farm areas or rough roads, negative effects on manual harvesters and shellers, additional costs for picking up cobs, potential harvest delays, field damage, and concerns about unclean and poor-quality output. High postharvest losses were observed by 58.21 percent of adopters and 28.72 percent of non-adopters as the most



frequently cited drawback. Observations indicate that the use of CCH results in a higher incidence of postharvest losses than manual harvesting. It is possible that respondents who reported high postharvest losses to the CCH did not account for the additional hauling and shelling losses that occur during manual harvesting. Another drawback mentioned was the inapplicability of the CCH to small farm areas or those with rough roads leading to the farm. About 25.37 percent of adopters and 9.57 percent of non-adopters expressed this concern. According to the farmers, the size and maneuverability of the harvester may be impractical or limiting in such areas, making it difficult to navigate and harvest crops without causing damage to the field or surrounding areas. In addition, smaller farm areas require a smaller number of laborers than larger farms. In these instances, manual labor is more readily available, and the use of a mechanized harvester like the CCH may not be necessary or cost-effective. Similar to the findings of Ghosh (2010) and Akudugu et al. (2012), small-scale farmers are at a disadvantage when it comes to adopting farm mechanization. About 4.48 percent of adopters and 27.66 percent of non-adopters have reported the negative effects of using the CCH on manual harvesters and sheller operators. Farmers also mentioned an additional cost of nearly P1,000 per hectare for picking up the cobs following the CCH operation, commonly known as "tudtud." This cost was reported by 2.99 percent of adopters and 4.26 percent of non-adopters. This shows that there are additional expenses associated with collecting the cobs left behind by the harvester, adding to the overall operational costs. Around 2.99 percent of adopters mentioned the harvest delays caused by machine breakdowns and bad weather. This indicates that the CCH is susceptible to breakdowns, which can cause harvesting delays. In addition, weather conditions can be disruptive and prevent the use of technology. According to 1.49 percent of adopters and 4.26 percent of non-adopters, CCH would be detrimental to the field. About 1.49 percent of adopters cited the high cost of renting a corn combine harvester as a drawback of the machine. Costing nearly P9,000.00 per hectare to rent a corn combine harvester, is viewed as a disadvantage by these farmers. About 10.64 percent of non-adopters viewed that the CCH's output was unclean and of low quality. Typically, corn shellers process pre-harvested corn cobs that have been manually separated from field debris, resulting in a cleaner input for the shelling process. In contrast, corn combine harvesters collect corn cobs and other plant debris such as leaves, stalks, and husks directly from the field. Although combine harvesters are equipped with mechanisms to separate corn kernels from debris during harvesting, residual material is still present in the final output. Finally, 2.99 percent of adopters and 14.89 percent of non-adopters reported that the CCH did not have any disadvantages.

#### IV. CONCLUSION

The socioeconomic factors are crucial for promoting the adoption of combine harvesters in the corn farming sector. The findings emphasize the influence of age, education, gender, farming experience, household size, farm size, and

off-farm income on technology adoption. The findings on the institutional characteristics of corn farmers highlight the importance of land ownership, collective participation through farming organizations, knowledge acquisition through seminars, access to credit, and extension services in the context of combine harvester adoption. These factors play a significant role in shaping farmers' decision-making and resource availability in the adoption of corn combine harvester. The results regarding the physical characteristics of corn combine harvesters illustrate the varying levels of accessibility and availability of combine harvesters for adopters and non-adopters. Access to these machines is generally more convenient for adopters, particularly within their immediate vicinity, while non-adopters face greater limitations in terms of availability within their community.

Farmers' perceptions and attitudes regarding the benefits and characteristics of combine harvesting vary based on their adoption status and direct experience with the technology. The findings indicate that adopters have positive perceptions of the CCH in terms of speed and cost, while non-adopters perceive it as a technology with potential benefits in terms of yield, losses, and transportation costs. Adopters' and non-adopters' perceptions of the technical characteristics of corn combine harvesters (CCH) are revealed by their recognition of the limitations of CCH in harvesting flattened corn and the possibility that some chaff and husk may be present in combine-harvested corn. The responses indicate a nuanced understanding of the technical aspects of CCH among both adopters and non-adopters, influenced by their experience and knowledge of the technology. On the perceptions of farmers regarding the quality of manually harvested corn, while there is a common understanding of the efficiency of manual harvesting methods, there is some variation in perceptions regarding the quantity of corn on the cob left behind in the field. Insights into the perspectives of adopting and non-adopting farmers regarding the labor displacement caused by corn combine harvesters demonstrates the divergent attitudes of farmers, with non-adopters showing a stronger inclination towards protecting manual labor employment and being more cautious about the use of corn combine harvesters. These attitudes were influenced by various factors, including the perceived social and economic impacts of mechanization on manual laborers.

On the advantages and non-advantages of corn combine harvester, while it offers significant benefits in terms of efficiency and cost reduction, there are challenges and limitations that farmers need to consider when deciding whether to adopt this technology. The adoption and non-adoption of Corn Combine Harvesters (CCH) can be attributed to various reasons such as cost, labor availability, post-harvest losses, local employment, logistical challenges, and output quality influence their decision-making process. Moreover, farmers consider several conditions under which they would utilize the CCH. Considering these conditions can help policymakers and stakeholders understand the factors that influence farmers' decisions to adopt or not adopt the CCH. It also underscores the importance of addressing labor availability, time efficiency, and infrastructure development to

promote the adoption of mechanized harvesting technologies in the agricultural sector. Furthermore, the willingness to continue using the CCH among adopters is unanimous, indicating high satisfaction and confidence in the machine's benefits and effectiveness. Adopters have experienced positive outcomes and are likely to incorporate the CCH into their future farming practices. However, a small percentage of non-adopters plan to use the CCH in the next cropping season, while the majority has decided not to. Non-adopters cite concerns, preferences for traditional methods, and perceived barriers to adoption as reasons for their reluctance to explore CCH benefits. Understanding these reasons can help stakeholders address barriers and concerns surrounding the adoption of mechanized harvesting technologies like the CCH. Efforts to address labor considerations, accessibility, performance, and compatibility with different farming systems can promote the wider adoption of such technologies and their potential benefits in the agricultural sector.

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