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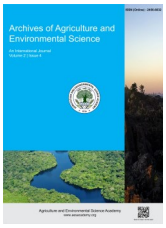

ORIGINAL RESEARCH ARTICLE

# Status of farm mechanization and factor affecting its adoption among the rice (*Oryzae sativa*) farmers in Sarlahi district, Nepal

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**ABSTRACT**

This study aimed to investigate the degree of agricultural mechanization adoption and the factors influencing its acceptance in the Haripurwa municipality and Parsa rural municipality of Sarlahi district, specifically concerning rice agriculture using a multistage random sampling method. A total of 98 respondents were selected for the study, 52 were from Haripurwa municipality and 46 were from Parsa rural municipality. Primary data were collected using semi-structured questionnaires, focal group discussion, and key informant interviews whereas secondary data were obtained through review of relevant literature. The data was analyzed using descriptive statistics, scaling and indexing, chi-square tests, T-tests, and the logit model. By analyzing the adoption index, 62.245% and 37.755% of respondents were under the adopter and non-adopter categories respectively. In contrast to 100% physical labor for transplanting, fertilizer application, and other intercultural tasks like weeding and harvesting, the study found that land preparation was done mechanically (100%). The two biggest obstacles to the use of agricultural machinery were small farms scattered terrain and poor infrastructure with index values of 0.845 and 0.843, respectively. Major factors influencing agricultural mechanization were respondents' educational status, gender, farmers' experience, participation in organizations, loan availability, and primary source of family income. Thus, it can be said that socio-economic determinants which had a significant association with adoption status and most needed farm implements for farmers can be considered by the concerned authority to increase the farm mechanization and enhance profitability from rice farming.



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## INTRODUCTION

More than four billion people throughout the globe rely on rice (*Oryza sativa* L.) as a staple crop (Prasad *et al*., 2017). Worldwide, the nations that produce the most rice include China (212.84 million tons), India, Bangladesh, Indonesia, Vietnam, Thailand, and so on (FAOSTAT, 2023). Nepal ranks fifteenth in global rice production, with a net output of 5.62 million tons. There were 1,473,474 hectares, 5,621,710 metric tons, and 3.82 metric tons per hectare in production (MOALD, 2021). Rice is the most significant source of nutrition for Nepalese people, accounting for around 40% of their daily calorie consumption, 20% of agricultural GDP, and nearly 7% of GDP (CDD, 2015). Rice meets 30% of the nation's overall calorie needs and 50% of its total grain needs (Pokhrel *et al*., 2021) Nepal has lagged in increasing productivity to fulfill the rice demand of the increasing population (CDD, 2015). The primary causes of the worldwide low production and productivity of paddy are inadequate irrigation systems, inadequate nutrient management and soil imbalances, salt stress, a lack of appropriate organic and

inorganic fertilizers, ineffective weed control, a lack of resistant and improved varieties, disease and pest infestation, a lack of mechanization and appropriate production technology, a lack of labor and high labor costs, small land-holdings of farmers, and a low proportion of researchers and extension workers (Bhattarai *et al.*, 2024; Fahad *et al.*, 2019; Paudel *et al.*, 2021). A total of 84,678 hectares is utilized for agricultural purposes, with 45,500 ha irrigated and 46,296 ha not irrigated, which is seen as an issue. The bulk of farmers cultivate rice during the primary season, with just a tiny fraction growing it in the spring. In 2020/21, the total area and output of rice were determined to be 46,600 ha and 170,287 Mt, respectively (MOALD, 2022). This shows rice yield in 2020/21 at 3.650 mt/ha. This productivity seems to be somewhat lower than the national average but greater than the prior year. Mechanization is a viable alternative in Nepal where farmers face labor shortages and high production costs as major issues with the cost of farming operations such as planting, harvesting, and land preparation. Farmers that have used automation in their rice cultivation have decreased production costs by 27% and boosted profits per hectare by 36% (Uprety, 2010). The cost per hectare to produce rice was NRs. 87,215.50. Labor costs were found to be more than 40% higher than automated. Mechanized farms had a lower average total cost of production (NRs. 67,191.74 per ha) than non-mechanized farms (NPR 1,07,239.27 per ha). The average gross revenue was greater in mechanized farms (NPR 1,26,042.90 per ha) than in non-mechanized farms (NPR 1,22,067.00 per ha) (Khatiwada *et al.*, 2021). Agricultural techniques in Nepal are mostly traditional but fast evolving with automation, and the use of better seeds and inputs, although they are not employed or applied at the needed quantity (Thapa *et al.*, 2019). The farmers with modest holdings can use the farm equipment from the custom hiring center, and the proper use of time by farm mechanization reduces crop loss (Verma & Tripathi, 2015).

The mechanization is concentrated on commercial farmers and rich people in the case of Sarlahi. Any of the small and poor farmers are not aware due to which the increase in yield is not significant. Thus, there is a wide gap difference for the adoption of mechanization, and the factors affecting its adoption which has a direct impact on the production of rice in Sarlahi. The result of this study helps the PMAMP and the policymakers to analyze the available machinery with the farmers and the need for other machinery to boost production. However, no research has been done in the Sarlahi district on this very aspect which has created a wide research gap. Hence, this study is crucial. This study would also assist the concerned authority in addressing the major constraints that hinder the adoption of farm machinery and the perception of the farmers in the study area regarding the adoption of farm machinery.

## MATERIALS AND METHODS

### Site selection

Sarlahi District is located in Madesh Province and covers an area of 1259 square kilometers and ranges in altitude from 60-659 masl. It is situated between 26°45' 27°10'' N latitude and 85°20' 85°50'' E longitude. The rice zone program is implemented in this district's Haripurwa municipality (wards no. 1, 2, 5, 6, 7, 8, and 9) and Parsa rural municipality (wards no. 1 and 2). The ethical committee of Agriculture and Forestry University (AFU), Rampur Campus, Chitwan, Nepal approved this study on 24$^{th}$ April 2023.

### Sampling procedure and population

A multi-stage sampling method (precisely, a three-stage sampling procedure) was used in selecting the respondents that were used for the study. The first stage was the purposive selection of two (Haripurwa Municipality and Parsa RM) out of twenty locals, the second stage involved a random selection of two wards from each municipality and the third stage involved a random selection of approximately 15 % of registered rice farmers of each ward. From a sample frame of 350 agricultural families, 98 were chosen by simple random selection without replacement. The site selection was performed purposively, where the block program was implemented.

### Data types and collection techniques

Primary data was collected through a face-to-face household survey at Haripurwa Municipality and Parsa Rural Municipality of Sarlahi District using a pre-tested questionnaire to collect information regarding social and demographic factors, machinery used, and problems related to mechanizations. Agricultural technicians, extension officers, local leaders, and progressive farmers associated with paddy production and marketing were identified. Concerned stakeholders were asked a series of questions to collect information on mechanization in paddy production area increment and mechanization after the adoption of the paddy block program, their economic feasibility, and constraints. A total of 98 Household surveys and 4 Key Informant Interviews (KII) were used as research instruments for the collection of information. Primary and secondary data were collected using different sources, and the data were analyzed accordingly. Primary data were collected directly from farmers involved in paddy farming to gain first-hand information on changes in mechanization under paddy cultivation and mechanization after the adoption of the paddy block program, their awareness level on different recommended practices, the cost of production, different subsidies, and associated constraints. Different reports, bulletins, proceedings, articles, and websites were assessed to collect relevant information on the Paddy Block Program. An informed consent form has been filled out for each research that involves human subjects. The consent was written.

### Data analysis

All the important primary data that were collected from households were entered in MS-Excel 2016, and SPSS (Version 25) was used for further analysis. Collected data were analyzed using the descriptive method by using frequencies, percentages, and standard deviation. Moreover, for inferential statistics,

chi-square tests were done. T-test and logit regression were done to determine the factors affecting the adoption of farm mechanization. A binary logistic regression analysis (Tranmer & Elliot, 2016) was used to find socioeconomic and agricultural characteristics that explain the adoption of farm mechanization. Variables were found using the following model:

$$P(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 +, \ldots, +\beta_n X_n,$$

where: P (Y) is the probability of Y occurring; β0, β1, β2, . . ., βn are unknown parameters; X 1, X 2, . . ., Xn are explanatory variables

The level of adoption was categorized into adopters or non-adopters by using the Adoption Index (AI). The adoption index was calculated from the adoption score. The adoption score was calculated by the sum of scores for the adoption of different machinery in nine different farm operations used in rice production. Based on the value of AI, the respondents were grouped into two categories i.e. non-adopters (less than average) and adopters (more than average). Adoption Index is the degree to which an innovation is adopted by the farmer.

Adoption Index was calculated as (Dangol, 2004):

AI = TAF/MSO × 100 %
Where; AI: Adoption Index; TAF: Total adoption score obtained by an individual farmer; MSO: Maximum score one can obtain.

Thus, adopters were categorized as:
Non-adaptors: non-adaptors refer to the farmers who had got the value of Adoption Index value (AI) below the average of the total farmers.

Adaptors: Adaptors refer to the farmers who had got the value of Adoption Index value (AI) higher than the average of the total farmers.

A total of 9 operations were taken to get the adoption index; those operations are:

- Use of primary tillage tools used in land preparations.
- Use of secondary tillage tools used in land preparations.
- Use of mechanized transplanter in transplanting rice seedlings.
- Use of mechanized fertilizer application methods in fertilizer application.
- Use of mechanized irrigation methods in irrigation.
- Use of mechanized weeding methods.
- Use of mechanized plant protection methods in plant protection.
- Use of mechanized harvesting method in harvesting.
- Use of mechanized threshing methods in threshing

## RESULTS AND DISCUSSION

### Demographic and socio-economic status

Table 1 shows the gender distribution of respondents. Among 98 farmers interviewed, 69.4 percent of the respondents were male whereas 30.6 percent of the respondents were female. The gender of the respondents was found significantly different between adopters and non-adopters at a 10% level of significance. The age of the respondents was categorized into 5 groups i.e., up to 30 years, 30-40 years, 40-50 years, 50-60 years, and more than 60 years and the percentage of respondents of those categories were 8.2, 24.4, 36.7, 27.6 and 3.1 respectively. The age of the respondents was not significantly different between adopters and non-adopters. For the study religious groups were categorized into 3 different groups. Among the 98 respondents, Hinduism (81.6%) was found to be the major religion followed by Muslim (16.33%) and Buddhism (2.04%). The religion of the respondent wasn't found to be significant with the adoption status at 1%, 5%, and 10% level. Similarly, the ethnic groups were classified into 4 different groups. Among the 98 respondents, Madeshi (55.1%) was found to be the major ethnic group followed by Brahmin/Chhetri (24.5 %), Dalit (11.2 %), and Janajati (9.2%). The ethnicity of the respondents was found to be significantly different between adopters and non-adopters at a 10% level of significance. The study revealed that out of 98 respondents, 56 (57.1%) had nuclear families and 42 (42.9%) had joint families. The family type of the respondents was found highly significantly different between adopters and non-adopters at a 1% level of significance. Figure 1 shows that the average family size of the study area was 7.37 with a maximum member of family 17 and a minimum member of family 2. The average family size is higher than the national average which is 4.37 (CBS, 2021). The educational status of the study area was categorized into 6 different levels: Illiterate, those who can read and write, Primary (up to 5 classes), Secondary (up to 10 classes), Higher (up to 12 classes), Bachelor and above with frequency 9, 13, 27, 39, 8, and 2 respectively. The majority of the respondents in the study area were literate. The educational status of the respondent was found highly significant with the adoption status at a 1% level of significance showing the difference in adoption between educated and non-educated respondents. Agriculture (42.9%) was found to be the major occupation of the study area followed by agriculture with livestock (13.3%), government service (13.3%), remittance (9.2%), wages labor (8.2%), business (7.1%), and private sector (6.1%). The major source of income of the respondent family was found highly significant with the adoption status at a 1% level of significance. The experience in rice cultivation was categorized into four groups: less than 5 years, 5 to 10 years, 10 to 20 years, and more than 20 years with the percentage of respondents 2%, 42.9%, 21.4%, and 33.7% respectively. The experience of the rice cultivation of the respondent was found significantly different between adopters and non-adopters at the 1% level of confidence. The majority of the members of the study area were members of certain agriculture

**Table 1.** Demographic and socio-economic characteristics of household heads in the study area (2023).

| Independent factors | | Adoption status/ category | | Total | Chi-square value | p-value |
|---|---|---|---|---|---|---|
| | | Non-adaptors | Adaptors | | | |
| Gender | Male | 22 (59.5%) | 46 (75.4%) | 68 (69.4%) | | |
| | Female | 15 (40.5%) | 15 (24.6%) | 30 (30.6%) | 2.758* | 0.097 |
| Age | < 30 yrs | 2 (5.4%) | 6 (9.8%) | 8 (8.2%) | | |
| | 30-40 yrs | 13 (35.1%) | 11 (18%) | 24 (24.4%) | | |
| | 40-50 yrs | 8 | 28 | 36 | 8.266 | 0.082 |
| | >60 yrs | 1 (2.7%) | 2 (3.3%) | 3 (3.1%) | | |
| Religion | Hinduism | 30 (89.2%) | 50 (93.4%) | 80 (81.6%) | | |
| | Buddhism | 0 (0.0%) | 2 (3.3%) | 2 (2.0%) | 1.460 | 0.482 |
| | Muslim | 7 (18.9%) | 9 (14.8%) | 16 (16.3%) | | |
| Ethnicity | Brahmin/ Chhetri | 12 (32.4%) | 12 (19.7%) | 24 (24.5%) | 7.029* | 0.071 |
| | Adhibasi/ Janajati | 6 (16.2%) | 3 (4.9%) | 9 (9.2%) | | |
| | Madheshi | 15 (40.5%) | 39 (63.9%) | 54 (55.1%) | | |
| | Dalit | 4 (10.8%) | 7 (11.5%) | 11 (11.2%) | | |
| Family type | Nuclear | 12 (32.4%) | 44 (72.1%) | 56 (57.1%) | 14.821*** | 0.000 |
| | Joint | 25 (67.6%) | 17 (27.9%) | 42 (42.9%) | | |
| Education | Illiterate | 4 (10.8%) | 5 (8.2%) | 9 (9.2%) | 15.654*** | 0.008 |
| | Only read & write | 11 (29.7%) | 2 (3.3%) | 13 (13.3%) | | |
| | Primary Level | 8 (21.6%) | 19 (31.1%) | 27 (27.6%) | | |
| | Secondary Level | 12 (32.4%) | 27 (44.3%) | 39 (39.8%) | | |
| | Higher Secondary Level | 2 (5.4%) | 6 (9.8%) | 8 (8.2%) | | |
| | Bachelor | 0 (0.0%) | 2 (3.3%) | 2 (2.0%) | | |
| Major source of income | Ag. only | 11 (29.7%) | 31 (50.8%) | 42 (42.9%) | 18.715*** | 0.005 |
| | Ag. + Livestock | 4 (10.8%) | 9 (14.8%) | 13 (13.3%) | | |
| | Gov. service | 3 (8.1%) | 10 (16.4%) | 13 (13.3%) | | |
| | Business | 3 (8.1%) | 4 (6.6%) | 7 (7.1%) | | |
| | Private sector | 2 (5.4%) | 4 (6.6%) | 6 (6.1%) | | |
| | Foreign employment | 8 (21.6%) | 1 (1.6%) | 9 (9.2%) | | |
| Farming experience | < 5 yrs | 2 (5.4%) | 0 (0.0%) | 2 (2.0%) | 11.422*** | 0.010 |
| | 5-10 yrs | 22 (59.5%) | 20 (32.8%) | 42 (42.9%) | | |
| | 10-20 yrs | 5 (13.5%) | 16 (26.2%) | 21 (21.4%) | | |
| | >20 yrs | 8 (21.6%) | 25 (41.0%) | 33 (33.7%) | | |
| Organization membership | Not a member | 23 (62.2%) | 23 (37.7%) | 46 (46.9%) | 42.426*** | 0.000 |
| | Member | 14 (37.8%) | 38 (62.3%) | 52 (53.1%) | | |
| Training | Not taken | 32 (86.5%) | 36 (59.0%) | 68 (69.4%) | 8.182*** | 0.004 |
| | Taken | 5 (13.5%) | 25 (41.0%) | 30 (30.6%) | | |

Source: Household Survey, 2023; Note: Signs * and *** indicate 10% and 1% level of significance respectively.

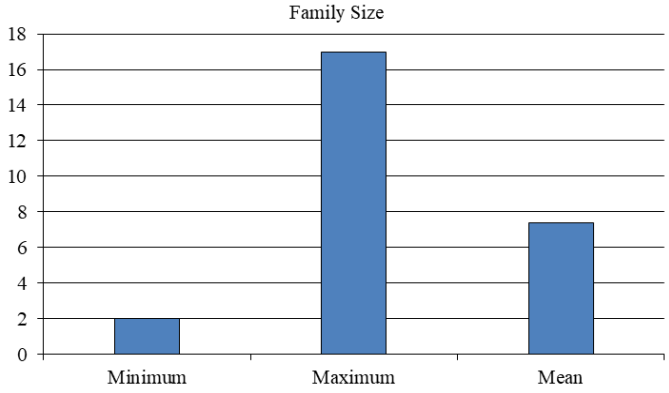


**Figure 1.** *Family size of the respondent (Source: Household Survey, 2023).*

-related organizations with 53% of respondents and 47% weren't members of agriculture-related organizations. Farmers as the members of the organization, farmer group, and cooperative were found to be highly significant with the adoption status at a 1% level. The majority of the respondents (69%) in the study area hadn't taken any sorts of training on rice cultivation and mechanization. Only a few farmers (31%) had participated in various kinds of training provided by different institutions. Attainment of training by the respondent was found significantly different between adopters and non-adopters at a 1% significance level.

### Machinery used during different operations of rice cultivation

Figure 2 illustrates that mechanization (use of machinery) was concentrated mainly on operations such as land preparation (100%) and threshing (87.75%) followed by other operations such as plant protection (81.63%) and irrigation (69.38%) whereas operations like transplanting, fertilizer application, weeding, earthing up, and harvesting were not mechanized at all.

### Different machinery implements adopted by farmers

Figure 3 shows that the cultivator (91.83%), rotavator (95.91%), tractor-operated thresher (85.71%), pump sets (74.49%), and knapsack sprayer (54.08%) were the major five machinery implements adopted by farmers in the study area.

### The extent of adoption based on the mechanization of farm operations

Those respondents whose adoption index value was below the mean adoption index value were considered non-adopters. In contrast, those whose adoption index value was above the mean adoption score were considered as adopters. Table 2 shows that the mean adoption index value was 39.45 with a standard deviation of 19.98. 61 respondents were adopters and 37 were non-adopters. Similarly, the maximum adoption score was 77.78, and the minimum adoption score was 11.11.

**Table 2.** Extent of adoption based on mechanization of farm operations in study area (2023).

| Adoption category or status | | Min. adoption index value | Max. adoption index value | Mean adoption index value | Standard Deviation |
|---|---|---|---|---|---|
| Adaptor | Non-adaptor | | | | |
| 61(62.245%) | 37(37.755%) | 11.11 | 77.78 | 39.45 | 19.338 |

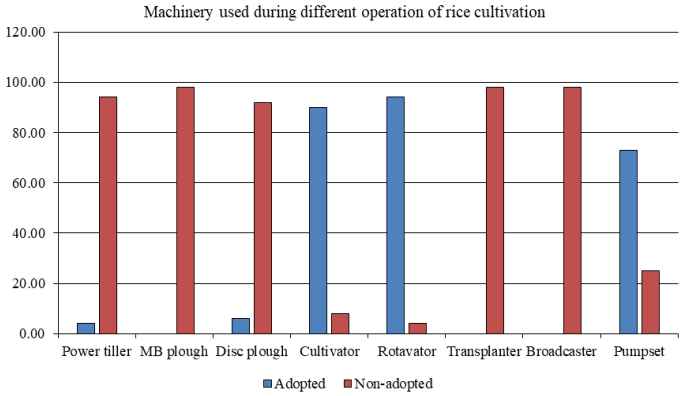


**Figure 2.** *Machinery used during different operation of rice cultivation (Source: Household Survey, 2023).*

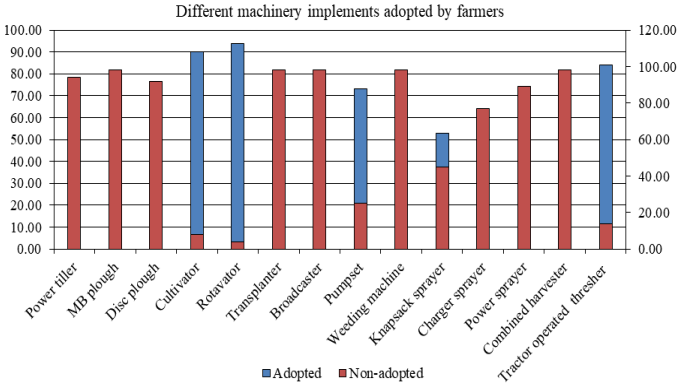


**Figure 3.** *Different machinery implements adopted by farmers in the study area (2023) (Source: Household Survey, 2023).*

**Table 3.** Association between land holding, satisfaction toward rice cultivation with adoption status.

| Independent factors | | Adoption status/ category | | Total | Chi-square value | p-value |
|---|---|---|---|---|---|---|
| | | Non-adaptor | Adaptor | | | |
| Land Holding status | Small land holding | 34 (91.9%) | 33 (54.1%) | 67 (68.4%) | 15.211*** | 0.000 |
| | Large land holding | 3 (8.1%) | 28 (45.9%) | 31 (31.6%) | | |
| Satisfaction toward rice Cultivation | Highly satisfied | 3 (8.1%) | 20 (32.8%) | 23 (23.5%) | 7.998** | 0.018 |
| | Moderately Satisfied | 26 (70.3%) | 33 (54.1%) | 59 (60.2%) | | |
| | Considerable highly unsatisfied | 8 (21.6%) | 8 (13.1%) | 16 (16.3%) | | |

Source: Household Survey, 2023; Note: Signs ** and *** indicate significant at 5% and 1% level respectively.

**Table 4.** Association of land holding of respondents with adoption status (2023).

| Variable | Adoption status | | Total Mean | Mean Difference | T- value |
|---|---|---|---|---|---|
| | Non-Adopter | Adopter | | | |
| The landholding of the respondent | 0.49 | 1.03 | 0.76 | -0.535 | -3.186** |

Source: Household Survey, 2023; Note: Sign ** indicates a 5% level of significance.

### Association between different factors and adoption status

**Association between land holding status, satisfaction toward rice cultivation with adoption status:** Table 3 shows the significant association between land holding and the satisfaction of the respondents toward rice cultivation with the adoption status of mechanization. Landholding status was highly significant with the adoption category at a 1% level of significance whereas the satisfaction of the respondent toward the rice cultivation was significant at a 5% level of significance.

**Association between the land holding of the respondent with the adoption status:** Table 4 shows there is a significant association between the landholding of the respondent with the adoption status at a 5% level of significance.

### Factor affecting the adoption of farm mechanization

Logit Regression was done to analyze different socio-economic and others farms factor affecting the adoption of farm mechanization. The explanatory variables (age, education, farmer's involvement in the organization, farm size, and credit access) were selected based on previous studies on Socioeconomic factors affecting the adoption of agricultural machinery (Akram *et al.*, 2020). The variables such as Gender, family type, Attainment of training, income source, and experience of farmer respondents were selected based on a previous study on the Mechanization of small-scale farms in South Asia: Empirical evidence derived from farm households survey (Aryal *et al.*, 2021). Based on different literature reviews and different responses of respondents 10 different explanatory variables were selected to investigate the different factors affecting the adoption of farm mechanization. A statistical description of these variables is shown in Table 5. The educational status of the respondent, Gender of the respondent, Experience of the respondent with rice cultivation, Organizational membership, access to credit sources, and income source of the family were positively significant. The age of the respondent and the major income source of the family of the respondent had a negative influence on the adoption of mechanization whereas all other factors have a positive influence on the adoption of farm mechanization. The study revealed that if the respondent had a higher education the probability of farm mechanization adoption found to increase by 12.4% and was highly significant at a 1% level of significance.

**Table 5.** Different factors affecting the adoption of farm mechanization.

| Variables | Coefficient | Standard error | P(z) | dy/dx |
|---|---|---|---|---|
| Education | 1.200*** | 0.393 | 0.000 | 0.124*** |
| Gender | 1.727** | 0.877 | 0.033 | 0.179** |
| Age | -0.057 | 0.422 | 0.157 | -0.00593 |
| Family Type | 1.465 | 1.052 | 0.151 | 0.152 |
| Experience | 0.644** | 0.298 | 0.017 | 0.0668** |
| Organization | 1.805*** | 0.776 | 0.008 | 0.187*** |
| Training | 0.730 | 0.955 | 0.437 | 0.0757 |
| Credit Source | 2.509** | 1.284 | 0.035 | 0.260** |
| Family Size | 0.214 | 0.143 | 0.881 | 0.0022 |
| Income source | -0.337* | 0.191 | 0.060 | -0.035* |
| **Summary statistics** | | | | |
| N | 98 | | | |
| LR chi$^2$(10) | 66.13*** | | | |
| Prob > chi2 | 0.0000 | | | |
| Log-likelihood | -31.894 | | | |
| Pseudo R2 | 0.509 | | | |

Source: Household Survey, 2023; Note: Signs *, **, and *** indicate significance at 10%, 5%, and 1% levels respectively.

This was consistent with the finding of Barman *et al.* (2019) who reported that the adoption of farm mechanization was more prevalent among the farms having relatively literate respondents in the study area. Akram *et al.* (2020) and Gc *et al.* (2019) found that education helps farmers get information from organizations and encourages them to take calculated risk-related agricultural machinery investments. This perhaps might be due to higher the education level of the farmer more interested in the extension activities and more involved in the training that allows more adoption of farm mechanization. Higher education increases the ability of the farmer to adopt innovations to increase the efficiency of production.

If the respondent is male the probability of adoption of farm mechanization increases by 17.9% and is significant at the 5% level. Male-headed households are more likely to use different machinery in comparison with female-headed households. This is consistent with the finding of Gc *et al.* (2019)who found that male-headed households are more likely to own, adopt, or operate machinery than households headed by women in Bangladesh. Male farmers have better contact with the extension worker and male respondents are keener on taking the training. The higher the experience of the farmer in rice cultivation the probability of an increase in the adoption of farm mechanization is by 6.68% and is positively associated with the adoption of farm mechanization. A similar result was found by Sisay Getaneh (2021) that the experience of the farmer was found to positively correlate with the adoption of irrigated fodder technologies by small-scale irrigation project sites in Ethiopia. Following our expectations, more experienced farmers have a greater ability to process information and search for technologies suitable to their production constraints than those who are less experienced. Those farmers who were members of the farmer's organizations or cooperatives have more probability of adopting farm mechanization by 18.7% which is positively associated with the adoption of farm mechanization. A similar result was found by Sisay Getaneh (2021) that the more the farmers are involved in farmer organizations' meetings and activities, the more they will access new information about improved technologies and the more they will easily develop positive attitudes towards the adoption of production technologies. The farmer as a member of the organization gets the information related to the benefits of using machinery and gets access to the organization-owned machine.

Availability and provision of the credit source to the farmer are positively correlated with the adoption of the adoption of farm mechanization. If the farmers get the credit the probability of adoption of farm machinery increases by 26%. Our result coincides with the findings of Akram *et al.* (2020) availability of credit assists people in the adoption of agriculture machinery in South Asia. With the availability of necessary credit, farmers can purchase productive farm inputs and invest in machinery and technology. The access to credit eases liquidity constraints, and the farmers can rent farm machinery. The major income source of the family is positively associated with the adoption of farm mechanization. The income source is negative and significantly (at a 10% level) related to the adoption of farm mechanization. However, the negative sign of this relationship is contradictory to our initial hypothesis. This negative sign indicates that with increasing income of the family, the probability of farmers' adoption of farm mechanization decreases. Before this study, it was expected that the sign of an increase in income of the family would increase the probability of adoption of farm mechanization as the higher income assists the farmer in buying the machinery and assists in hiring the required machinery. The result was found contradictory to Bhandari *et al.* (2023) that higher-income farmers are possibly less risk-averse and have more access to information. The family with a higher income does less farming and leases the land to others to do the farming activities. The age of the respondent has a negative impact and is insignificant to the adoption of farm mechanization. A similar result was found by Bhandari *et al.* (2023) argued that young farmers comparatively would be in favor of new technology while, older farmers are conservative in adopting new technology. Similar findings were reported in a study by Akram *et al.* (2020) younger farmers are more likely to adopt machinery. Likewise, Sisay Getaneh (2021) found that increasing age reduces the likelihood of new technology adoption.

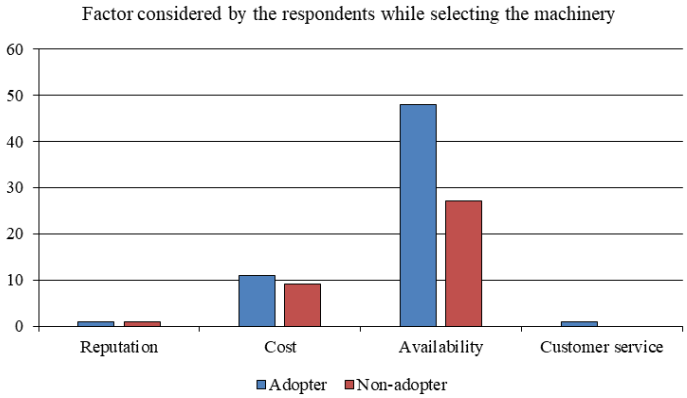


**Figure 4.** *Factor considered by the respondents while selecting the machinery in study area (2023).*

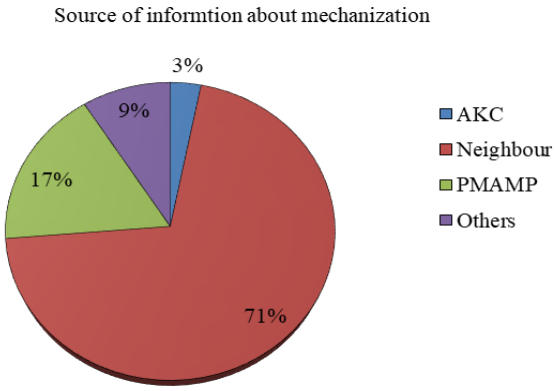


**Figure 5.** *Source of information about mechanization in the study area (2023) Source: Household Survey, 2023.*

**Table 6.** Ranking of perceptions and constraints regarding the adoption of farm machinery in the study area (2023).

| | Statements | Scores | | | | | Index | Ranking |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 0.8 | 0.6 | 0.4 | 0.2 | | |
| Perception | Time saving | 53 | 39 | 3 | 1 | 2 | 0.885 | II |
| | Low labor requirement | 54 | 39 | 5 | 1 | - | 0.904 | I |
| | Production increment | 15 | 65 | 16 | 1 | - | 0.786 | VI |
| | Low cost of production | 32 | 53 | 8 | 5 | - | 0.829 | III |
| | Reduce drudgery | 31 | 47 | 19 | 1 | - | 0.820 | IV |
| | Precision in input use | 43 | 24 | 28 | 3 | - | 0.818 | V |
| Constraints | High cost of machinery | 28 | 51 | 11 | 8 | - | 0.802 | III |
| | Price hike of petroleum products, repairing & others | 21 | 27 | 43 | 7 | | 0.727 | VI |
| | Small farm holding and fragmented land | 45 | 31 | 21 | 1 | - | 0.845 | I |
| | Poor infrastructure to take the machine to field | 47 | 30 | 17 | 3 | 1 | 0.843 | II |
| | Highly technical | 28 | 42 | 26 | 2 | - | 0.796 | IV |
| | Not suitable for all cultural practices | 21 | 44 | 30 | 3 | - | 0.769 | V |

Source: Household Survey, 2023.

Furthermore, it was shown from our study that if a farmer had a business or another job besides farming, their financial position would be much better, and less interested in farming on their own and less adoption farm machinery. Training received, family size, and land holding of the respondents were not statistically significant in the model. The result was quite surprising thus further research with larger data sets may give us different results than this.

### Factor considered by the farmer while selecting farm machinery

Figure 4 shows about 79% of farmers in the adopter category adopt the farm machinery based on the availability of the machinery around them. Only 1% of farmers adopt the farm machinery based on reputation and customer service.

### Source of information about mechanization

The results show that most of the respondents got the information about the mechanization from the neighbor (71%) followed by PMAMP (17%), other sources (9%), and AKC (3%). PMAMP could disseminate information related to mechanization with the association of farmers of neighbors as presented in Figure 5.

### Perception regarding the adoption of farm machinery

Different perceptions regarding the adoption of farm machinery were obtained via primary and secondary sources and were ranked based on the responses of respondents. The index value was obtained and ranking was done based on the higher index value. Table 6 illustrates; that low labor requirement was ranked first with the index value 0.904 which means more respondents were convinced of the statement that farm machinery reduces the number of labors required to perform different activities on the field. However, statement production increment was ranked sixth with an index value of 0.786.

### Constraints/Barriers regarding adoption of farm machinery

Different constraints/barriers regarding the adoption of farm machinery were obtained via primary and secondary sources and were ranked based on the responses of respondents. The index value was obtained and ranking was done based on the higher index value. Table 6 illustrates; small farm holding and fragmented land as the main barriers or constraints regarding the adoption of farm machinery with an adoption index of 0.845. However, the statement price hike of petroleum products, repairing and others was ranked sixth with the adoption index 0.727.

## Conclusion

Mechanization is a need-based procedure that offers an adequate time gap for the self-adjustment of different inputs, resulting in a favorable influence on agricultural productivity. The present study revealed that land preparation was completely mechanized which was provided by a tractor-operated Rotavator and cultivator followed by land threshing, Irrigation, and Plant protection using a knapsack sprayer. The average land

holding of respondents was 24.81 katha which was above the national average due to which the adoption of machinery was a bit higher. Gender, educational status, experience of farmer, organizational membership and access to credit are the factor affecting the adoption of farm mechanization found by the logit regression analysis. Mechanization reduces labor requirements was the main perception regarding the adoption of farm machinery and small farm holding & fragmented land were the main barriers to farm machinery adoption. The research concludes that the lack of availability of machine, and low and holding with poor infrastructure to take the machines to the field are not satisfactory. Farmers required three agricultural implements: a pump set, a rice transplanter, and a rice harvester to aid with rice cultivation and increase rice yield.

## DECLARATIONS

**Authors contribution:** Conceptualization, methodology, Investigation: D.K., M.S.T., H.P., R.K., and P. S.; Software, validation, Data curation, Writing, original draft preparation: D.K. and M.L.; Review and editing: M.S.T. and K.D. All authors have read and agreed to the published version of the manuscript.

**Conflict of interest:** The authors declare no conflict of interest.

**Ethics approval:** Ethical approval was taken for this study.

**Consent for publication:** All co-authors gave their consent to publish this paper in AAES.

**Data availability:** The data that support the findings of this study are available on request from the corresponding author.

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## REFERENCES

Akram, N., Akram, M. W., & Hongshu, W. (2020). Study on the Socioeconomic Factors Affecting Adoption of Agricultural Machinery. *Journal of Economics and Sustainable Development*, 68–80. https://doi.org/10.7176/jesd/11-3-07

Aryal, J. P., Rahut, D. B., Thapa, G., & Simtowe, F. (2021). Mechanisation of small-scale farms in South Asia: Empirical evidence derived from farm households survey. *Technology in Society*, *65*, 101591. https://doi.org/10.1016/J.TECHSOC.2021.101591

Barman, S., Deka, N., & Deka, P. (2019). Factors Affecting Farm Mechanization – A Case Study in Assam, India. *Asian Journal of Agricultural Extension, Economics & Sociology*, 1–7. https://doi.org/10.9734/AJAEES/2019/V32I130146

Bhandari, S., Bhandari, S., K.C., S., Badu, R., Dhital, P. R., & Khanal, A. (2023). Assessment of agricultural mechanization status in rice production and its challenges in the western Nepal. *Archives of Agriculture and Environmental Science*, *8*(2), 236–243. https://doi.org/10.26832/24566632.2023.0802021

Bhattarai, P., Gyanwali, P., Pokharel, N. P., Bashyal, P., Mainali, R., & Khanal, R. (2024). Agro-morphological analysis of yield and yield attributing traits of wheat under heat stress condition. *Agriculture and Food Sciences Research*, *11* (1), 30–35. https://doi.org/10.20448/aesr.v11i1.5486

CDD. (2015). Rice varietal mapping in Nepal: Implication for development and adoption. Crop Development Directorate, DoA, Hariharbhawan, Lalitpur.

Dangol, B. B. S. (2004) Extension education. Dangol Printers, Kathmandu, Nepal.

Fahad, S., Adnan, M., Noor, M., Arif, M., Alam, M., Khan, I. A., Ullah, H., Wahid, F., Mian, I. A., Jamal, Y., Basir, A., Hassan, S., Saud, S., Amanullah, Riaz, M., Wu, C., Khan, M. A., & Wang, D. (2019). Major Constraints for Global Rice Production. In *Advances in Rice Research for Abiotic Stress Tolerance* (pp. 1–22). Elsevier. https://doi.org/10.1016/B978-0-12-814332-2.00001-0

*FAOSTAT*. (2023). Retrieved March 21, 2023, from https://www.fao.org/faostat/en/#home

Gc, A., Yeo, J., & Ghimire, K. (2019). *Turkish Journal of Agriculture - Food Science and Technology Determinants of Farm Mechanization in Nepal*. *7*(1), 87–91.

Khatiwada, D., Dutta, J. P., Shrestha, K., Adhikari, G., & Paudel, H. (2021). Economic Impact of Agricultural Mechanization in Rice Farming in Shivasatakshi Municipality of Jhapa District, Nepal. *Food and Agri Economics Review*, *1*(1), 41–45. https://doi.org/10.26480/faer.01.2021.41.45

MoALD, 2021. (2021). Statistical Information On Nepalese Agriculture (2077/78 ). *Publications of the Nepal in Data Portal*, *73*, 274.

MOALD. (2022). *Statistical Year Book*. Singhadurbar, Kathmandu: Government of Nepal.

Paudel, S., Pokharel, N. P., Adhikari, S., & Poudel, S. (2021). Heat and Drought Stress Effect in Wheat Genotypes: a Review. *Food and Agri Economics Review*, *1*(2), 77–79. https://doi.org/10.26480/faer.02.2021.77.79

Pokhrel, A., Dhakal, S., Kafle, R., & Pokhrel, A. (2021). Adoption status of improved production technology in rice cultivation in Kanchanpur, Nepal. *Archives of Agriculture and Environmental Science*, *6*(2), 178–185. https://doi.org/10.26832/24566632.2021.060209

Prasad, R., Shivay, Y. S., & Kumar, D. (2017). Current Status, Challenges, and Opportunities in Rice Production. In B. S. Chauhan, K. Jabran, & G. Mahajan (Eds.), *Rice Production Worldwide* (pp. 1–32). Springer International Publishing. https://doi.org/10.1007/978-3-319-47516-5_1

Sisay Getaneh. (2021). *Drivers to Adoption of Irrigated Fodder Technologies and Its Impact on þÿSmallholder Farmers Income: Evidence from Innovation Lab for Small-Scale Irrigation Project Sites , Ethiopia . Master Thesis*. 1–18.

Thapa, G., Kumar, A., & Joshi, P. K. (2019). Agricultural transformation in Nepal: Trends, prospects, and policy options. In *Agricultural Transformation in Nepal: Trends, Prospects, and Policy Options* (Issue November 2019). https://doi.org/10.1007/978-981-32-9648-0

Tranmer, M., & Elliot, M. J. (2016). *Binary Logistic Regression Mark Tranmer Mark Elliot*. *April*.

Uprety, R. (2010). Meshing mechanization with SRI methods for rice cultivation in Nepal. *Paper Presented at Rice for Future Generations the Third International Rice Congress IRC 812 November 2010 in Hanoi Vietnam*, 1–5. http://www.ricecongress.com/previous/pdflink/3932.pdf

Verma, M., & Tripathi, A. (2015). Perspective of agricultural mechanization in Supaul district of North Bihar-a Research. *Journal of Agriculture and Veterinary Science*, *8*(8), 4-12.