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Adoption of Mechanization by Paddy Growers In Rjkip Project Command Area, Kailali

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Abstract

This study aims to assess the mechanization status and constrains faced by the rice growing farmers and its impact in paddy production in Kailali district. The study was conducted in command area of RJKIP which covers Tikapur municipality, Lamki-Chuha municipality and Janaki rural municipality which were purposively selected. Sampling of 92 rice growers was done using simple random sampling method and primary data was collected via household survey. Multiple linear regression model was used to analyze the factors affecting adoption of mechanization among rice growers. The findings showed education level, larger land holdings, income of farmers had significantly increased the adoption of mechanization where, age, family size and labour cost had negative effect on adoption. Major problems in adoption of mechanized agriculture system were higher cost of machine followed by lack of technical knowledge, small land holdings, lack of subsidy etc. Farm mechanization can be enhanced by providing subsidy on machineries, technical assistance on using different tools and farming practices followed by land management scheme

Keywords: adoption, command area, mechanization, subsidy, regression

Introduction

Paddy is the major cereal crop in the context of production and area allocation in Nepal. It can be grown in different agro-climatic conditions from Terai to high Hills of the country. Rice is the most preferred staple food crop of Nepal and fulfils more than 50% of the calorie requirement of the Nepalese people. Rice occupies about 1447789 hectares of land which yields 5486472 tonne having average productivity 3.79 tonne per hectare. Among the seven province, Madhesh province has highest production i.e. 1388841 tonne while Karnali Province produces the least at 129473 tonne per hectare. Sudurpaschim Province recorded 589221 tonnes from 162520 hectares. The reports indicate Kailali district contributes 322646 tonnes from 71380 hectares (Department of

Agriculture [DoA], 2024). Rice contributes more than 20% of the agricultural GDP and the 50.27% of the total food grain production of country (Statistical Information Book, 2024). The crop is grown in height range from 60 m (Kanchanakalan, Jhapa) to high altitude as 3050 masl (Jumla Valley) of Nepal, which was the highest elevation for growing rice in the world.

In the last 15 years the agriculture sector of Nepal experienced several changes. The proportion of household operating agricultural holding as well as the average size of operated has decreased. About 60% of active population is dependent on agriculture (MoALD, 2024). Share of commodities to agriculture GDP from cereal and other crops account for 49.41% and separately constituted from vegetables and nursery 9.71%, fruits and spices 7.04%, domestic animal and poultry 23.25%, other animal farming 2.43% and forestry 8.07% (ABPSD, 2007). Nepal is a tiny, landlocked nation that lies between China and India. The majority of Nepal's population depends on agriculture for their livelihood, and it is the primary source of GDP, income, and job opportunities in the country. Approximately 34.7% of the country's GDP comes from agriculture, which also employs 73.9% of its people full- and part-time (NLFS, 2008). Population of Nepal is increasing over a period of time but the production of crops decreased over a period of time. The hill and mountain regions are highly food deficit and therefore have become vulnerable to food security. Nepal has been relying on unofficial imports from India to meet its food deficit so this indicates increase in paddy production for food security (DoA, 2020).

Kailali district covering an area of 3235 km2 among this 40.3% (1303.7 km2) hills and 59.7% (1931.3 km^2) terai. Total annual rainfall of this area was 1840mm. Maximum and minimum temperature of this area was 43°C and 5°C respectively (DADO, 2017). In addition to lowering drudgery, the adoption of agricultural tools, machinery, and other implements provides technology to support agriculture through the efficient use of inputs (Verma & Tripathi, 2015). Meeting the rising need for food to feed the nation's growing population is the largest problem facing the agriculture sector (Singh, 2015). Mechanization, along with other new technology, has induced an upward shift in production by increasing output and decreasing costs. Globally the paddy production is low, reason behind this is due to various factors such as inadequate irrigation facility, low soil fertility and nutrient, salt stress, ineffective weed control, lack of resistant and improve verities, lack of mechanization and inappropriate production technology (Fahad *et al*., 2019; Paudel *et al*., 2021). In addition to facilitating the efficient use of different inputs like seeds, fertilizer, plant protection agents, and water for irrigation, agricultural mechanization also reduces poverty by making farming a desirable business. To boost productivity and ultimately raise the amount of produce, even small-scale farmers use specific, upgraded agricultural equipment on a custom-hire basis. It is preferred to employ such enhanced farm tools and equipment in order to lower production costs as well (Verma & Tripathi, 2015).

Agricultural mechanization plays an increasingly important role in agricultural production. It reduces around 27% of production cost and increased profit per hectare by 36% (Uprety, 2010). Agricultural activities in Nepal are mostly carried out by traditional method but with swift automation and high-quality seed and input materials are not even employed by farmers in adequate quantity (Thapa et al., 2019). Farmers are affected by agricultural mechanization in a number of ways, including new seed, fertilizer technology, contemporary farming implements, cultural farming practices, and adjustments to operating schedules. But generally speaking, technological advancements also raise capital productivity and change the technological rates at which capital can be substituted for labor, lowering the quantity of capital required to replace a unit of labor at specific output levels. In order to achieve certain output levels, fewer workers relative to land are required thanks to other improvements (Verma & Tripathi, 2015).

Due to a number of factors, including resource poverty, farmers are not adopting rice technology at high rates, so enhancing efficiency is crucial to raising output (Hormozi, Asoodar & Abdeshahi, 2012). Ghana's 13.6 million hectares of arable land, 8 million hectares, or 59%, are now suitable for mechanization (AESD, 2012). Just 20% (1.6 million hectares) of these fields were mechanized nationwide as of 2007. In Nepal's lowlands, tractor adoption has increased equitably (Takeshima et al., 2020). Ghana has recently seen an increase in demand for agricultural mechanization (Diao, Cossar & Kolavalli, 2014). Availability to extension agents, who were positively correlated with adoption and availability to farm equipment, were the main factors influencing the adoption of farm mechanization. Access to experienced labor, replacement parts, farm machine maintenance, and timely machine availability are among the issues encountered. Therefore, in order to raise farmers' understanding of the advantages of automation, more effort should be put into expanding their access to extension agents. Additionally, farmers that have access to credit are more likely to embrace mechanization (Ayandiji & Olofinsao, 2012). In Kailai districts, mechanization is limited only in large farmers or commercial farmers. Small and medium farmers are greatly affected by lack of mechanization due to unaware about agricultural mechanization. No adequate research activities have been conducted grading awareness and importance of adoption of mechanization in rice growers. Thus, the main objective of the study is to assess the farmers perception, constrain faced by farmers while adopting farm machineries.

Farmers have limited resources for production and farming was subsistence. Most of them were under-privileged and disadvantaged in terms of their socio-economic status due to poor level of production and productivity. Kailali district, though being terai district of Far Western Province faces deprivation of several infrastructures of development, education level, Poverty, socialization etc. In Nepalese agriculture, animal power is the primary source of energy. 36.3 and 40.5 percent of the nation's total farm power is derived from human and animal power, respectively. Just 23% of the nation's mechanical power is available. The majority of Nepal's mechanical power is located in the Terai, where it accounts for 92.28% of the country's total available mechanical power (FBC, 2006). Because hilly regions lack physical infrastructure (such as roads and electricity) and cultivate on small terraces, hill agriculture mostly relies on human and animal power. The main instruments and tools utilized in agricultural operations include sickles, local hoes, and indigenous wooden ploughs. Just 2.7% of estates in the hills have their own iron animal-drawn plough for agriculture. Farmers have begun employing power tillers for tillage operations in the valleys close to the road heads, and this practice is growing as rural roads are extended. In the majority of terai and hill settlements, sheller, polisher, and mechanical grinding mills are used. However, native tools like mortar and pestle, quern, and traditional water mills are still used for milling in the mountains (Shrestha, 2013). As we know that as population goes on increasing, land holding diminishes and production of crops goes declines, so we must increase either cropping land or productivity. And it is impossible to increase land holding but we can increase productivity by implying various improved technologies. Among them mechanization is one of the options for increasing productivity.

Methodology

Site selection

Kailali district has the latitude between 28022'-29005'North and longitude between 80030'-81018' East with the altitude of109m to 1957m from MSL. The total area cultivated under Rice in Nepal was 14,73,474 ha and the production was 56,21,710 MT in the fiscal year 2077/78 with the productivity as 5.62 MT/ha (MoALD,2024). The study was conducted basically focusing on paddy cultivation in command area of Rani Jamara Kulariya Irrigation Project (RJKIP) which occupies Tikapur municipality, Lamki Chuha municipality and Janaki rural municipality of Kailali district, Nepal.

Data collection methods

Tikapur municipality, Lamki Chuha municipality and Janaki rural municipality were purposively selected. Sample size of 90 rice growers was determined using Raosoft tool at 90 percent level of confidence. Primary data were collected by household survey and field observation from different ward of above three municipalities using simple random sampling. Both primary and secondary sources of information were used. The necessary data and information were gathered using semi-structured questionnaires. To triangulate the information provided by respondents, a key informant survey (KII) was also conducted. A variety of publications from government and non-governmental organizations, including the Ministry of Agriculture Development (MoALD), Agriculture Knowledge Center (AKC), Central Bureau of Statistics (CBS), District Profile, National Population and Housing Census (NPHC), and others, were reviewed.

Data analysis techniques

With the help of Excel tools, descriptive analysis was done using mean, frequency, percentage, etc. However, inferential statistics was applied through multiple regression analysis to determine the factors affecting the adoption of farm mechanization. Similarly, the relationship between the dependent variable i.e. adoption index (adoption of agricultural mechanization) and selected socio-economic characteristic as independent variables was determined by multiple regression analysis.

$$Y= \alpha+\beta_1 X_1+ \beta_2 X_2+ \beta_3 X_3+ \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 +\beta_7 X_7 +e$$

Where,

Y= adoption of agricultural mechanization as dependent variable

X_1= age of farmer (years)

X_2= education (schooling years)

X_3= family size (number)

X_4= land holdings (ha)

X_5= income (in rupees)

X_6= labour (in rupees)

X_7= inputs (in rupees)

Adoption categories

The extent of adoption of mechanization was analyzed by adoption intensity index. The adoption score was assessed by the sum of scores for the adoption of various machineries in four different farm operations used in paddy production. The level of adoption was indicated by adopters and non-adopters by using value one and zero respectively.

Adoption index was calculated by using following formula (Dangol, 2004)

$$AI= \frac{TAF}{MSO} x100\%$$

Where, AI = adoption index

TAF = total adoption score gained by individual farmers

MSO = maximum score one can obtain

The respondents were categories as low, medium and high adopter on the basis of extent of adoption of machineries.

1. Low adopters (up to 33 percent)
2. Medium adopters (34-66 percent)
3. High adopters (67-100 percent)

A total five operations were taken to calculate the adoption index. The selection of these operations was identified as major operations performed using mechanization in the study area.

Table 1

Farm machinery/ implements used in paddy production

S.No.	Operations	Machineries/implements used
1.	Tillage	MB plough, Cultivator, Mini tiller, Power tiller Harrow, Rotavator, Leveler
2.	Sowing/ planting	Hand operated rice seeder, Paddy transplanter
3.	Intercultural operations	Weeder, Hoe, solar operated irrigation pump, Fuel operated pump
4.	Plant protection measure	Knapsack sprayer, power sprayer
5.	Harvesting	Reaper, Mini paddy cutter Combine harvester, Thresher

Results and Discussion

Socio- demographic status of the study area.

Age of the Respondents

Out of 90 respondents, the minimum age of the respondent was found to be 18 years while the maximum was 70 years. The average age of the respondents was found to be 43 years with the standard deviation of 12.589.

Table 2

Age of the respondents

	Minimum	Maximum	Mean	Std. Deviation
Age of the respondents(years)	18	70	42.51	12.589

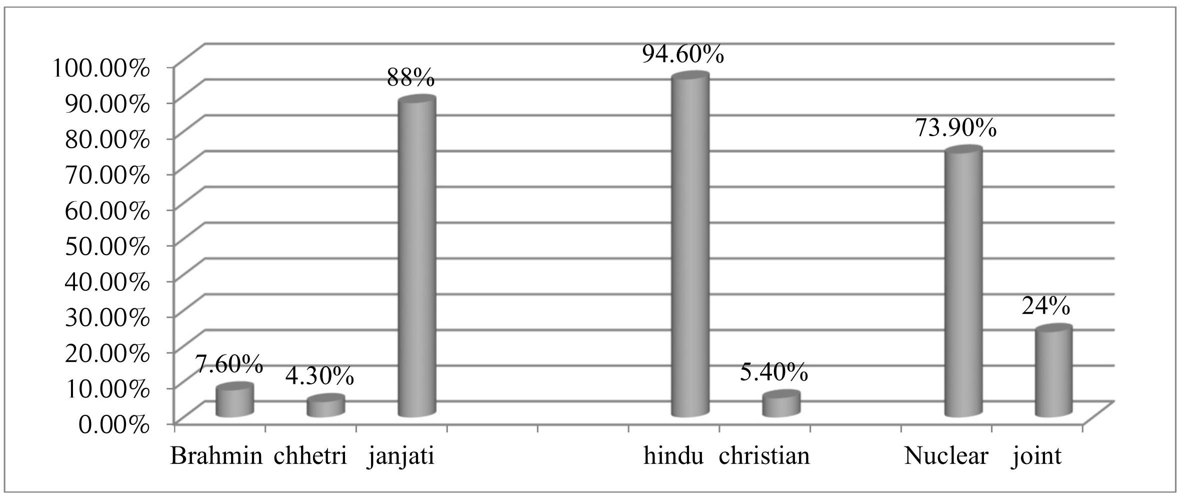
Gender of respondents

Among 90 respondents, only 27.9 (31%) were found to be female while remaining 62.1(69%) were male respondent. Female respondents were less as they are not the household head and they are involved to support agricultural activities with the male.

Caste, religion and family type of the respondent

Figure 1

Caste, religion and family type of the respondent

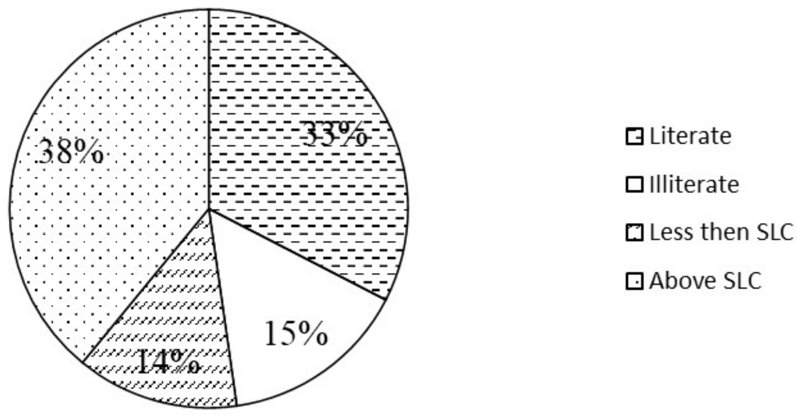


Among 90 respondents, only 9 (10%) were Brahmin, 14.85 (16.5)% were Chhetri and majority i.e. 59.85 (66.5%) were Janajati in the study site. Minority were Muslim, only 5.85 (6.5%) in the study area. In the study area, 72 (80%) were nuclear family and 18(20%) were joint family.

Education status of the respondents

The educational status of the respondents in the family was enumerated and categorized in four categories i.e. illiterate, literate, below SLC and Above SLC. The frequency distribution of the respondents by educational status was analyzed and presented in the Figure 2.

Figure 2
Educational status of the respondents

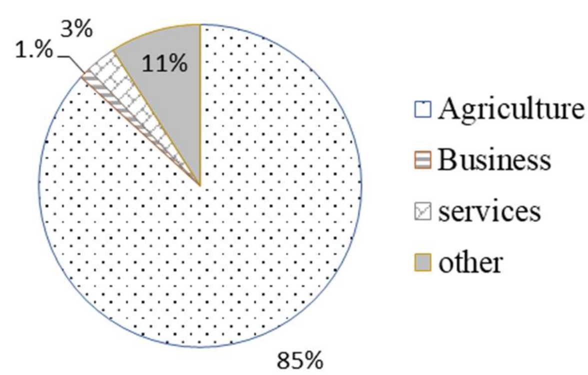


Among 90 respondents, only 13.5 (15%) were Illiterate, 12.6 (14%) were less than SLC, 29.7 (33%) were literate and rest of them were above SLC i.e. 34.2 (38%).

Main Occupation of the respondent

The occupation was categorized into Agriculture, Business, Service and other (wages) and shown in the figure.

Figure 3
Main occupation of the respondents



Land holding of respondent

The land holding of the respondents in the study area is given in the Table 3. The frequency of the land holding was analyzed and the mean, sum values and Std. Deviation were calculated. The total land was 98.37 hectare and the mean of total land was 1.069 hectare with the standard deviation of 0.91. Among that total land the total cultivable land was 98.20 hectare with the average of 1.067 hectare. Out of which 74.87 hectare was used for rice cultivation and the average of rice cultivation was 0.81hectare. From the above table the total production was 258.95ton and average of 2.81 ton was found. Also, for the above table the total productivity was also calculated which was 3.46 ton per hectare.

Table 3

Land holdings of the respondents

Particulars	Sum	Mean	Std. Deviation
Total land (ha)	98.37	1.069	0.91
Total cultivable land (ha)	98.20	1.067	0.97
Paddy cultivated land (ha)	74.87	0.81	0.76
Total production (tonne)	258.95	2.81	2.83

Adoption index of the respondents

Together with an overall adoption level, the table 4 displays the mechanization adoption index for the five main farm activities such as tillage, sowing/planting, intercultural operations, plant protection, and harvesting. The results show that different agricultural operations vary significantly in their levels of mechanization. With 92.2% of respondents falling into the high adoption category (67–100%) and just 7.8% indicating a medium level, tillage operations exhibit the highest level of automation adoption. This implies that tillage is the most automated phase of crop production, most likely as a result of power tillers and tractors being readily available. These findings are consistent with those of Singh et al. (2015) and Kumar et al. (2020), who found that because land preparation is labor-intensive and mechanical tillage instruments are very inexpensive, it is frequently the first agricultural task in South Asia to be mechanized.

On the other hand, mechanization in sowing and planting activities is primarily low (95.6%), with only 4.4% demonstrating medium usage. Small and dispersed landholdings, the continued use of traditional seed broadcasting techniques, and restricted access to seed drills or planters may all be contributing factors to this low level of mechanization. This observation supports the findings of Thapa and Pokharel (2019), who pointed out that smallholder farmers in Nepal.100% of respondents are classified as low adopters for intercultural activities (such weeding and soil management), showing a total reliance on manual labor. In plant protection operations, when mechanization has not been used, similar patterns are seen. These findings are consistent with those of Upadhyay et al. (2021), who found that there is little mechanization in the intermediate and crop-care stages due to the lack of such tools or their incompatibility with tiny plots and a variety of crop systems. Similarly, the usage of harvesters and threshers is modest in mountainous and smallholder-dominated regions, harvesting is still entirely unmechanized (100% low adoption)

(FAO, 2022). Due to expensive expenses and the fact that huge harvesters are not suitable for uneven terrain, farmers frequently rely on sickles and family labor. The general adoption trend for mechanization, just 5.6% of respondents had low adoption, while 94.4% have medium adoption (34–66%). This implies that the total mechanization index is moderate, with some stages like tillage being highly mechanized while others lag behind.

Table 4
Adoption index of mechanization during different operation

Operation	Category for level of doption	Frequency	Percentage
Tillage	Low (up to 33%)	0	0.0
	Medium (34-66%)	7	7.8
	High (67-100%)	83	92.2
Sowing/ planting	Low (up to 33 %)	86	95.6
	Medium (34-66%)	4	4.4
	High (67-100%)	0	0.0
Intercultural operation	Low (up to 33 %)	90	100.0
	Medium (34-66%)	0	0.0
	High (67-100%)	0	0.0
Plant protection	Low (up to 33 %)	0	0.0
	Medium (34-66%)	0	0.0
	High (67-100%)	90	100.0
Harvesting	Low (up to 33 %)	90	100.0
	Medium (34-66%)	0	0.0
	High (67-100%)	0	0.0
Overall	Low (up to 33 %)	5	5.6
	Medium (34-66%)	85	94.4
	High (67-100%)	0	0.0

Source: Field survey, 2024

Factors affecting adoption of mechanization among the respondents

A relatively strong model fitness was obtained, which showed that the chosen socioeconomic variables together account for almost 63% of the variation in the adoption index (R2 = 0.63). Farm size is one of the variables that has a positive and significant effect ($\beta = 0.792$, $t = 2.60$), indicating that farmers with bigger landholdings are more inclined to adopt improved agricultural methods because they have better access to resources and perceive less risk (Feder, Just, & Zilberman, 1985). According to Mwangi and Kariuki (2015), other factors like inputs and education level have positive but negligible effects, suggesting that farmers with more access to inputs and education are more likely to adopt new technologies. On the other hand, there are negative correlations between age, family size, and labor, suggesting that older farmers, larger families, and households with more workers are less likely to embrace innovations, perhaps as a result of their adherence to established methods and lack of receptivity to change (Kassie et al., 2015; Amsalu & De Graaff, 2007). Income indicates that without further institutional support, economic ability alone does not ensure adoption, despite having a positive but negligible coefficient (Doss, 2006). According to diffusion theory, which emphasizes that socioeconomic and resource-related factors significantly influence adoption behavior, the findings generally show that landholding size continues to be the primary determinant of technology adoption, with education and input accessibility playing facilitating roles (Rogers, 2003).

Table 5

Multiple regression analysis of adoption index with selected independent variables

Independent variable	Coefficient	t- value
Constant	3.210	8.015
Age of farmer	-0.006***	-0.89
Education status	0.028**	0.65
Family size	-0.005***	-0.30
Land holdings	0.792**	2.60
Income	0.001***	0.08
Labour cost	-0.276	-0.25
Inputs	0.058	0.75
R^2 = 0.63		

Note: ** means significant at 0.01 and *** means significant at 0.05 level

Problem regarding adoption of mechanization by rice growers

Farmers confronted several problems while adopting mechanization in paddy production. Those problems were ranked on priority basis. The weightage was given with calculating index value. Thus, highest index value gives rank 1st and then in subsequent order. Among the problems faced by farmers, higher cost of machinery was the major constrain faced by the majority of farmers (index value 0.79), as the farmer were low economic status. Similarly, lack of technical knowledge to operate farm machineries (0.75), followed by small size of land holdings which increases cost rather than profit (0.56). Similarly, lack of government subsidy (0.55) and limited use of machineries (0.43) were subsequently affected on the adoption level of farmers.

Table 6

Ranking of problem that arise while adoption of mechanization

Problem	Index value	Rank
Limited use of machineries	0.43	V
Lack of technical knowledge	0.75	II
Lack of subsidy	0.55	IV
Higher cost of machinery	0.79	I
Small farm holdings	0.56	III

Conclusion

Overall, the study demonstrates that agricultural mechanization has significant potential to enhance farm income through productivity gains and cost reduction; however, its adoption remains moderate and uneven across farm operations, being largely concentrated in tillage activities. The influence of education, landholding size, and farm income on adoption highlights the importance of human capital, financial capacity, and scale in facilitating mechanization, while the negative effects of age, family size, and labor cost suggest persistent structural and demographic barriers. The presence of severe constraints particularly high machinery costs, limited technical knowledge, small and fragmented holdings, inadequate subsidy support, and restricted access to machinery indicates that adoption is constrained more by institutional and economic limitations than by farmer willingness. These findings imply that policies promoting mechanization should move beyond general advocacy and focus on improving access through targeted subsidies, credit facilities, extension services, and shared-use models such as custom hiring centers, especially for smallholders. Addressing these constraints is essential for accelerating mechanization adoption and realizing its potential contribution to farm income growth and sustainable agricultural development.

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