

## **Benefits of Agricultural Mechanization in Rice Farming of Chitwan, Nepal**

**Om Prakash Singh<sup>1</sup>, Laxmi Devkota<sup>2</sup>**

<sup>1</sup>Department of Agricultural Extension and Rural Sociology

<sup>2</sup>Agriculture and Forestry University, Rampur, Chitwan, Nepal

**Corresponding Author:** *Om Prakash Singh*; Email: opsingh@afu.edu.np

### **Abstract**

A study was conducted in the Chitwan district to investigate the benefits of mechanization in rice farming. The study aimed to determine the rate of adoption of mechanization in rice farming in Chitwan, analyze farmers' preferences towards mechanization for rice farming, and identify constraints during the implementation of farm machinery. A sample of 150 rice-growing commercial farmers in Chitwan was selected using a simple random sampling method from five municipalities. Descriptive analysis was used to study different socio-economic, demographic, and physical factors related to mechanization in rice farming. Primary data were collected using a semi-structured questionnaire, while secondary data were obtained through a review of literature from various sources. The results showed that farmers prefer Mould Board Plough and Cultivator as primary tillage operations. Labor scarcity was the major reason for adopting mechanization in rice farming, and some farmers preferred mechanization due to the unavailability of traditional tools in the study area. The reduction of human drudgery by mechanization was found to be moderate as human labor was not entirely replaced by machines. A binary logit regression model was used to determine the benefits of mechanization among paddy cultivators. The study found that the benefits of mechanization included an increase in total annual income, income from rice farming, off-farm income, total area under rice cultivation, improvement in living standards, and a reduction in the cost of production. The major problems in the implementation of mechanization in rice farming were ranked, and low income was identified as the main problem, followed by low subsidy.

**Keywords:** mechanization, rice farming, tools, benefits, labour shortage

---

Copyright 2023 ©Author(s) This open access article is distributed under a Creative Commons



Attribution-NonCommercial 4.0 International (CC BY-NC 4.0) License.

## Introduction

Nepal is a small, landlocked country situated between India and China, with agriculture being the primary occupation for over 60% of the population (MoALD, 2020). However, Nepal faces severe food insecurity, with more than two-thirds of its districts experiencing food deficits each year (Joshi, 2012). To mitigate these issues and enhance farm productivity, profitability, and efficiency, farm mechanization has emerged as a critical solution (GC et al., 2019).

The history of farm mechanization in Nepal dates back to the 1970s with the introduction of two- and four-wheel tractors (Takeshima, 2017). Institutional development for formal sector farm mechanization began with the establishment of the Agricultural Implement Research Unit in Birgunj in 1960 (MoAD, 2014). Currently, agriculture in Nepal is undergoing modernization, with a coexistence of traditional farming practices and the infusion of large machinery (Houssou & Chapoto, 2014). However, complete mechanization, where animal or human labor is entirely replaced by power-operated machines, has yet to be realized (Verma, 2006).

Farm mechanization in Nepal faces significant challenges due to the diversity of its geography and the prevailing inequalities in ownership of property and other economic conditions (Rahman et al., 2019). The fragmentation of landholdings and the small average holding size of 0.98 hectares have also hindered the growth of four-wheel tractors in the country (Justice & Biggs, 2013). Moreover, the availability of mechanical power in Nepal is only 23%, with the majority of mechanical power concentrated in the Terai region, accounting for 92.28% of the total mechanical power available in Nepal (Shrestha, 2011).

The government of Nepal has taken steps to promote farm mechanization in the country, with the Agricultural Development Strategy (ADS) 2015-2035 emphasizing the need to adopt a mechanized approach to agriculture and increase the availability of agricultural machinery and equipment (MoALD, 2015). Additionally, various policies and programs have been introduced to provide subsidies and loans to farmers for purchasing agricultural machinery and equipment. However, the adoption of farm mechanization in Nepal remains slow due to various factors, such as the lack of infrastructure, access to finance, and technical knowledge among farmers.

Despite the challenges, the benefits of farm mechanization are apparent in Nepal. Studies have shown that farm mechanization leads to increased crop productivity, reduced labor requirements, and decreased production costs (GC et al., 2019). Mechanization also facilitates timely planting and harvesting of crops, thereby reducing post-harvest losses (Joshi, 2012). Additionally, mechanization can increase the farmer's income by enabling them to take on more farm activities, leading to higher overall farm profitability (Houssou & Chapoto, 2014).

In a nutshell, farm mechanization in Nepal has the potential to address food insecurity and enhance farm productivity, profitability, and efficiency. Despite the challenges, the government's efforts to promote farm mechanization are a positive step towards achieving these goals. To ensure the widespread adoption of farm mechanization in Nepal, more investment in infrastructure, access to finance, and technical knowledge among farmers is needed. With proper support, farm mechanization can contribute significantly to improving the livelihoods of farmers and promoting sustainable agricultural practices in Nepal.

The problem at hand is the need for agricultural mechanization in smallholder farming systems in Nepal, particularly in rice farming in the Chitwan district. Agricultural mechanization is one of the key processes that will affect the future of smallholder farming systems in Asian countries, including Nepal, where just 8 percent of farmers use tractors, 26 percent use iron plows, and more than 60 percent of intercultural operations are managed by women (Mano et al., 2020). Poor infrastructure is a major constraint on the mechanization of agriculture in Nepal. However, Kaur and Arshreen (2017) argue that providing easy credit and raising awareness of financial intermediaries can help mitigate these constraints and facilitate mechanization. Moreover, declining farm size with land fragmentation poses a significant challenge for agricultural mechanization in Nepal. Smaller landholding sizes reduce the self-sufficiency of farms and decrease farmers' interest in investing in mechanization in agriculture due to weak economies of scale (Gauchan & Shrestha, 2017).

The need for mechanization in agriculture is further underscored by labor shortages, outmigration of young people, and the need to increase production of staple crops to meet the demand of a growing population (Takeshima, 2017b). According to Olaoye JO (2010), the appropriate choice and proper use of mechanized inputs into agriculture have a direct and significant effect on land productivity, labor productivity, the profitability of farming, sustainability, environment-friendliness, and the quality of life of people engaged in agriculture.

Despite efforts by farmers and various organizations, mechanization in rice farming remains low, with mechanization only present in a few activities such as plowing and threshing. While the government, private sector, and I/NGOs are encouraging farm mechanization, the direct impact of mechanization on farmers in rice farming remains unknown. Furthermore, although some level of mechanization has been implemented in rice farming in the Chitwan district, the benefits of mechanization have not been fully observed, and there is a weak research and development system on agricultural mechanization and its benefits in rice farming.

The research questions for this study are as follows: What are the benefits of mechanization in rice farming in the Chitwan district? What is the rate of adoption of mechanization in rice farming? What are the major problems faced by farmers in implementing mechanization for rice farming? By addressing these questions, this study aims to explore the potential for providing easy credit and raising awareness of financial intermediaries to facilitate mechanization and reduce the human drudgery faced by farmers in rice farming within the Chitwan district. Moreover, the study seeks to identify existing mechanization systems, people's preferences in mechanization, and problems encountered by farmers during mechanization in rice farming within the Chitwan district.

This study aims to explore the benefits of agricultural mechanization in rice farming in the inner Terai region of Nepal, where agriculture is the primary occupation. The lack of previous research in this area prompted the study, as the findings could be useful for researchers, policymakers, and administrators to improve agriculture mechanization activities and improve the livelihoods of farmers. The study focuses on the productivity of rice, annual income of farmers, off-farm income, cropping intensity, and reduction of human drudgery. Gauchan and Shrestha (2017) note that agricultural mechanization is often misunderstood as tractorization, and this study aims to encompass semi-automated manual and animal-drawn equipment.

The current study endeavors to investigate the relationship between mechanization and various indicators such as production, productivity, annual income, working efficiency, and the living standard of farmers in the context of rice farming. Despite the apparent advantages of mechanization, there is a dearth of literature regarding this issue in our country. Thus, this study aims to address this research gap by providing empirical evidence on the scope and benefits of mechanization in rice farming.

The practical implications of the study's outcomes are substantial for farmers, researchers, and policymakers alike. The study's findings can be used to facilitate the adoption of mechanization among farmers, advance researchers' knowledge on the subject matter, and inform policymakers to develop or refine existing policies for the effective implementation of mechanization in rice farming.

Therefore, this study's findings are expected to contribute significantly to enhancing the overall knowledge on the scope and benefits of mechanization in rice farming in our country, thereby fostering the growth and development of the agriculture sector.

This study is subject to several limitations that could affect the external validity and reliability of its findings. The first limitation pertains to the sample size, which may

not be representative of the wider population. Moreover, the study's findings may not necessarily apply to other regions of the country with distinct psychological, cultural, and socioeconomic characteristics.

Another limitation concerns the study's geographical scope, which was confined due to budgetary and time constraints. The sample was drawn from five municipalities, one metropolitan city, and one rural municipality, which could introduce bias into the results. Additionally, the data collected may be subject to response errors, as the farmers' ability to recall information from their memory may vary.

Overall, while the present study provides valuable insights into the benefits and scope of mechanization in rice farming, it is essential to take into account its limitations while interpreting the results. Future research endeavors could address these limitations by employing larger and more diverse samples, covering broader geographic regions, and utilizing more robust data collection methods.

The general objective of this study is to determine the benefits of mechanization in rice farming in Chitwan district. The specific objectives of the research are:

1. To determine rate of adoption of mechanization in rice farming.
2. To find out preference of farmer towards mechanization in rice farming.
3. To analyze the reduction of human drudgery by mechanization in rice farming.
4. To identify the problems during mechanization in rice farming in Chitwan district.

## **Materials and Method**

The reason for selecting Chitwan district for the study because this district has implemented some degree of mechanization in rice farming; however, the benefits of mechanization in this area have not been extensively studied. Furthermore, the research and development system for agriculture mechanization and its benefits in rice farming are weak in Chitwan. This study was initiated to investigate the rate of adoption of machinery, existing mechanization systems, people's preferences in mechanization, the reduction of human drudgery, and the problems encountered during mechanization in rice farming within the Chitwan district. The findings from this study will contribute to filling the knowledge gap on the benefits of mechanization in rice farming in Chitwan and serve as a basis for policy formulation and decision-making by stakeholders.

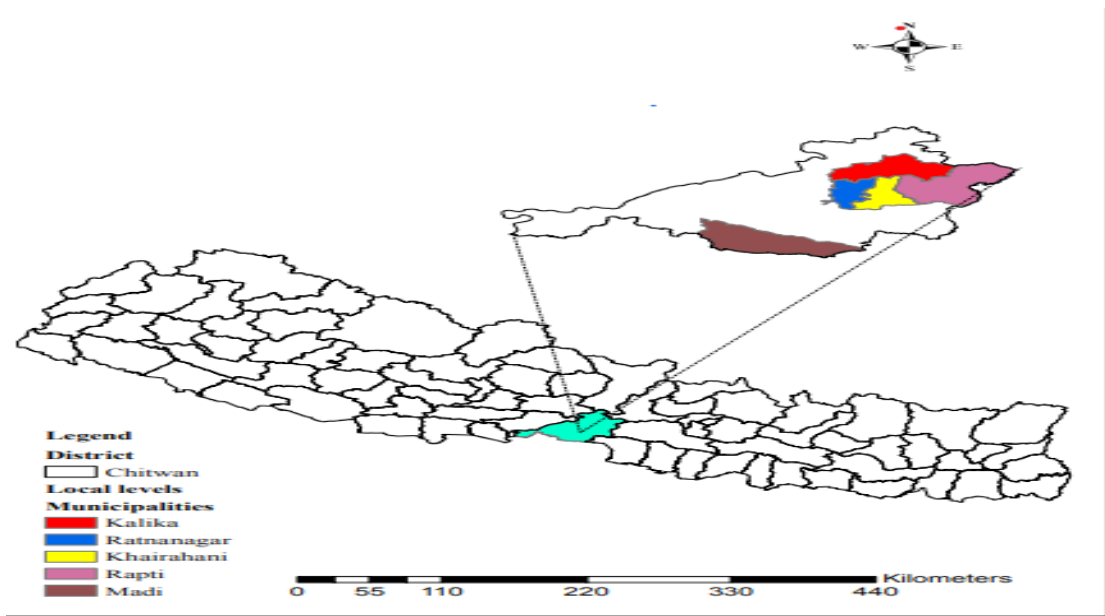
### **Description of Study Area and Study Site**

Chitwan district of Bagmati province was purposively selected for the study. Chitwan, the inner Terai district of Nepal, popularly known as Rapti valley or Chitwan Doon valleys lies between Mahabharat and Siwalik and valley covers an

area of approximately 2238.39 sq. km. and it lies about 139 km southwest of capital Kathmandu. The elevation varies from 144 to 1947 mean sea level. Chitwan valley has a subtropical and tropical climate with hot and moist summer and cool and dry winters. Rice is the major crop grown in the Chitwan district with productivity equal to national level (MoALD, NPC CBS, 2019). There are five municipalities; Ratnanagar, Khairani, Rapti ,Kalika and Madi and one rural municipalities Ichhakaman and one Bharatpur metropolitan municipalities were biased for making the sample homogeneous. The geography and climate of Chitwan district highly favour rice farming.

**Figure 1**

*Map of Chitwan District Showing Five Municipalities*



This study was conducted in 2021 in Chitwan district (inner terai) of Nepal. In this study, 150 farmers from five municipalities were selected randomly from commercial farmers of Chitwan. Ratnanagar, Khairani, Rapti, Kalika and Madi were the five municipality where study conducted where as one rural municipalities Ichhakaman and one Bharatpur metropolitan municipalities were left for making the sample homogeneous. The information collected was analyzed by using Statistical Packages for Social Science version 16.0 and Microsoft office excel 2013.

**Methods of Data Analysis**

***Rate of Adoption of Machinerics and Famer’s Classification***

The rate of adoption of machinerics was based on the number of machinerics adopted

for rice farming to the total number machinery available for the farming purpose. Total twelve machinery were recommended they were Mould Board plough, Cultivator, Disc plough, Rotavator, Harrow, Leveler, Puddler, Knapsack sprayer, Pumpset, Paddy reaper, Paddy thresher, thinkand combined harvester. High implementers and low implementers are categorized as per rate of adoption of the machinery which was 50.27%. The respondent whose adoption rate was more than 50% were categorized into high implementers and those whose rate of adoption was less than 50 % were categorized into low implementers and low implementers were consider as non-adopters.

$$\text{Rate of adoption (\%)} = \frac{\text{No of adopted farm machinery in last two year}}{\text{Total no of recommended farm machinery in rice farming}} * 100$$

### ***Farmers' Preference towards Mechanization***

A five point and seven-point scaling technique were used to rank the farmer's preference towards mechanization tool and problems faced by farmers for rice production during implementation of mechanization. An index value was calculated using the following formula and final rank was obtained.

$$I_{\text{prob}} = \frac{\sum S_i F_i}{N}$$

Where,

$I_{\text{prob}}$  = Index value for intensity (0<I<1)

$\sum$ =Summation

$S_i$  = Scale value of  $i^{\text{th}}$  intensity

$F_i$ =Frequency of  $i^{\text{th}}$  response

$N$ =Total number of respondents

A binary logit model of regression was carried out to find out the impact of mechanization in rice farming in the study area. The logit model was based on following econometric expression;

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_{10} X_{10i} + e_i$$

$Y_i$  is a dependent binary variable i.e. Implementation of farm machineries measured as dummy (1=high implementers, 0=low implementers)

$\beta_0$ =constant term



$\beta_1, \dots, \beta_{11}$  = regression coefficient to be estimated  
 $X_{1i}, \dots, X_{12i}$  = explanatory variables explained as below  
 $X_{1i}$  = Total land of farmers (continuous)  
 $X_{2i}$  = Total land under rice farming (continuous)  
 $X_{3i}$  = Annual production (continuous)  
 $X_{4i}$  = Total household annual income from rice farming (continuous)  
 $X_{5i}$  = Total annual income (continuous)  
 $X_{6i}$  = Total land under rice farming (continuous)  
 $X_{7i}$  = Years of farming experience (continuous)  
 $X_{8i}$  = Credit taken (1=Yes, 0=No)  
 $X_{9i}$  = Years of schooling (continuous)  
 $X_{10i}$  = Involvement in cooperatives (1=Yes, 0=No)  
 $X_{11i}$  = Gender of the Gender of the household head (1=male, 0= female)  
 $e_i$  = Error term

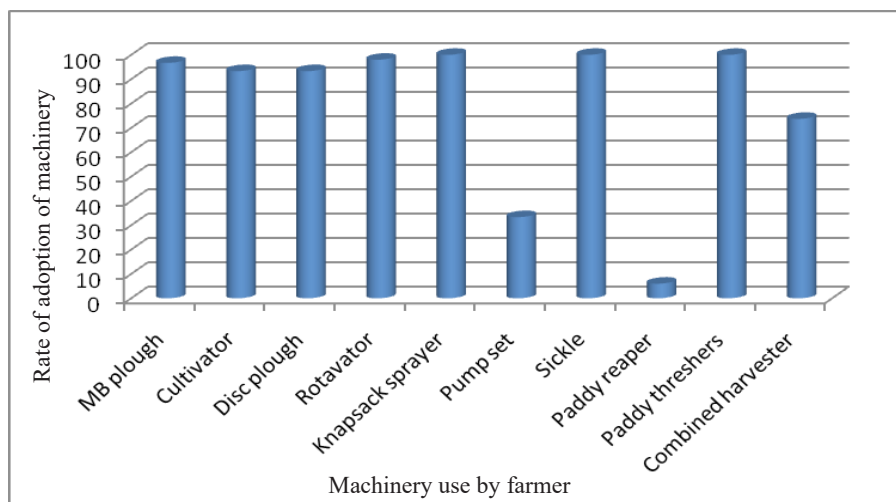
## Results and Discussion

### Status of Machineries Used by Farmers in the Study Area

In this study, majority of the farmers (96.7 %) were found adopting Mould Board plough and 93.33 % were using Disc Plough and Cultivator (Figure 2) for primary tillage and for secondary tillage rotavator was used by 98% farmers. Knapsack sprayer Pump set was also used in good proportion the study area. Sickle was used by 100 % farmers for harvesting and for threshing 100% farmers used paddy thresher while combined harvester was used by 73.7 % farmers.

**Figure 2**

*Adoption of Different Farm Machineries by Farmers in Chitwan District (in 2021)*





## Framers' Preference towards Mechanization

Among 150 respondents, maximum prefer mechanization due to labour shortage in Chitwan district (Table1). More profit by mechanization was ranked as second, easy availability was ranked third position, easy cultivation by machinery ranked fourth among the respondent and unavailability of traditional tool for cultivation was ranked fifth position.

**Table 1**

*Farmer's Preference towards Mechanization Tools in Chitwan District (in 2021)*

Preference	Score					Index value	Rank
	1	0.8	0.6	0.4	0.2		
Labor shortage	29	74	18	22	7	0.24	1
More profit in comparison to traditional method	42	39	47	13	9	0.23	2
Easy availability of machinery	20	20	51	46	13	0.19	4
Easy cultivation practice by machinery use	54	11	25	46	14	0.22	3
Unavailability of old tool for cultivation	5	8	10	22	105	0.11	5

## Benefit of Mechanization in Human Labour

The study observed a significant reduction in human labor usage in the study area due to the implementation of mechanization in rice farming. The use of machinery for land ploughing, puddling, and threshing operations was reported by all respondents. However, manual bunting and sowing activities were still being carried out by all farmers. Mechanical weeding was preferred more, along with pre-emergence herbicide use in the rice field. Only 9% of farmers used paddy reaper for harvesting, while the remaining 94% performed harvesting manually. Overall, the study highlights the positive impact of mechanization on reducing human labor requirements in rice farming operations.

**Table 2**

*Human Labour Displaced by Mechanization in the Chitwan District (in 2021)*

Field operations	Use of machineries	Manual adoption
------------------	--------------------	-----------------

Ploughing	150 (100)	0
Bunting	0	150 (100)
Puddling	150 (100)	0
Sowing	0	150 (100)
Pre emergence use of herbicide + manual weeding	0	120 (80)
Only manual weeding	0	30 (20)
Harvesting	9 (6)	141 (94)
Threshing	150 (100)	0

### **Benefit of Mechanization in Area, Production, Income from Rice Farming**

A binary logit regression was used to analyze the relationship between the selected variables and impact of mechanization. The dependent variable was the level of mechanization which is a dichotomous variable consisting of high implementers and low implementers. Farmers whose adoption ratio of mechanization was more than 50% are categorized as high implementers and rest of the farmers are low implementers.

**Table 3**

*Benefits of Mechanization in Different Activities in Chitwan District (in 2021)*

Variables	B	S.E.	Wald	Sig.	Exp(B)
Total Land in kattha	.146	.123	1.415	.234	1.157
Total area under rice in kattha**	.361	.166	4.749	.029	1.435
Annual production rice (Metric ton)**	3.393	1.712	3.928	.047	2.002
Income from rice**	.000	.000	5.963	.015	1.004
Annual income**	.000	.000	6.012	.014	1.005
Time periods of farming years	.094	.062	2.321	.128	1.099
Credit taken	2.080	1.340	2.409	.121	8.008
Years of schooling*	1.408	.806	3.048	.081	1.088
Involvement in co-operatives	1.618	1.608	1.012	.314	.198

Gender	1.337	1.267	1.115	.291	3.809
Source of information	.150	.664	.051	.821	1.162

\*\*\*indicates significance at 1% level of significance

\*\*indicates significance at 5% level of significances

\*Indicates significance at 10% level of significance

### Explanations of Variables Used in the Table

B= Logistic regression coefficient for constant,

S.E= Standard error

Wald = Wald chi-square test

Sig = Significant level

Exp (B) = odd ratio

The result shows that by keeping other factors constant, with an increase in one year of schooling, the high implementers prefer the mechanization 1.08 times more than low implementers. High implementers adopt mechanization by 1.435 times more than low implementers in large rice farming area. High implementer has 2.002 times high production of rice than the low implementers. The average income from rice of high implementers was higher than low implementers. The annual incomes from rice farming of high and low implementers were Nepalese Rupees 2,49,213 and 1,29,186 respectively. There was rise in income from rice farming of high implementer's by 1.004 times than low implementers. The average annual income of high implementers is higher than low implementers. The average annual incomes of high and low implementers are about Nepalese Rupees 5,83,835 and Nepalese Rupees 2,46,815 respectively. A raise in a unit of a total annual income, there is a chance of being a high implementer by 1.005 times. An increase in one year of schooling, the high implementers prefer the mechanization 1.08 times more than low implementers. Farmers with high level of education tends to be more and good implementers of the heavy machineries in the rice farming (Ayodele et al., 2012).

### Table 4

*Activities Having Impact by Mechanization in Rice Farming in Chitwan (in 2021)*

Activities	High implementers	Low implementers
Years of School	5.75	4.33
Total land holdings	24.413	13.6

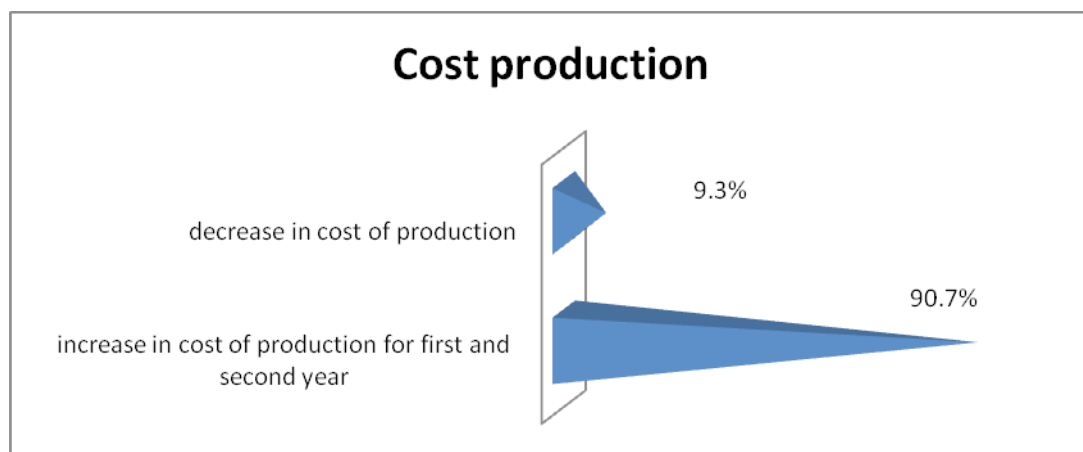
Area for rice farming	22.08	11.03
Production of rice farming (metric ton)	5.19	3.02
Income from rice farming (Nepalese Rupees)	249213.333	129186.667
Annual income (Nepalese Rupees)	5,83,835.616	2,46,815.789

### Benefit of Farm Mechanization on Cost of Production in Rice Farming

In this study, majority of the farmers including both high and low implementers (90.7 %) had experienced increase in cost of production for first and second year and decrease in cost of production thereafter, after the adoption of agriculture machines in different agriculture operations (Figure 3). This finding is in agreement with the study of Uprety (2010), where it was found that farmers who have introduced mechanization into their rice farming can reduce production costs by 27% and increase their profits per hectare by 36%.

**Figure 3**

*Farmer's Perception and Cost of Production in Chitwan (in 2021)*



### Benefit of Mechanization in Cropping Rotation Intensity

Crop rotation intensity is high among the high implementer than among the low implementers. Low implementers keep land fallow for one season while high implementer does not keep fallow land. High implementers produce both Aus and Spring rice but only spring season rice is produced by low implementers.

**Table 5***Crop Rotation Intensity of Farmers in Chitwan (in 2021)*

Crop rotation	Average
High implementers	301.33
Low implementers	261.33

**Benefit of Mechanization in Cropping Intensity**

In the study high implementers have 121.57% cropping intensity and low implementers have 93.05 % cropping intensity. More crop products are obtained by high implementers than the low implementers. Tractor-owning farms had a higher cropping intensity as compared to the case of those without a tractor (NCAER, 1974).

**Table 6***Cropping Intensity and Level of Mechanization in Chitwan (in 2021)*

Crop intensity	Average
High implementers	121.57
Low implementers	93.05

**Benefit of Mechanization on-off Farm Income**

Off-farm income of the high implementers was more by 19.72% than the low implementers. High implementers were able to earn more income for the household by many other supplementary activities. Tractorised farms reduced their draught animal stock and increased their milch stock and the tractor owners and users derived higher per hectare gross income compared to bullock farms (NCAER, 1980).

**Table 7***Off-farm Income and Level of Mechanization in Chitwan (in 2021)*

Income in Neplease Rupees	Mean
High implementers	401853.33
Low implementers	335653.30

**Problems in Mechanization Implementation in Rice**

There are many problems faced by the farmers in the implementation of mechanization in rice farming.

**Table 8***Problems in Implementation of Machinery in Chitwan (in 2021)*

Problems	Score							Index	Rank
	1	0.85	0.71	0.57	0.42	0.28	0.14		
Lack of subsidy	38	83	18	7	4	0	0	0.21	II
Low income	92	43	13	2	0	0	0	0.23	I
Illiteracy	15	21	85	26	2	0	1	0.14	III
Lack of information about machinery	4	1	29	92	20	4	0	0.11	IV
Difficult in handling machine	0	1	4	18	113	13	1	0.09	V
Un-access to hiring center	1	1	0	4	11	118	15	0.07	VI
Unsafe in handling machine	0	0	0	1	1	15	133	0.04	VII

Major problems related in implementation of mechanization were ranked. Ranking of the problems was done by using the comparative rating scale. The use of seven-point scale was done based on the response of the farmers during the interview schedule. Low income was ranked as a major problem in the adoption of mechanization in the Chitwan district. Lack of subsidy was ranked as a second major problem. Illiteracy, lack of awareness about machinery, difficulty in handling machinery's-access to hiring center and unsafe in handling machine were ranked as third, fourth, fifth, sixth, and seventh, respectively.

### Conclusion

The use of machines in rice farming has positive impacts on working efficiency, productivity, and household income. Mould Board Plough and rotavators are commonly used for primary and secondary tillage, respectively. Paddy threshers are used for threshing, displacing the need for human labour. Mechanization is preferred by farmers due to labor shortages during peak farming periods. Lack of income and government subsidies hinder the implementation of mechanization. Strong government support is needed for the purchase and distribution of machines to farmers.

### References

- Ayodele, O., Pt, O., Aa, A., Oo, A., & Gf, K. (2012). Economic Impact of Agricultural Mechanization Adoption: Evidence from Maize Farmers in Ondo State, Nigeria. *Journal of Agriculture and Biodiversity Research*, 1(2), 25–32. <http://www.onlineresearchjournals.org/JABR>
- Gauchan, D., & Shrestha, S. (2017). *Agricultural and rural mechanisation in Nepal: Status, issues and options for future*.

- GC, A., & Ghimire, K. (2018). A SWOT analysis of Nepalese agricultural policy. *International Journal of Agriculture, Environment and Food Science*, 2(4), 119-123.
- GC, A., Yeo, J.-H., & Ghimire, K. (2019). Determinants of Farm Mechanization in Nepal. *Turkish Journal of Agriculture - Food Science and Technology*, 7(1), 87-91.
- Hiroyuki, K., & Takeshima, H. (2017). *Overview of the evolution of agricultural mechanization in Nepal. A focus on tractors and combined harvesters*. IFPRI Discussion Paper.
- Houssou, N., & Chapoto, A. (2014). *The changing landscape of agriculture in Ghana: Drivers of farm mechanization and its impacts on cropland expansion and intensification*. December, 52. <http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/128706/filename/128917.pdf>
- Joshi, K. C. (2012). *Agriculture, seed, and innovation in Nepal: Industry and policy issues for the future*. Project Paper. International Food Policy Research Institute.
- Justice, S., & Biggs, S. (2013). Rural and agricultural mechanization in Bangladesh and Nepal: Status, processes and outcomes. In J. E. J. Kienzle (Ed.), *Mechanization for rural development - A review of patterns and progress from around the world* (pp. 336). Food and Agriculture Organization of the United Nations.
- Kaur, & Arshreen. (2017). *Agriculture mechanization in Nepal*. International Food Policy Research Institute.
- Mano, Y., Takahashi, K., & Otsuka, K. (2020). Mechanization in land preparation and agricultural intensification: The case of rice farming in the Cote d'Ivoire. *Agricultural Economics (United Kingdom)*, 51(6), 899–908. <https://doi.org/10.1111/agec.12599>
- MoAD. (2014). *Agriculture Mechanisation Promotion Policy*. Ministry of Agricultural Development, Government of Nepal.
- MoALD. (2015). *Ministry of Agriculture and Livestock Development: Annual Report*. Government of Nepal.
- MoALD. (2020). *Statistical Information on Nepalese Agriculture 2018/2019*. Agri Statistics Section, Monitoring, Evaluation and Statistics Division. Ministry of Agricultural Development. Singha Durbar, Kathmandu, Nepal.
- NCAER. (1974). *Demand for tractors*. Report by National Council of Applied Economics Research.
- NCAER. (1980). *Implication of tractorisation for farm employment, productivity and income*. National council of Applied Economic Research.



- Olaoye JO, R. A. (2010). Measurement of agricultural mechanization index and analysis of agricultural productivity of farm settlements in Southwest Nigeria. *Agric. Eng. Int. J.*, (pp. 125–134).
- Rahman, M. S., Miah, M. A. M., Hossain, S., & others (2019). *JAPS, Journal of Animal and Plant Sciences* No Title. Pakistan Agricultural Scientists Forum.
- Shrestha, S. (2011). *Status of agricultural mechanization in Nepal*. In United Nations Asian and Pacific Center for Agricultural Engineering and Machinery (UNAPCAEM) (Ed.), 4, 1-4. <http://www.unapcaem.org/Activities%20Files/A1112Rt/np.pdf>
- Takeshima, H. (2017b). *Overview of the evolution of agricultural mechanization in Nepal*. Washington, DC: IFPRI Discussion Paper 01662, Development Strategy and Governance Division International Food Policy Research Institute.
- 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 8-12 November 2010 in Hanoi Vietnam, 1–5. <http://www.ricecongress.com/previous/pdflink/3932.pdf>
- Verma, S. R. (2006). *Impact of Agricultural Mechanization on Production, Productivity, Cropping Intensity Income Generation and Employment of Labour*. (Doctoral dissertation). College of Agril. Engg., Punjab Agricultural University.