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ORIGINAL RESEARCH ARTICLE

Factors affecting the adoption of farm mechanization in Rupandehi, Nepal

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ABSTRACT

Agricultural mechanization is pivotal in farmer's fields as it functions more efficiently and helps increase farm productivity. Despite the massive involvement of people in agriculture, farm productivity is relatively low. One main reason for this is the staggered implementation of farm mechanization. This paper aims to explore the factors affecting the adoption of farm mechanization using the Chi-square test and identify the major problems using relative frequency values. A total of 112 respondents, 28 each from 4 municipalities of Rupandehi district were interviewed based on stratified random sampling technique. The results showed that the adoption rates of various farm machinery were notably high, with tractors, cultivators, mills, and sprayers being universally employed by 93.75 % of the surveyed individuals. The government subsidies to only 7% of farmers facilitate machinery procurement. The size of the total cultivated land was found to be significant over the use of harvester, grass cutter, and power tiller, and owing of milling machine. The availability of subsidies and owning of mills were found inter dependent. The annual expenditures of farmers and their access to the Custom Hiring Centre were found to be significant. Lastly, with index values of 0.402 and 0.393, the high costs of farm machinery and small land holdings were major problems in the adoption of farm mechanization. Therefore, addressing the high initial costs of modern farm equipment, providing targeted subsidies, innovative institution formation to provide better services to marginalized farmers, and expanding extension services are essential steps to promote the adoption of farm mechanization.

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INTRODUCTION

In an agrarian country like Nepal, agriculture is the mainstay of the national economy, contributing 23.95 % of GDP(NRB, 2021/22). Farm mechanization plays a significant role in augmenting the scale of farm operations, decreasing production costs, alleviating manual labor, reducing operational time, enhancing crop productivity, and contributing to farmer's income. Farm mechanization has the potential to enhance crop productivity, and improve food security, and rural livelihoods in the developing world, where small farms, low crop productivity, high food insecurity, and poverty are common (Paudel *et al.*, 2019). Farm mechanization is the development and introduction of machines for assistance at any level of sophistication in agricultural production to improve the efficiency of labor and farm production (Behrendt & Paparas, 2020) and the quality of livelihood involved (Rasouli *et al.*, 2009). Where potential yield gains are substantial, their influence on smallholder growth can also be substantial if, in the process, mechanization is introduced (Takeshima & Liu, 2020). The availability of agricultural machinery can lead to a decline in operating costs (Peng *et al.*, 2022). With increasing population and decreasing agriculture land, the best way to meet soaring demand is by increasing productivity of land by increasing resource and input use efficiency through technology adoption and mechanization. It will increase the marginal productivity of labor sustainably and have a higher

return per unit of land and labor (Ghosh, 2010a, b). However, the surge in meeting chemical demand and intense mechanization can lead to serious soil health issues and pollution (Chi *et al.*, 2021). Thus a balanced farm mechanization adoption becomes crucial in farm productivity and ecological welfare. However, human power and animal power still occupy 36.3 and 40.5 percent of the total farm power available in the country, respectively. The available mechanical power in the country is only 23 percent and is concentrated in Terai, which is 92.28% of the total available mechanical power in Nepal (Shrestha, 2012). To signify the relevancy of farm mechanization, the Nepalese government-formulated Agricultural Mechanization Promotion Policy 2014 aims, in part, to reduce food production costs by improving mechanization efficiency. Although the Terai is relatively homogeneous within Nepal's diverse production environments, significant heterogeneity exists among farm households across regions. It is important to assess how mechanization policies can be tailored to specific types of farmers (Takeshima *et al.*, 2015). Agricultural Development Strategy (ADS) -2015 has created a set out a distinct pathway for fostering agricultural mechanization in Nepal. With three tiers of government, Prime Minister Agricultural Modernization Project (PMAMP) and Centre for Agricultural Infrastructure Development and Mechanization Promotion (CAIDMP), Agricultural Mechanization Promotion Center (AMPC), CGIAR (The Consortium of International Agricultural Research Centers) centers like International Maize and Wheat Improvement Centre (CIMMYT) and International Rice Research Institute (IRRI) played important roles in the agricultural development of Nepal by strengthening the national research and extension system (Shrestha, 2022). It becomes critical to analyze the factors affecting the adoption of farm machinery to enhance farm productivity, reduce labor shortage, and increase farm efficiency. This paper aims to explore the factors affecting the adoption of farm mechanization using the Chi-square test and identify the major problems using relative frequency values. Thus, transforming traditional farming methods, improve livelihood, identify barriers to the adoption of farm mechanization in the Rupandehi district of Nepal.

MATERIALS AND METHODS

The district under study was Rupandehi district of Nepal. Geographically, a part of Lumbini province with six rural and ten urban municipalities. A total of 112 households were surveyed through a stratified random sampling technique. The survey was conducted in 4 municipalities with 28 samples from each. Namely Sainamaina, Siyari, Tillottoma, and Omsatiya municipalities. For the study, both primary and secondary data were taken. Information was obtained through a questionnaire, then noted and arranged systematically, codes were designed and units were standardized before entering the data into MS -EXCEL. An indexing technique was adopted to find out the intensity of problems in the adoption of farm machinery. SPSS was used to determine if a change in one variable is associated with changes in another variable and thereby study test of independence (Namuth-Covert *et al.*, 2012) ; Chi-square test was carried out.

RESULTS AND DISCUSSION

Status of farm machinery adoption

The decision-making process regarding the adoption of farm machinery, including the selection of specific machines and the determination of appropriate usage conditions, exhibited a significant gender disparity. Notably, 88 % of these decisions were led by male individuals, while female counterparts played a role in only 12% of cases. A mere 3.90% of household heads possessed post-graduate degrees, whereas a substantial majority (71.85%) had not completed primary-level education. Among the surveyed respondents 60 % had less than 5 years of experience incorporating farm machinery into their cultivation practices. A noteworthy finding revealed that 45% of the respondents relied solely on agriculture as their primary source of income, underscoring the pivotal role of agriculture in sustaining livelihoods within the study population. The adoption rates of various farm machinery were notably high, with tractors, cultivators, mills, and sprayers being universally employed by 93.75 % of the surveyed individuals. Additionally, water pumps were widely utilized, with a substantial 89.28 % of respondents. Threshers also played a significant role, finding application in the farming practices of 84.82 % of those surveyed. Rotavators had a commendable adoption rate of 75.89 %, followed by harvesters at 58.03 %. Grass cutters were employed by 31.25 % of respondents, while power tillers were found in use for 16.96 %. In stark contrast, corn shellers exhibited the lowest adoption rate, with a mere 3.57 % of farmers utilizing this machinery within the study area. Regarding the government subsidies on farm machinery acquisition, it was observed that subsidies to only 7% of farmers facilitate machinery procurement.

Factors affecting adoption of farm mechanization

Among various sets of farm machinery used in the farm, in our study, we found that total cultivated land had a 1 % level of significance over the use of harvester and grass cutter and a 5 % level of significance over the use of power tiller. The larger the land of farmers of any level, the chances of farmers adopting and using different machinery seemed more likely. Similarly, total cultivated land had a 1 % level of significance over owning a mill. The larger the land of farmers of any level, the chances of farmers owning Milling machines seem to prosper. Also, type of farming had a 1 % level of significance over the use of grass cutters and a had 5 % level of significance over the use of harvesters. This may also be related to larger size holding having a significant over using and owning of different farm machinery as commercial farmers have more land access and thereby are more likely to use farm machinery than subsistence farmers.

Further, the annual expenditure of farmers had a 10 % level of significance over access to custom hiring centers. Later in the study, we found that 41 % of respondents stated that one major problem in the adoption of mechanization was the high cost.

Table 1. Relation between total cultivated land and use of farm machinery.

Machinery	Total cultivated land (Kattha)	Use		Chi-square
		No	Yes	
Harvester	<5	22(71.0)	9(29.0)	33.555***
	5-10	8(23.5)	26(76.5)	
	10-15	6(35.3)	11(64.7)	
	>15	1(3.3)	29(96.7)	
Power tiller	<5	26 (83.9)	5(16.1)	9.398**
	5-10	30(88.2)	4(11.8)	
	10-15	16(94.1)	1(5.9)	
	>15	19(63.3)	11(36.7)	
Grass cutter	<5	30(96.8)	1(3.2)	29.791***
	5-10	22(64.7)	12(35.3)	
	10-15	9(52.9)	8(47.1)	
	>15	9(30.0)	21(70.0)	
Reaper	<5	31(96.8)	1 (3.2)	10.156
	5-10	23 (67.6)	11(32.4)	
	10-15	14(82.4)	3(17.6)	
	>15	26(86.7)	4(13.3)	
Rotavator	<5	6(19.4)	25(80.6)	0.256
	5-10	5(14.7)	29(85.3)	
	10-15	3(17.6)	14(82.4)	
	>15	5(16.7)	25(83.3)	

Note: *, **, *** denotes data are significant at 10%, 5% and 1% level of significance and figures in parenthesis indicates %.

Table 2. Relation between Total cultivated land and owning farm machinery.

Total cultivated land (Kattha)	Own farm machinery		Chi-square
	Yes	No	
<5	30 (96.80)	1 (3.2)	
>5	27 (79.4)	7 (20.6)	26.140***
>10	10 (58.8)	7 (41.2)	
>15	12 (40)	18 (60)	

Note: *, **, *** denotes data are significant at 10%, 5% and 1% level of significance, and figure in parenthesis indicates %.

Table 3. Relation between type of farming and use of farm machinery.

Machines	Types of farming	Use		Chi-square
		Yes	No	
Reaper	Subsistence	18(75)	6(25)	
	Commercial	30(88.2)	4(11.8)	1.756
	Semi commercial	45(83.3)	9(16.7)	
Grass cutter	Subsistence	18(75)	6(25)	
	Commercial	12(35.3)	22(64.7)	15.424***
	Semi commercial	40(74.1)	14(25.9)	
Rotavator	Subsistence	6(25)	18(75)	
	Commercial	5(14.7)	29(33.3)	1.400
	Semi commercial	8(14.8)	46(85.2)	
Power Tiller	Subsistence	20 (83.3)	4(16.7)	
	Commercial	24(70.6)	10(29.4)	3.92
	Semi commercial	47(87)	7(13)	
Harvestor	Subsistence	12(50)	12(50)	
	Commercial	5(14.7)	29(85.3)	8.677**
	Semi commercial	20(37)	34(63)	

Note: *,**, *** denotes data are significant at 10%, 5% and 1% level of significance and figure in parenthesis indicates %.

Table 4. Relation of Annual expenditure of farmers with their access to Custom Hiring Center.

Annual expenses	Do you know about the custom hiring center?		Chi-square
	Yes	No	
< 1 lakh	40	7	6.453**
1-2 lakhs	38	0	
2-5 lakhs	21	3	
>5 lakhs	3	0	

Note: *, **, *** denotes data are significant at 10%, 5% and 1% level of significance, and the figure in parenthesis indicates %.

Table 5. Problems in the adoption of farm mechanization.

Rank	Problem	Frequency	Relative frequency (Index value)
1	High Initial Cost	45	0.402
2	Small Land Holding	44	0.393
3	Lack of Extension Services	9	0.080
4	Unavailability of Machinery	7	0.062
5	Lack of Technical Knowledge	6	0.054
6	Lack of Infrastructure	2	0.018

This indicates that, the cost of farm mechanization is extremely high, and farmers face difficulty in its adoption. Landholding size and governmental services were key found to have a positive relation with the adoption of farm mechanization (Kalita, 2018).

Major problems affecting farm mechanization adoption

Based on the responses from the 112 farmers surveyed, the primary barrier affecting the adoption of farm mechanization is the high initial cost of farm machinery, with an index value of 0.402. Closely following this is the issue of small land holdings which has an index value of 0.393. The lack of extension services, with an index value of 0.080, the unavailability of machinery, with an index value of 0.062, and the lack of technical knowledge among farmers with an index value of 0.054. and the least significant problem identified is the lack of infrastructure, with an index value of 0.018. The major problem of farm mechanization in Jhapa district was the high initial cost rate (Kandel *et al.*, 2021).

Conclusion

The gender imbalance is concerning and highlights the need for greater gender inclusivity and empowerment in agricultural decision-making processes. The lower adoption rates for machinery like power tillers and corn shells suggest potential areas for intervention or support from agricultural extension services. Tractors, cultivators, mills, and sprayers are widely adopted, reflecting their importance in modern agriculture. However, the limited accessibility of government subsidies, which only benefited 7% of farmers indicates poor effectiveness of these programs and suggests a need for better-targeted subsidy schemes. The chi-square test revealed that the use of harvesters and grass cutters is dependent on the size of the cultivated land and the type of farming, with larger and more commercialized farms more likely to adopt these machines. Similarly, the use of power tillers is influenced by land size, and ownership of milling machines is significantly related to the type of farming and availability of government subsidies. The small asset base of farmers restricts the adoption of modern agricultural implements (Ghosh, 2010b). The reliance on custom hiring centers for farm machinery is linked to the annual expenditure of farmers, indicating that the high cost of machinery is a primary barrier to its adoption. The fragmented land holdings were reported as another crucial factor hindering the adoption of farm machines. In conclusion, addressing the high initial costs of modern farm equipment, providing targeted subsidies, improving educational outreach, empowering female decision-makers, innovative institution formation to provide better services to marginalized farmers, and expanding extension services are essential steps to promote the adoption of farm mechanization. These measures will not only improve agricultural mechanization and thereby increase agriculture productivity, but also contribute to the economic stability and sustainability of farmers' livelihoods.

DECLARATIONS

Author contribution statement

Conceptualization: S.D and S.P.; Methodology: S.D; Software and validation: Y.D., S.P. and S.D.; Formal analysis and investigation: S.D.; Resources: Y.D.; Data curation: S.D.; Writing—original draft preparation: S.D. and S.P.; Writing—review and editing: S.D. and S.P.; Visualization: Y.D.; Supervision: Y.D.; Project administration: S.D.; Funding acquisition: S.D. and S.P. All authors have read and agreed to the published version of the manuscript.

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Ethics approval: The research study entitled Factors affecting adoption of Farm mechanization in Rupandehi, Nepal was conducted following the ethical guidelines and principles outlined by IAAS, TU. All participants provided informed consent before their inclusion in the study, ensuring their voluntary participation. The confidentiality and anonymity of participants were maintained throughout the research process, and all data were securely stored.

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

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