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# ANALYSIS OF THE FACTORS AFFECTING ADOPTION OF FARM MECHANIZATION IN RICE FARMING IN NEPAL

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Adoption of mechanization ensures timeliness of agricultural operations reduces the cost of production as well as reduces drudgery in carrying out various agricultural operations. A research was conducted to analyze factor affecting the adoption of farm mechanization in rice farming in Nepal. A sample of 494 respondents from Mechanized (274) and Traditional rice farms (220) were interviewed through structured and semi-structured questionnaires. The data were analyzed using Logistic Regression Model. The labor wage rate, number of migrants from household, household size, access to machines, education level of farmers, affiliation to groups and cooperatives significantly affected the adoption of farm mechanization in rice farming in study areas. The study revealed higher cost of machines, lack of training, lack of repair and maintenance services were the major problems identified as bottlenecks to promote farm mechanization in rice farming in Nepal.

Keywords: Mechanization, Rice, Adoption, Logistic regression, Problems

## INTRODUCTION

Agricultural productivity and profitability from farming in Nepal are low due to low use of modern and mechanized technologies, high cost of production, limited commercialization and diversification of agriculture (Gauchan and Shrestha, 2017). In recent years, agriculture sector in Nepal is facing acute labor shortage due to rapidly increasing labor outmigration, especially migration towards the golf countries in search of better employment opportunities. The labor shortage in agriculture sector has increased the rural labor wage rates (Wang et al., 2016; Wiggins and Keats, 2014; Zhang et al., 2014). The increase in rural wages has increased the cost of production for agricultural crops. The increased labor outmigration particularly the male-out migration has also increased the responsibility of the female thereby turning them into de-facto household head (Gartaula et al., 2012, 2010).

Agriculture in Nepal is perceived as most drudgeries occupation due to lack of appropriate farm mechanization and the prevalence of subsistence farming. Therefore, farm mechanization in Nepal is critically important and can be one of the potential options for addressing agricultural labor scarcity, high cost of production and promoting commercialization in agriculture and thereby enhancing farm productivity, profitability, efficiency and hence the food security.

In the contextin of Nepal, the rationale for mechanization in agricultural development is to increase the scale of farming operations and to improve the timeliness, quality, and efficiency of the operations for increase production, productivity and profitability of farming operation by increasing land and labor productivity as envisaged in Agriculture Perspective Plan (1995-2015) and newly formulated Agriculture Development Strategy (2014) of the Government of Nepal (Gauchan and Shrestha, 2017).

Farm mechanization implies the use of various power sources and improved farm tools and equipment, with a view to reducing the drudgery of human beings and draught animals, enhancing the cropping intensity and the precision, timeliness and efficiency of various crop inputs, and reducing the losses at different stages of crop production (Verma, 2008). Farm mechanization can contribute at various stages of crop production by saving in seeds (15-20%), saving in fertilizers (15-20%), saving in time (20-30%), reduction in labor (20-30%), increase in cropping intensity (5-20%)

and higher productivity (10-15%) (Tewari et al 2012).

Food grain production is the most important activity in Nepal, which provides income and employment to a large section of the population. Among the food grain crops, rice is most important in terms of area coverage and supply of calories in the diet. Rice ranks the first among cereal crops in terms of area, production and livelihood of the people (Regmi, 2017).

Rice is considered a labor-intensive crop since it requires a large number of laborers for nursery establishment, seedling uprooting, tillage and puddling, transplanting, and weeding (Bhandari et al., 2015; Dhital, 2017). Labor scarcity during crop establishment time prolongs the age of seedlings and transplantation of old seedlings affects rice productivity (Liu et al., 2017). Timeliness of agricultural operations is one of the most important factors for successful crop production. The use of improved implements and machinery is important for completing the farm operations in time. Therefore, mechanization in rice production is crucial to reduce the cost of production and accomplish timely crop establishment and other inter-cultural operations.

Adoption of mechanization ensures timeliness of agricultural operations reduces cost of production as well as reduces drudgery in carrying out various agricultural operations. Despite of tremendous importance of farm mechanization in rice cultivation in Nepal, the mechanization level is quite low. The study analyzes the various factors responsible for the adoption of farm mechanization in rice farming in Nepal. The study also explores the effects of several factors in accelerating the rate of adoption of agricultural tools and machines for rice cultivation in Nepal.

#### MATERIALS AND METHODS Area of study

The research was carried out using the survey method in Province No. 1 and Province No.5 of Nepal. The research area was limited to three districts namely Jhapa and Sunsari districts of Province no.1 and Bardiya district of Province No. 5. These districts were purposively selected to represent an average condition of the most intensive farming system of rice production and the highest level of mechanization adopted in the province. These three districts (Jhapa, Sunsari and Bardiya) share 12.6% and 14.1% of the total national area and production in Nepal (MoALD, 2019). These districts are the command district of Rice zone/super zone of government implemented Prime Minister Agriculture Modernization Project that has promotion of mechanization as one of the strategic intervention to promote rice sector in Nepal (PMAMP, 2017). The rural municipalities/municipalities lying under the command areas of Rice Zone/Super zone of Prime Minister Agriculture Modernization project were selected within the districts. The rural local bodies were selected because the rice mechanization promotion activities of Rice zone/Super zone's activities since the projected was launched were implemented in these rural municipalities/municipalities. Moreover, as per the record of PIU, and information gained through key informants and officials of local government, these rural municipalities/municipalities had higher level of rice mechanization as compared to other local bodies.

In the present study, multistage random sampling technique was adopted for the selection of study area and sample respondents for collection of information required for the study. Accordingly, Kachankawal Rural Municipality of Jhapa, Gadi and Duhabi Municipality of Sunsari and Rajapur Municipality and Geruwa Rural Muncipality of Bardiya were selected for the study.

## Data and methods

The rice growing farm was divided into two categories i.e. Mechanized and Traditional rice farms. Mechanized farm referred to the rice farm that uses at least one or more of agricultural machines for rice cultivation. Traditional farms referred to as rice farm that uses none of the agricultural machines for rice cultivation. The data was collected through structured and semi-structured questionnaires. Based on the population size, the sample size of the study was 494 respondents. Among them, 220 respondents were from traditional rice farms and 274 respondents were from Mechanized rice farm category. The focused group discussion, key informant interview, stakeholders analysis were performed during the study. The sample size was determined using the following formula.

$$n = \left[ \frac{[N z^2 p (1-p)]}{[(N-1)d^2 + z^2 p (1-p)]} \right]$$

(Daniel, 1999)

Where:

n = Sample size N = Total population size/household p= Estimated proportion of population included d = Error limit (10%) In absence of pilot study information, the estimated proportion of the population was taken as 50% which is considered as a conservative estimate (Hamburg, 1970).

By running the Kendall's coefficients of concordance, (W), the mean rank of various problems were assessed. The field survey was conducted in the month of December 15, 2018 – April15,2019.

#### **Analytical Approaches**

In this present study logit model was used to study the adoption behavior of respondents. The logit model rather than the linear regression model has been used as the dependent variable, i.e., the index of farm machinery is a binary of dummy variable. The variable takes the value 1 for farms that have adopted mechanization in rice farming and 0 for those who have not done so. The choice of the influencing variable was made based on literature review. Conceptually, the behavioral model employed to examine factors influencing mechanization adoption is given by:

 $Pi = f(B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5 + B_6X_6 + B_7X_7 + ... + Ui$  (Feder et al., 1985).

Where. Dependent variable Yi = Farmers adoption decision: 1 if Mechanized and 0 if Traditional Independent variables  $X_1 = Age of the farmer (year)$  $X_2$  = Farmer's education level (years)  $X_3 =$  Farm size (ha)  $X_4 =$  Farming experience (year)  $X_5$  = Access to extension visits (1=yes, 0=otherwise)  $X_6$  = Access to formal credit (1=yes, 0 = otherwise)  $X_7$  = Access to machines (1=yes, 0= otherwise)  $X_8$  = Household size (No.) X<sub>9</sub> =Gender of household head (1=Male, 0=Female)  $X_{10}$  = Caste of household (1= General caste, 0=Others)  $X_{11}$  = Occupation of household head (1=Farming, 0=Others)  $X_{12}$  = Number of Livestock Holding (No.)  $X_{13}$  = Bullock availability (1=Difficult, 0=Easy)  $X_{14}$  = Own mobile phone (1=Yes,0=No)  $X_{15} = Own \ television \ (1=Yes, 0=No)$  $X_{16} = Own machines (1=Yes,0=No)$  $X_{17} = Off farm income ('000 NRs)$ X<sub>18</sub> = Nearest input market distance (Km)  $X_{19} = No.$  of household members migrated (No.) X<sub>20</sub> = Membership to group/cooperatives (1=Yes,0=No)  $X_{21}$  = On farm labor wage rate (NRs/day) X<sub>22</sub> = Fertilizers (NPK) applied (kg/ha) X<sub>23</sub> = Manures applied (1=Yes, 0=No)  $X_{24}$  = Use of improved variety (1=Yes,0=No)  $X_{25}$  = Use of Hybrid (1=Yes, 0=No) X<sub>27</sub>= Grow Spring rice (1=Yes, 0=No) X<sub>28</sub>= Irrigation Status (1=Irrigated,0=Non irrigated) Ui= Error term  $B_0$  - $B_5$ ...= parameters to be estimated

#### **Results and discussion**

The Tarai region of Nepal is flat land and adoption of farm mechanization is expected to accelerate at a higher rate. However, the level of mechanization has not been increased as expected in Tarai region. Many farmers have been adopting tillage related machines for many years in rice cultivation. The adoption rate of other machines like transplanters, reaper, weeders, combines etc. have been at a slower rate than it had to be. Study was focused to reveal the factors responsible for adoption of farm machines for rice cultivation in study areas. The influencing variable reflecting the demographic, human capital, household assets, land and livestock assets, access to various facilities, farm inputs related attributes are presented in Table 1. The study showed the difference in mean of the various variables expected to affect in the adoption of mechanization in rice farming. The mean difference in education, household size, wage rate of on-farm labor, access to machines, number of livestock holdings, availability of bullocks etc. was significant at 1% and 5% level of significance as shown in Table 1.

Table 1: Attributes of adopters (Mechanized)	and non-adopters (Non-mechanized)	) of mechanization in rice farming
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Variables	Full samples (N=494)		Mechanized	(N=274)	Traditional (N=220)		diff %
	Mean	Std. error	Mean	Std. error	Mean	Std. error	
Demographic							
Age of Household head (years)	45.68	6.92	44.01	6.7	47.35	7.19	7.45
Household size (no)	6.36	3.76	5.98	4.2	6.75		11.88*
Gender of HH head (1=Male, 0=Female)	0.78	0.42	0.75	0.43	0.8	0.42	6.11
Caste of household (1=general caste,	0.26	0.43	0.25	0.43	0.26	0.44	3.00
0=others)	0.20	0.43	0.25	0.43	0.20	0.44	3.09
Human capital	0.00						
Education of household head (years)	7.00	3.46	8.8	3.42	5.2	3.29	-69.91**
Farming experience (years)	26.88	7.28	26.8	7.45	26.96	7.07	0.59
Occupation of household head	0.71	0.45	0 72	0.44	07	0.45	-2.87
(1=farming, 0=others)	0.71	0.40	0.72	0.44	0.7	0.45	-2.07
Land and livestock assets	0.00						
Farm size (ha)	0.97	0.22	1.12	0.77	0.82	0.55	-36.61
No of livestock holding	1.45	1.35	0.79	1.03	2.1	1.36	62.43**
Bullock availability (1=difficult, 0=easy)	0.53	0.49	0.45	0.5	0.61	0.5	26.66**
Household assets	0.00						
Own mobile phone (1=yes, 0=no)	0.82	0.45491	0.87	0.5	0.76	0.32	-14.51
Own machines (1=yes, 0=no)	0.20	0.347	0.3	0.29	0.1	0.03	-10.00**
Off-farm income ('000 NPR)	126.97	282.19	120.51	176.2	133.43	135.98	9.71**
Access to facilities							
Access to visit extension visits (1=Yes,	0.37	0.49	0.45	0.43	0.20	0.45	-55 22*
0=No)	0.57	0.49	0.45	0.45	0.29	0.45	-00.22
No of household members migrated (no)	0.34	0.76	0.3	0.2	0.37	0.6	18.94**
Credit access (1=yes, 0=no)	0.22	0.42	0.23	0.42	0.21	0.42	-9.56
Group/cooperative members (1=yes,	0 33	0 34	0 45	0.12	0.21	0.11	-114 29
0=no)	0.00	0.04	0.40	0.12	0.21	0.11	114.20
Easy access to machines	0.33	0.23	0.44	0.21	0.12	0.22	-10.0**
Farm Inputs							
On-farm labor wage rate (NPR/day)	411.50	40.73	418.3	42.52	404.7	37.05	-3.36**
NPK fertilizer applied (kg/ha)	69.05	5.08	68.6	3.12	69.5	7.77	1.25
Farmyard manure applied (1=yes, 0=no)	0.59		0.56	0.22	0.61	0.65	8.20
Used improved rice variety (1=yes, 0=no)	0.73	0.44	0.77	0.41	0.68	0.46	-13.24
Used hybrid rice variety (1=yes, 0=no)	0.20	0.44	0.27	0.44	0.12	0.44	-125.00
Grow spring rice (1=yes, 0=no)	0.26	0.46	0.33	0.47	0.18	0.45	-83.33*
Irrigation status (1=irrigated, 0=not	0.68		0.7	0.13	0.65	0 14	-7 69
irrigated)	0.00		0.1	0.10	0.00	0.17	1.00

Note: \* and \*\* refers to the significant at 5 and 1 percent level of significance, respectively (Field Survey, 2019)

## Factors affecting adoption of farm mechanization in rice farming

Logistic regression model was adopted to explore the factors affecting adoption of farm mechanization in rice. The estimates of coefficients of different independent variables is presented in Table 2. The study shows the number of factors that are associated to affect the adoption of farm mechanization in rice farming in the study area.

The effect of household size to adoption of farm mechanization in rice farming was significant and negative. The more number of household members means they can be available to perform farm operation during rice cultivation. So, there was an adverse relationship between increased household members and adoption of mechanization for rice cultivation. The education of farmers was significant and positive, a unit increase in the education of farmers increase the log odds of impact on adoption of mechanization by 0.14 units. That means respondents having higher level of education can

have access and skill to use the information technology to explore various mechanization options for rice farming. There was seen the adverse relationship between adoption and difficulty of availability of bullock and the number of bullock holding in household. That means Respondents facing the difficulties in finding the bullocks and also having

the lower number of bullock were found to adopt mechanization in rice farming. A unit increase in level of adoption decreased the number of bullocks holding by 0.76 unit. The increase in number of migrants from the household was demanding the agriculture tools and machines for rice farming. In miany studies, we see the positive relation between increase in farm size and adoption of machinery But, in this case, the farm size in the study area was already higher than the district land holding size and thus, an increase in farm size was not responsible for making farmers adopt agricultural machines for rice farming. That is why the effect of farm size to adoption of mechanization was positive but not significant. The effect of increase in wage rate of labor in adoption of mechanization in rice farming was significant and positive. This means the increase in wage rate of labor would demand for the machines for farm operation in rice cultivation. Since, the study sites were based on Tarai where farmers are habituated to adopt improved and hybrid varieties of rice, effect of adopting new improved and hybrid varieties of rice did not make significant effect in increasing the adoption of mechanization in rice production in study sites. The effect of having access to farm machines was significant and positive. A unit increase in access to farm machines would accelerate the adoption of farm mechanization in rice cultivation by 0.33 units. Similarly, as mentioned above in the initial section of result and discussion, majority of respondents in both farm category had access to year round irrigation through mega irrigation project of government, the effect of availability of irrigation facility was not significant. The affiliation to group/cooperatives was found to increase the adoption of machines for rice farming. It was because the government of Nepal has provision to support for farm machines to farmers adopting group approach and farmers willing to get support of machines in subsidy from government would require to be affiliated in group. So, effect of affiliation to groups and cooperatives to the adoption of farm mechanization in rice was positive and significant.

Variables	Coefficient	SE	Sig.
Constant	-7.60	2.285	-
Demographic			
Age of Household head (years)	-0.00	.022	0.77
Household size (no)	-0.12**	.039	0.00
Gender of HH head (1=Male, 0=Female)	0.16	.382	0.67
Caste of household (1=general caste, 0=others)	-0.68	.367	0.06
Human capital			
Education of household head (years)	0.14**	.047	0.00
Farming experience (years)	-0.006	.021	0.70
Occupation of household head (1=farming, 0=others)	0.23	.357	0.50
Land and livestock assets			
Farm size (ha)	.096	.249	0.70
No of livestock holding	-0.76**	.137	0.00
Bullock availability (1=difficult, 0=easy)	-0.06	.322	0.85
Household assets			
Own mobile phone (1=yes, 0=no)	3.20**	.620	0.00
Own machines (1=yes, 0=no)	1.09**	.480	0.02
Off-farm income ('000 NPR)	0.00	.000	0.06
Access to facilities			
Access to visit extension visits(1=Yes, 0=No)	1.001	.727	0.76
No of household members migrated (no)	1.14**	.231	0.00
Credit access (1=yes, 0=no)	0.28	.373	0.16
Easy Access to machines (1=Yes, 0=N0)	0.45*	.739	0.04
Group/cooperative members (1=yes, 0=no)	1.16*	.231	0.04
Farm Inputs			
On-farm labor wage rate (NPR/day)	.013**	.004	0.00
NPK fertilizer applied (kg/ha)	-0.006	.004	0.07
Farmyard manure applied (1=yes, 0=no)	0.89	.332	0.54
Used improved rice variety (1=yes, 0=no)	0.38	.342	0.25
Used hybrid rice variety (1=yes, 0=no)	0.20	.352	0.56
Grow spring rice (1=yes, 0=no)	0.11	.342	0.73
Irrigation status (1=irrigated, 0=not irrigated)	-0.26	.428	0.54

#### Table 2: Estimation of coefficients for factor affecting the adoption of farm mechanization in rice cultivation

(Field survey, 2019)

Note: \* and \*\* refers to the significant at 5 and 1 percent level of significance, respectively Log likelihood: 285.266

#### Problem faced in farm mechanization of rice in Nepal

By running the Kendall's coefficients of concordance, (W), the mean rank of various problems determined and are presented below in Table. The constraints study revealed that the farmers were facing several problems while adoption the agricultural machines for rice farming. The most important and serious problem was higher initial cost of machine. Because of higher cost of machines, farmers were unable to afford the machines even though they were interested to adopt. They reacted that the same machine is too cheap in Indian market but it becomes expensive when purchased from dealer at Nepal side. The next major constraints revealed by farmers was lack of government support through subsidy to agricultural machines for rice farming. Farmers were seeking the subsidy from government to afford machines but majority of respondents could not receive it. Similarly, lack of technical know how to operate machines was another major problem faced by farmers. This was the reason for some of the machines like transplanter and laser land leveler was not in use by most farmers. Most of the farmers had no idea to run these machines also did not know the technical guideline to operate those machines. The constraint then was followed by lack of repair and maintenance facility. The farmers were using the farm machines for rice cultivation through taking in hire from groups/cooperatives. However, it was matter of head ache for officials of cooperatives and groups to find out repair and maintenance option for those machines. As result, once the machines get damaged, they had no other option than to keep them in store. Lack of spare parts and higher hiring charges were also found the serious constraints to adopt farm machines in rice production in study areas. The other problems stated by the respondents along with their mean rank is shown in Table 3:

SN	Constraints	Mean Rank	Remarks
1	Higher cost of machines	1.67	
2	Capacity build up and training for technical knowhow on farm machines	3.54	III
3	Lack of subsidy for purchasing farm machines for rice cultivation	2.44	11
4	High hiring charges	5.21	VI
5	Lack of repair and maintenance facility	3.94	IV
6	Unavailability of spare parts	4.67	V
7	Lack of awareness and information	8.55	IX
8	Heavy size of machines	8.14	VII
9	Lack of soft loan/credit to buy machines for rice cultivation	11.16	XI
10	Difficult to operate in smaller farm size	8.38	VIII
11	Underutilization of machines	10.20	Х
12	High cost of repairs and maintenance	14.54	XV
13	Fuel cost (High and unavailable regularly)	13.95	XIV
14	Negative impact on environment	15.42	XVI
15	Lack of skilled labor to operate farm machines	11.36	XII
16	Decreased quality of straw	13.67	XIII
17	Chances of accidents while using machines	16.15	XVII
		(Field surv	ey, 2019)

## CONCLUSION

The mean difference was seen for attributes like farm size, household number, number of migrants from household, off farm income between Mechanized and Non-mechanized rice farm. The on farm wage rate of labor, number of household members migrated, access to the machines, size of households, number of livestock holdings, affiliation to groups and cooperatives, education level of farmers were the major influencing factors for adoption of farm machines for rice mechanization in Nepal. Farmers need to be aware about importance of mechanization in rice crops to minimize cost, drudgery and increase farm income. Since migration of people to abroad for work and education is very common in Nepal, the adoption of mechanization would be panacea for agricultural in general and rice in particular. The study suggests to pay attention in addressing issues associated with identified influencing factors in adoption of mechanization in rice in Nepal.Based on present study, the following recommendations are put forward for promoting farm mechanization in rice farming in Nepal:

- Encourage farmers to be affiliated in the group so that they can afford farm machines for rice cultivation and also be eligible to get support from the government.
- The concerned authority of government should make the list of available machines with price for rice cultivation and make them available to public

- The existing subsidy policy on farm machines used for rice cultivation should be reviewed and make it more practicable.
- Technical capacity build up and establishment of repair and maintenance service centers are the urgent need to promote farm mechanization in rice in Nepal.

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