Research article

DETERMINANTS FOR ADOPTION OF FOUNDATION RICE SEED PRODUCTION: EVIDENCE FROM KAILALI DISTRICT OF NEPAL

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ABSTRACT

Rice seed production is an emerging agricultural enterprise to increase the income of farmers in Kailali. However, adoption of seed production technology is very limited in spite of its potential, which results in the poor supply of quality seed for its multiplication. Thus, this paper examines the influencing factors affecting farmers' decision to adopt the foundation rice seed production in Kailali, Nepal. In total 158 households, 116 certified, and 42 foundation seed producers were selected using a stratified random sampling technique. The primary data were collected from September to November 2021. T-test, chi-square, and binary logistic model were applied for data analysis using SPSS. The result revealed that land size, experience, gender of household head, access to credit, training, extension contact, and type of family are statistically significant between two categories. Besides, the empirical result of logistic regression analysis indicated that out of twelve, six explanatory variables such as age, experience, training, extension contact, education, and type of family had significantly influence on adoption decision. Therefore, it is concluded the rice seed training programs and increasing the extension services would be beneficial to motivate the farmers for the production of foundation rice seed production.

Keywords: Experience, logistic model, training

INTRODUCTION

Rice (*Oryza sativa)* crop plays the most substantial role in food security in Nepal. Out of 3 belts, the Terai region covers 70% volume of the total rice production (Gadal et al., 2019). In addition, the lower production of 5,151,925 t. of rice in 2017/18 was increased to 5,550,878 t. in 2019//20 (MoALD, 2021) showing the steady increase in the production of rice in Nepal. However, the production of rice is not sufficient to meet the national demand due to the low volume of production. Also, efforts have been made from the government sector to release new rice varieties for contributing to the productivity gap. Despite this, farmers still face production constraints because of the low amount of quality seed supply from the formal sector. In fact, the traditional informal seed exchange system occupies 70-90% of total seed demand (Gauchan, et al., 2018). The seed sub-sector is handicapped by the weak marketing network and low seed replacement rate (Bhandari et al., 2021). As a result, it hinders the scaling up the improved rice seed varieties. And, the lack of sufficient investment in research in rice (Tiwari & Pokharel, 2020) and the study gap on the household behavior to adoption (Ghimire et al., 2015) are the limitations. Consequently, few farmers have adopted the production of foundation and breeder seed (Sapkota et al., 2017). Farmers are aware of the use of improved seed to some extent but the motivation to apply the seed production technology in their locality seems to be very low.

Hence, such challenges in the rice sub-sector need to be addressed in order to make the product viable. Importantly, the government of Nepal has envisioned for accessibility of certified quality seed to farmers (NSV, 2013). Moreover, the results of empirical research stated that productivity could be enhanced only by adopting improved agricultural technology (Bello et al., 2020). Though, farmers' motivation plays a key role in order to fulfill the production gap. Further, the existing literature describes the gender, age, family size, income, land size (Adhikari et al., 2019; Piya & Joshi, 2021), access to extension, and credit (Lamichhane et al., 2018), experience, farm size (Chete, 2021), training, education (Hagos et al., 2018) and type of family (Kattel & Acharya, 2016) are the primary variables influencing for the decision of farmers. However, no study to date has been noted in Kailali about the adoption decision behavior of farmers on rice seed production. To address this gap, this paper examines the influencing factors affecting farmers' decision to adopt the foundation rice seed production in Kailali district of Nepal.

The theoretical concept of this research is based on the theory of adoption (Rogers & Shoemaker, 1971). Later, this was modified as a theory of acceptance (Venkatesh et al., 2003). Hence, the technology adoption from this theory was hypothesized that adoption of foundation rice seed (whether or not-certified seed production) was the dependent variable, where the explanatory variables such as age, education, family size, active member, experience, land size, farm gate price, gender of household head (HH), type of family, extension contact, training, access to credit were major influencing factors for the adoption of foundation rice seed production. Other uncontrollable variables also exist (Mariyono, 2017).

MATERIALS AND METHODS

Selection of the study area and sample size

Tikapur municipality and Janaki rural municipality of Kailali district were chosen. In the study sites, seven cooperatives and six seed companies were producing and marketing different types of seed. In addition, farmers were found engaging intensively for the production of seed of cereal crops. Furthermore, Kailali district alone covers the area and production of rice with 71,710 ha and 306,202 mt respectively (MoALD, 2021). A total of 265 were identified as sampling frames from 13 entities (RJKIP, 2020). Rice seed growers were divided into two strata, namely the foundation and certified seed growers. Based on that, a stratified random sampling method was applied to select the households. 116 certified and 42 foundation seed producers were selected based on the proportional size. The random selection method was used to avoid biases (Baker et al., 2013). Pre-test surveys were conducted and few variables were adjusted as per the need. The primary data were collected through a household survey from September to November 2021.

Methods of data analysis

Data were analyzed through descriptive statistics such as cross-tabulation to describe the samples. Inferential statistics such as t-test and chi-square tests have been used to generalize the sample results for the population. In this regard, the Statistical Packages of Social Sciences (SPSS) software was used in the analysis. The binary logistic model was employed to ascertain the relative influence of the explanatory variables (Bui & Nguyen, 2021). The model was selected because it predicts the changes in the probability of occurring certain events on the outcome due to changes in the explanatory variables. In this study, the dependent variable is a binary dummy variable and takes the value of 1 for the adopter farmers and 0 otherwise.

The probability is given by,

$pi = 1/(1+e^{-zi})$, where, pi = probability of adoption of foundation rice seed production

$zi = \tilde{Y} = \log(odds) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \dots \dots \dots . + \beta_n X_n$

Where, β_0 is the constant term, β_1, β_2,……, β_n are the coefficients of explanatory variables and X_1, X_2,…., X_n are explanatory variables.

Odds: Odds is simply the ratio of the probability of adopting foundation rice seed production (pi) to the probability of not adopting foundation rice seed production (1- pi).

$$\text{Odds} = \frac{\text{pi}}{1-pi}$$

Wald test: Wald test measures the significance of given coefficients of the explanatory variables

= (B/ S.E.)^2, where, B= coefficient of explanatory variables, S.E. = estimate of the standard error of the coefficient. Based on the regressand and the regressors, the binary logistic analysis was specified by using the following equation:

$$\tilde{Y}=\log(odds)=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7+\beta_8X_8+\beta_9X_9+\beta_{10}X_{10}+\beta_{11}X_{11}+\beta_{12}X_{12}$$

$\tilde{Y}$ = Estimator of adoption of foundation rice seed production

β_0 is a constant term and β_1, β_2, β_3, β_4, β_5, β_6, β_7, β_8, β_9, β_{10}, β_{11}, β_{12} are coefficient of explanatory variables. The description of explanatory variables used in the model are illustrated in Table 1. The average Variance Inflation Factor (VIF) from 1.48 to 2.29 was found at the acceptance level.

Table 1. Description of explanatory variables used in the logistic regression model

Notation	Variables	Description	Variable type
Y	Adoption (Dependent)	Adoption of foundation rice seed production	Dummy: 1 if adopted, 0 otherwise
X1	Age	Age of farm holders (years)	Continuous
X2	Family size	Family members (no.)	Continuous
X3	Active member	Active members (no.)	Continuous
X4	Experiences	Experience in seed production (years)	Continuous
X5	Land size	Land for rice seed production (ha.)	Continuous
X6	Farm gate price	Farm gate price after selling (NRs./t)	Continuous
X7	Education	Education category	Dummy:1 if Literate, 0 otherwise
X8	Gender of HHH	Gender of the household head	Dummy:1 if male, 0 otherwise
X9	Type of family	Type of family	Nuclear=1, Joint=2
X10	Extension contact	Extension service taken	Dummy: 1 if Yes, 0 otherwise
X11	Training	Participation in training	Dummy: 1 if Yes, 0 otherwise
X12	Access to credit	Access to credit facilities	Dummy: 1 if Yes, 0 otherwise

RESULTS AND DISCUSSION

Effects of explanatory variables on adoption

As depicted in Table 2, the result of the t-test showed that land size and experience in rice seed production of two categories are statistically different at 1% level of significance. The average years of experience of adopters were found to be 9.26 whereas non-adopters had a mean value of 5.18. In this line, Kattel et al. (2020) observed the better farm performance with the experienced households. It denotes that rice seed growers have developed better skills in seed production technology. Likewise, the mean size of the land was higher (1.95 ha) for adopters than for non-adopters (1.51ha). This is agreed by Kumar et al. (2019), who found a higher rate of adoption in large farm size. Similarly, the adopters had average family members of 7.3 and active members of 5.3, which was slightly higher than non-adopters. However, the differences in age, family size, active members, and farm gate price of two categories are not statistically significant.

Table 2. Descriptive analysis of the continuous variables (n=158)

Variables	Mean differences between two categories				
	Adopter	Non-adopter	Total	t-value	p-value
Age (years)	41.26±12.12	45.1±10.8	44±11.2	1.919	0.057
Family size (no.)	7.26±2.25	6.90±1.79	6.99±1.9	-1.057	0.292
Active members(no.)	5.3±1.81	5.1±1.50	5.12±1.6	-0.676	0.500
Experiences (years)	9.26±4.41	5.18±2.90	6.27±3.8	-5.582	0.000**
Land size (ha)	1.95±0.79	1.51±0.75	1.63±0.78	-3.178	0.003**
Farm gate price (NRs.)	30524±634	30302±636	30361±64	-1.942	0.056

(Source: Field survey, 2021), Note: Value after “±” indicate standard deviation * indicates at 5% and ** at 1% probability level)

The chi-square test was performed for categorical and dummy variables (Table 3). The variables of the gender of household head, type of family, extension contact, training, and access to credit are statistically different between adopters and non-adopters at 1% level of significance. The household head is dominated by male as 64% and 85% of male-headed households in adopters and non-adopters respectively. Similar findings were observed by Adebayo et al. (2021) in the adoption behavior of rice farmers in Nigeria, who reported majority (83.1%) were male respondents. We can conclude that the majority of household heads were male-dominated.

Table 3. Descriptive analysis of the categorical variables (n=158)

Variables	Description	Percentage differences between two categories				
		Adopter	Non-Adopter	Total	χ2-value	p-value
Gender of HHH	Male	27 (64.3)	99(85.3)	126(79.7)	8.467	0.004**
	Female	15 (35.7)	17 (14.7)	32(20.3)		
Type of family	Nuclear	14(33.3)	76 (65.5)	90 (57)	13.028	0.000**
	Joint	28(66.7)	40(34.5)	68 (43)		
Extension Contact	Yes	40(95.2)	56(48.3)	96(60.8)	28..523	0.000**
	No	2 (4.8)	60(51.7)	62(39.2)		
Training	Yes	39(92.9)	51(44)	90(57)	30.066	0.000**
	No	3(7.1)	65(56)	68(43)		
Education	Illiterate	15 (35.7)	29(25)	44 (28.4)	1.762	0.184
	Literate	27(64.3)	87 (75)	114 (71.6)		
Access to credit	Yes	20 (47.6)	27 (23.3)	47 (29.8)	8.774	0.003**
	No	22 (52.4)	89 (76.7)	111(70.2)		

(Source: Field survey, 2021), Note: figures in parentheses indicate percentage, * indicates at 5% and **at 1% probability level)

Also, the type of family is important, the majority (66.7%) of respondents of adopters lived in joint families, which is higher than the non-adopters (34.5%). About 93% of adopters received training and 95% of them were exposed to frequent visits with the extension agents, which was higher than the non-adopters. Access to credit for adopter households is higher (47.6%) than for non-adopters (23.3%). The present findings from Table 3 showed the training, services receive from extension agents, and access to capital make the difference in adoption or not.

Factors determining the adoption of foundation rice seed production

The binary logistic regression was applied after the reiteration process initiating with 16 independent variables to fit the model. The final model is robust in defining the factors influencing the adoption (Table 4). Out of the twelve, six variables like age, experience, education, type of family, extension contact, and training were found to be statistically significant to influence the farmers' decision to adopt or not to adopt the foundation rice seed production. The remaining six variables family size, active members, land size, farm gate price, access to credit, and gender of household head were insignificant and were not determining the adoption behavior of farmers. The log-likelihood ratio of 78.763, indicated the chi-square goodness of fit value was 104.222 significant at the 5% level. R^2 value of the logistic regression analysis showed that 70.4% of the dependent variable is predicted by the explanatory variables in the model.

The estimated results of the binary logistic regression model (Table 4) showed the age of respondents had negatively and significantly effect on the adoption. This result indicates that an increase in the age of the farmer by 1 year, would lead to a decrease in the likelihood of adoption of foundation rice seed production by 0.940 times. This finding is consistent with the result of research in Ethiopia conducted by Melesse (2018), who reported that the probability of adoption decreases with older age. The reason could be due to fact that younger farmers are more eager to apply the new innovations. This view is agreed by Suvedi et al. (2017) as younger farmers are more capable to bear the risk. However, the contrast results reported that older aged farmers had positively and significantly impacted the rate of adoption (Donkoh, 2020).

As expected, the coefficient on experience appears to be positive and significant (Table 4). This shows that with each additional year of experience, the odds ratio of the adoption of foundation rice seed production increases by 1.30 times. In line with a previous study in Nepal, experiences significantly contributed to the adoption of a large farm, as a result, a higher agriculture income of adopters was found (Kattel et al., 2020). This is possible because farmers had more knowledge and better self-confidence. Adopter farmers of the study area might have more exposure to product networks and have better knowledge of the foundation rice seed production technology and marketing as well. Thus, learning from it enhances the ability of farmers to deliver better output than less experienced farmers. Further, the family who engaged for many years in the same occupation had more likely to adopt (Ashoori et al., 2019). The knowledge gained from experiences would be helpful to the choice of new innovations. On the contrary, many years of experience in rice seed production had negatively and significantly influenced the adoption of improved rice seed varieties in Indonesia (Fadillah et al., 2020), and less tendency for alteration was observed (Kumar et al., 2021). It means that expertise and trust gained over many years in old technology contribute not to adopting the new one.

Table 4. The Maximum likelihood estimation of the binary logistic model

Notation	Variables	B value	SE	Wald	Sig.	Odds ratio
X1	Age	-0.062	0.029	4.664	0.031*	0.940
X2	Family size	-0.042	0.243	.030	0.863	0.959
X3	Active members	-0.325	0.236	1.902	0.168	0.722
X4	Experiences	0.263	0.079	10.992	0.001*	1.300
X5	Land size	0.022	0.015	2.060	0.151	1.022
X6	Farm gate price	-0.170	0.518	0.107	0.743	0.844
X7	Education	-2.358	0.801	8.669	0.003*	0.095
X8	Gender of HHH	1.183	0.826	2.054	0.152	3.265
X9	Type of family	2.529	0.794	10.155	0.001*	12.545
X10	Extension contact	3.551	1.014	12.262	0.000*	34.849
X11	Training received	2.461	0.844	8.499	0.004*	11.714
X12	Access to credit	0.040	0.626	0.004	0.949	1.041
	Constant	1.279	15.672	0.007	0.935	3.592
	No. of observations		158			
	-2 Log likelihood		78.763			
	R2		70.4%			
	Chi-square value		104.222			

(Source: Field survey, 2021) Note: * indicates at 5% and ** at 1% probability level

The result showed that the association of education and adoption of foundation rice seed production were significant, but the coefficient was negative (Table 4). If the education level of farmers' changes from illiterate to literate the likelihood of adoption decreases by 0.095 times. The probability of adoption of foundation rice seed production decreases with the higher level of education. From these results, it is known that relatively less educated farmers had engaged more in foundation rice seed production. In line, Sapkota et al. (2021) reported the increasing the number of schooling in years, decreases the probability of adoption, but, the opposite result was observed that education had a significant impact on the higher rate of adoption in the research conducted in Nepal (Adhikari et al., 2018).

The type of family was found to be positively and significantly related to the adoption decision (Table 4). It means that if a family with a joint type they are more likely to adopt the foundation rice seed production by 12.545 times higher than the farmers who lived in nuclear. This result echoes with the study by Pandey et al. (2021), who reported that type of family plays a key role for the adoption decision of improved rice seed variety. However, the opposite result was observed in the study in Nepal done by Kattel and Acharya (2016) found that family of farmers with nuclear type, the likelihood of adoption increased by 76%. Thus, the family living in a single-parent or with joint members is important for making the decision of adoption.

The findings in Table 4 revealed the extension contact was found to have a significant and positive relationship with the adoption of foundation rice seed production. The effect of a 1 unit increases in the extension activity, the likelihood of adoption is increased by 34.849 times higher than the farmers who did not have frequent visits to extension-related programs. This means that additional extension-related activities will increase the probability of adoption. The services either in the form of visits to farmers' field or supports received from the extension agencies play a key role to motivate the farmers the use new technology. This finding corroborates the study in Nepal by Suvedi et al. (2017) who stated the frequent interaction and services between farmers and agriculture technicians had a positive influence on the adoption of new innovations in agriculture. Logically, the reason could be the farmers were able to timely follow the suggested improved practices. Therefore, the role of extension agents is important for suggesting to use of the protocols of foundation seed production technology. This is agreed by Zarafshani et al. (2017), who advised increasing the number of visits between the agriculture extension offices and farmers. On the contrary, a negative association between extension advice and the adoption of new rice varieties was observed in the study in India (Kumar et al., 2021).

Training appeared to be positive and significant (Table 4). The farmers who got an opportunity to participate in the training of rice seed production technology or related training, the likelihood of adoption would increase the odds ratio by 11.714 times higher as compared to non-participants. The result is consistent with the rice research in Nepal wherein training on seed production increased the probability of adopting foundation rice seed production by 4.6% (Sapkota et al., 2017). In the same line, Rahman et al. (2021) concluded that learnings received from the training sessions helped to upgrade the farmer's skills and had a positive influence on the adoption of improved practices. Briefly, training is an important aspect of acquiring knowledge and encouraging farmers, which in turn stimulates farmers to take the decision.

CONCLUSION

The survey results showed that a significant difference was found between the adopters and non-adopters of foundation rice seed production, in land size, experience and gender of household head, access to credit, type of family, training, and extension contact. Similarly, the likelihood estimation of the binary logistic model indicated that the age, experience, training, extension contact, education, and type of family had significantly affected the probability of adoption. Therefore, it is suggested to promote the rice seed production training and agricultural extension activities through an appropriate mechanism in access to quality inputs and support for market opportunities would be beneficial to motivate the farmers. Knowledge of farmers gained through their experiences could be utilized in farmer-to-farmer agricultural extension programs.

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