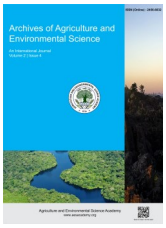
Archives of Agriculture and Environmental Science 6(2): 178-185 (2021)
https://doi.org/10.26832/24566632.2021.060209

e-ISSN: 2456-6632

This content is available online at AESA

Archives of Agriculture and Environmental Science

Journal homepage: journals.aesacademy.org/index.php/aaes



ORIGINAL RESEARCH ARTICLE

Adoption status of improved production technology in rice cultivation in Kanchanpur, Nepal

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ARTICLE HISTORY

Received: 13 April 2021
Revised received: 20 May 2021
Accepted: 18 June 2021

Keywords

Binary logit regression
Production practices
Rice cultivation

ABSTRACT

A study was carried out in 2020 to assess the scenario of the improved production technologies among rice growers in Kanchanpur and to identify the factors influencing the adoption of these technologies. The simple random sampling procedure was used to collect data from 90 respondents using a semi-structured interview schedule from Belauri, Bhimdutta municipality, and Beldandi rural municipality which are under the command area of the rice super zone, Kanchanpur. The information on prevailing cultural practice, production, and productivity, adoption of improved technology, problems/constraints faced by farmers in rice cultivation in the study area were collected from the farmers by interview. The data were processed, cleaned, and analyzed using software MS-excel and SPSS. The simple descriptive and inferential statistics like chi-square and binary logistic regression models were used to find the relationship between dependent and independent variables. Respondents adopted plant protection measures (chemical weed control, insects, and disease control) and seed treatment relatively less than they adopted recommended variety, Seed Replacement Rate (SRR), and storage treatment. The majority of the respondents were affiliated with the farmers' groups but the majority of them had not received training. Furthermore, spade, hoe, tractor, thresher, sickle, wooden plough bullock cart water pumps, tillers, reapers were used by respondents. Binary logistic regression revealed that membership of agriculture group, advice from agriculture technician, training, visit of extension workers and rice cultivated land had a positive and significant effect on the adoption of various production practices. Inadequate availability of fertilizers and inputs (0.85), Inadequate training (0.68), inadequate machinery availability (0.54) were the major constraints faced by the farmers on rice cultivation.

Citation of this article: Pokhrel, A., Dhakal, S., Kafle, R., & Pokhrel, A. (2021). Adoption status of improved production technology in rice cultivation in Kanchanpur, Nepal. *Archives of Agriculture and Environmental Science*, *6*(2), 178-185, https://dx.doi.org/10.26832/24566632.2021.060209

INTRODUCTION

Rice is grown worldwide in almost 100 countries on 165 million hectares with a total production of 750 MT (IRRI, 2019). It ranks second in the world in terms of production after maize (FAO, 2010). It is used as a staple food by more than 60% of the total world's population (FAO, 2010) More than 90% of the world's rice production is concentrated in the Asia continent. Among them, China (214 MT) and India (172MT) rank 1st and 2nd respectively in terms of the World's production (USDA, 2018). Nepal is predominantly an agricultural country. Agriculture is the backbone of Nepal's economy. It has contributed to about 27.6% of the total GDP of Nepal (CBS, 2017). Rice is the major cereal produced in 1.49 million hectares with a production of 5.61 million tons (MOALD, 2020). It contributes 27% to the total AGDP and 7% to the national GDP (CDD, 2017).

Rice is the major staple food in Nepal. Rice is grown from the

lowland of terai to high hills in Nepal (Sapkota *et al.*, 2011). It has immense contribution to food security. It fulfills 50% of the total grain requirement and 30% of the total calorie requirement of the country (Dhungel and Acharya, 2017). The population of Nepal is increasing at the rate of 1.25% per annum and to meet the demand of the growing population Nepal is importing almost 215 thousand tons of rice annually. The statistics reveal that rice production has decreased by 1.2% from the year 2015 to 2016 (CBS, 2017). Kanchanpur district follows the Rice-Wheat cropping system in which rice is cultivated in 46,215 ha with a production of 164,803 tons and productivity of 3.88 tons ha^{-1} (MOALD, 2020). Spring rice is also in cultivation in area less than 700 ha with a productivity of 4.48 tons ha^{-1} (MOALD, 2020).

Despite having access to markets, suitable topography, and having 89.74% irrigated land, the production of rice in Kanchanpur district has not met the actual production potential of the district (Zone Profile, 2018). The main reason for not having the anticipated production of rice might be the poor adoption of improved production technology by the rice-growing farmers. Low productivity might be the result of high level of subsistence farming, poor adoption of suitable on-farm and postharvest technology as well as the availability of inputs (seeds, fertilizers, chemicals, irrigation, machinery) (MOAD, 2015). These factors including ineffective research, poor integration of research and extension, Inadequate training, lack of production credit have resulted in poor adoption of the improved production technology (Shamsudeen *et al.*, 2018).

Commonly, the major problems related to the low productivity of rice is associated with inadequate use of the improved varieties, poor weed control, lack of inorganic fertilizer application, poor tillage operation, labor-intensive cultivation, lack of suitable hybrid varieties, and poor irrigation (Umar *et al.*, 2010). In Kanchanpur district, it had been noted that labor is scarce due to the emigration of youths to India in search of employment opportunities. So, the cost of labor is increasing ultimately increasing the cost of cultivation. The use of machines like power tillers, tractors, threshers will help to reduce cost of cultivation and saves time (Acharya and Bhandari, 2017).

In this context, this study assessed the current situation of the improved farm production technology as well as evaluated the status of farm mechanization used by the farmers in rice cultivation. The factors associated with technology adoption and mechanization were studied. The importance of this study was to generate and provide information to technology developers, policymakers as well as extension workers to take decisions concerning rice production in the area of study. The contribution of the improved production technology on economic growth can only be achieved when it has been studied properly and understanding of factors affecting the adoption is important. Furthermore, this report can be used as baseline data source for further research to be carried out in rice farming and mechanization.

MATERIALS AND METHODS

Description of the study area

The study was conducted in Kanchanpur district situated in the far- western province between latitude 28°32" to 29°28" and longitude 80°3" to 80°33" (District Profile, 2018) Bhimdutta and Belauri municipality and Beldandi rural municipality were purposively chosen because these sites were major rice-producing areas in Kanchanpur and easily accessible (Figure 1). A preliminary study was carried out to collect information regarding the feasibility of the study by direct field observation and informal conversation with farmers that provided insight regarding questionnaire preparation and rapport building.

It is very essential to determine the target population, determination of the sampling procedure, and deciding the rational sample size for research work. Estimate of farmers growing rice under the command area of rice super zone was obtained from the office of PMAMP PIU rice super zone and Agriculture Knowledge Centre (AKC) Kanchanpur and the sampling frame was made of 1000 farmers. A total of 90 households were selected based on simple random sampling. Simple random sampling was adopted to avoid biases as this provides an equal chance for the selection of elements from the sampling frame. The questionnaire was prepared in English language and was asked in Nepali for better information gathering from farmers. The information on prevailing cultural practice, production, and productivity, adoption of improved technology, problems/constraints faced by farmers on the adoption of improved rice production technology in the study area were collected from the farmers by interview.

A total of 3 Focus Group Discussions (FGD) were conducted using a pre-determined semi-structured checklist to supplement and verify the information collected from the household survey. Farmers from all cultural, gender, and ethnic backgrounds were included. Key informant interview (KII) was conducted with progressive farmers, farmer leaders, managers of private farms, and local extension workers to seek some key information about the overall trend of rice cultivation in the study area. The secondary data were collected by reviewing different publications from government and non-government organizations and co-operatives, reports from national organizations MOALD, PMAMP, ADS, CBS, AKC, etc.

Variables and their measurements

Dependent variables: The dependent variable in this study was the adoption of improved rice production technology. The selected dependent variables were:

- Chemical weed control method (Dummy)
- Insect control (Dummy)
- Disease control (Dummy)
- Storage treatment (Dummy)
- Seed treatment (Dummy)
- Use of appropriate seed replacement rate (Dummy)

- Use of recommended variety (Dummy)

All these variables were dummy variables i.e., those who adopted the technologies were coded with yes (1) and those who didn't adopt were coded as no (0).

Independent variables: Various predictors were used in this study for determining their influence on the adoption of improved production technologies.

- **Agriculture group:** Arbitrary value was assigned for measurement. Zero for non-membership and 1 for membership.
- **Advice from agriculture technician/ agro-vet:** Those respondents getting advice and suggestion from the technicians and agro-vet were assigned with 1 and those not getting any advice were assigned with 0.
- **Training:** Those respondents who have received training on rice cultivation were assigned with 1 and those who have not received any sort of training were assigned with 0.
- **Visit of extension workers:** Those respondents getting advice and who are in contact with extension workers were assigned with 1 and those not getting visits/ contacts with extension workers were assigned with 0.
- **Rice land:** Rice land was used as continuous variables and was measured in katthas (1 Katthas = 126.44 square meter).

Data analysis methods

General descriptive method

The collected data were edited and the local units of measurements were standardized into the scientific one. All the important primary data that were collected from households were entered in MS-Excel and Statistical Package for Social Science (SPSS) program (Version 23.0) for further analysis. Collected data were analyzed using the descriptive method by using frequencies and percentages.

Factors affecting adoption of various agriculture practices

Binary Logistic regression was used to assess the factors affecting the adoption of various agricultural practices in the study area. This regression or function is used when the outcome variable is a dummy.

The logistic equation is given by;

$$p/(1-p) = e^{b0 + b1x1 + b2x2+...bnxn}$$

Where, p/(1-p) is odds of an event; p is the probability of adoption of various improved production practices (dependent variables); e is base of natural logarithm; b0...bn are coefficients; x_1 ..... xn are independent variables.

Logit form of equation can be obtained by taking natural log both sides,

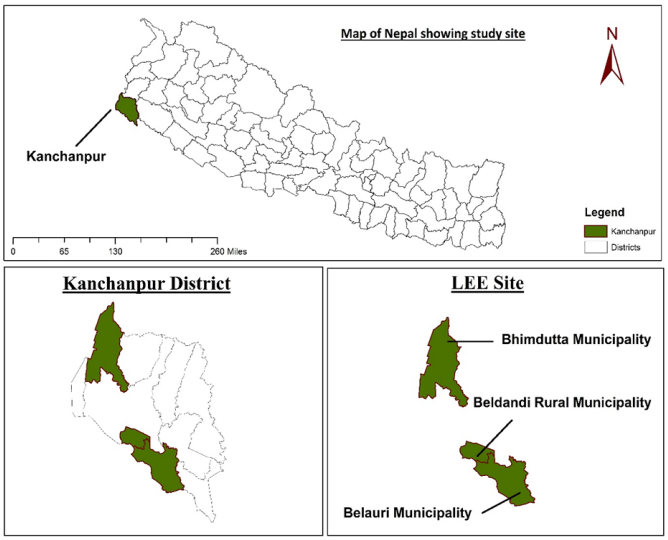

Figure 1. *Map showing the study area.*

$$\ln(p/1-p) = b_0 + b_1X_1 + b_2X_2 + ... b_nX_n$$

The dependent variables used were

- Chemical weed control method (Dummy)
- Insect control (Dummy)
- Disease control (Dummy)
- Storage treatment (Dummy)
- Seed treatment (Dummy)
- Use of appropriate seed replacement rate (Dummy)
- Use of recommended variety (Dummy)

Whereas independent variables (explanatory variables) were (X_1.....X_n)

- Agriculture group membership (Dummy)
- Advice from agriculture technician/ agro-vet (Dummy)
- Training (Dummy)
- Visit of extension worker (Dummy)
- Rice land (continuous in katthas)

Logistic regression modeling was run several instances for each dependent variable to determine how much it was influenced by each explanatory variable.

Indexing

Problems faced by respondents on the adoption of improved production technology of rice were ranked with the use of index. This technique provides the direction and extremity attitude of the respondent towards any proposition (Miah, 1993) was used to construct an index. The intensity of problems and measures were identified by using eight-point scaling technique using scores of 1.00, 0.875, 0.75, 0.625, 0.50, 0.375, 0.25 and 0.125. The formula given below was used to find the index.

$$I_{prob} = \Sigma\, S_iF_i/N$$

Where, I_{prob} = Index value for intensity; Σ = Summation; S_i = Scale; value of i^{th} intensity; F_i = Frequency of i^{th} response; N = Total number of respondents.

RESULTS AND DISCUSSION

Improved production practices

Table 1 Different improved production practices adopted by respondents in Kanchanpur during field survey (2020).

The government of Nepal has provided different sets of recommended varieties for rice cultivation according to the geographical and climatic conditions of the area (CDD, 2015). In Kanchanpur district, the recommended varieties are Radha-4, Sukhha dhan series, Ram, and Hardinath series. People using only non-recommended varieties were considered as non-adopter whereas using at least one of the recommended varieties were considered as adopter. It was evident from study that 60 % of the respondents adopted at least one recommended variety whereas 40% didn't adopt any recommended varieties. From field survey, it was also revealed that the trend of using Indian improved varieties like Silky and sarju-52 was also found to be high.

Seed treatment before sowing in the nursery helps to sort out damaged and deteriorated seed, to increase the vigor, germination capacity as well as preventive measures from diseases and pests (CDD, 2017). The data for the seed treatment was taken for self-stored seed. It has been found out that 40 (44.4%) of the respondents performed various types of seed treatments before sowing whereas 50 (55.6%) didn't perform any sort of treatment. It was evident that all the respondents used the manual method of weeding. The majority 63.3% of the respondents didn't adopt the chemical method of weed control whereas 36.7% adopted chemical weed control methods. 57.8% of the respondent adopted insect control methods whereas 57.8% didn't adopt them. 36.7% of the respondents adopted disease control method whereas 63.3% of the respondents didn't adopt the disease control method. The study revealed that relatively a smaller number of respondents adopted plant protection measures. The problem of borer, Rice gundhi bug, brown leaf hopper, rice blast, stem rot khaira was seen in the field of the respondents. Non-adoption of protective measures might be due to the lack of knowledge about importance of insects, pests, and disease management. 52.2% of the respondents performed storage treatment either chemical or local for protecting the harvest from rodents and storage pests whereas 47.8% didn't perform any treatment during storage of rice grains. 45.6% of the respondents adopted the appropriate seed replacement rate whereas 54.4% were non-adopters of appropriate seed replacement rate.

Machinery used

It was found from the study that, 90 (100%) of the respondents used spade, 66 (73.3%) used wooden plough, 8 (8.9%) used MB plough, 10 (11.1%) used mini-tiller, 20 (22.2%) used power tillage for tillage and land preparation. During the transplantation of rice, 98.9% of the respondents used hoe. In the study area, only one respondent was found using rice transplanter (drum seeder) for directly seeded rice. 36 (40%) of the respondents used sprayers for spraying insecticides pesticides and fungicides. 1 (1.1%) used hand pumps, 37 (41.1%) used diesel operated pumps and 29 (32.2%) used electricity operated pumps for irrigation. 88 (97.8%) used sickle and 23 (25.6%) used reaper/combine harvester for harvesting of the rice. 75 (83.3%) used mechanical threshers for the threshing of grains. Among all respondents, 21 (23.3%) used cycle/basket, 53 (58.9% bullock/animal cart, and 38 (42.2%) used tractor-trailer or cart for transporting the harvested grains from field to storage (Table 2).

Factors influencing adoption of improved production practices

The majority 61.1% of the respondents had got membership of groups and organizations related to agriculture whereas 38.9% of respondents didn't have the membership. 55% of the respondents had been getting advice from agriculture technicians and agro-vets regarding rice cultivation and 48.9% of the respondent are in contact with extension workers working around their locality to gain information. Majority (66.7%) of the respondents had not received training related to rice cultivation whereas only 33.3% had received training. The average land hold of the respondent was 24.92 katthas with standard deviation of 16.52 (Table 3).

Problem faced on rice cultivation

Various problems were identified at the farm level through focused group discussion which can affect adopting improved rice production technology and these problems were ranked based on farmers' responses towards those problems. Index value was obtained and ranking was done based on the higher index value. Inadequate availability of fertilizers and input, Inadequate training, Inadequate machinery availability, Due to risk felt over new technologies, Shortage of labors, Insects, pests and diseases, Lack of extension related activities, and irrigation insufficiency were ranked 1^{st}, 2^{nd}, 3^{rd}, 4^{th}, $5^{th,}$ 6^{th}, 7^{th} and 8^{th} important problems faced by farmers to use improved rice production technology, respectively (Table 4).

Factors affecting the adoption of chemical weed control

The result showed the odd of using the chemical weed control method by farmers having membership of agriculture group was 3.194 times the odds of chemical weed control method used by respondents not having membership of the agriculture group ($P<0.01$). Amount of land cultivated had positively significant ($P<0.05$) impact on adoption of the chemical weed control method. It means that, if the amount of land was increased by one kattha, the odds of adopting chemical weed control were increased by 1.046 times. The training had positively significant ($P<0.05$) impact on the adoption of chemical weed control method. It means that odds of adopting the chemical weed control method for respondents who have received training were 3.685 times the odds for the chemical weed control method being adopted by respondents that had not received training (Table 5).

Factors affecting the adoption of insect control methods

The study revealed that visit/ contact of extension workers to respondents had positively significant ($P<0.05$) impact on application of the insect control methods. The odds of adoption of

Table 1. Different improved production practices adopted by respondents in Kanchanpur during field survey (2020).

Production practices	Description	Adopter	Non-adopter
Chemical Weed Control Method	Use of chemical herbicides for controlling noxious weeds in rice fields	33 (36.7)	57 (63.3)
Disease Control	Use of chemical fungicides and other local methods for disease control	33 (36.7)	57 (63.3)
Insect Control	Use of local as well as chemical methods for pest control	38 (42.2)	52 (57.8)
Storage treatment	Use of repellants and preventive measures against storage pests and rodents	47 (52.2)	43 (47.8)
Use of recommended variety	Adopted at least one variety recommended by the Government of Nepal	54 (60)	36 (40)
Seed treatment	Adoption of seed treatment before sowing	40 (44.4)	50 (55.6)
Appropriate seed replacement rate (SRR)	If seed replacement is done within 3 years period.	41 (45.6)	49 (54.4)

Figures in parenthesis represent percentages (Source: Field survey, 2020).

Table 2. Different types of machinery used by respondents in Kanchanpur during field survey (2020).

Equipment's adopted	Frequency
Spade	90 (100)
Wooden plough	66 (73.3)
MB plough	8 (8.9)
Mini tiller	10 (11.1)
Power tiller	20 (22.2)
Hoe	89 (98.9)
Rice transplanter	1 (1.1)
Sprayer	36 (40)
Hand pump	1 (1.1)
Diesel operated pump	37 (41.1)
Electricity operated pump	29 (32.2)
Sickle	88 (97.8)
Thresher	75 (83.3)
Reaper/combine harvester	23 (25.6)
Cycle/basket	21 (23.3)
Bullock /animal cart	53 (58.9)
Tractor cart/ trailer	38 (42.2)

Figures in parenthesis represent percentages (Source: Field survey, 2020).

insect control method by respondents having contact with extension workers is 2.868 times the odds of the respondents having no contact with extension workers. Amount of land had positively significant ($P<0.01$) impact on the adoption of the insect control methods. It means that, if the amount of land was increased by one kattha, the odds of adopting the insect control methods were increased by 1.029 times.

Factors affecting the adoption of disease control method

The training had positively significant ($P<0.05$) impact on adoption of the disease control method. It means that odds of adopting the disease control method for respondents who have received training were 3.284 times the odds for the disease control method being adopted by respondents that had not received training. Amount of land cultivated had positively significant ($P<0.01$) impact on the adoption of the disease control methods. It means that, if the amount of land was increased by one kattha, the odds of adopting the disease control methods were increased by 1.029 times.

Factors affecting use of appropriate seed replacement rate

The result showed the odds of using appropriate seed replacement rate by farmers having membership of agriculture group was 3.721 times the odds of appropriate seed replacement rate used by respondents not having membership of the agriculture group ($P<0.05$). Similarly, the odds of using appropriate seed replacement rate by respondents getting advice from agriculture technicians/ agro-vet is 3.795 times the odds of using appropriate seed replacement rate by respondents not getting any advice from technicians/ agro-vet ($P<0.05$).

Factors affecting the adoption of storage treatment

The results on odds ratio showed that among five different explanatory variables only one variable advice from agriculture technicians was found significant at 5% level of significance. The odds of using storage treatment by respondents getting advice from agriculture technicians/ agro-vet is 2.974 times the odds of using storage treatment by respondents not getting any advice from technicians/ agro-vet ($P<0.05$).

Factors affecting the adoption of seed treatment

The results on odds ratio showed that among five different explanatory variables only one variable training was found significant at 10 % level of significance. The odds of using seed treatment by respondents who have received training is 2.493 times the odds of using seed treatment by respondents who had not received any sort of training in rice cultivation ($P<0.01$).

Table 4. Ranking of problems on rice cultivation faced by respondents in Kanchanpur during field survey (2020).

Rank	Weightage	Index	Rank
Inadequate availability of fertilizers and input	76.8	0.85	I
Lack of training	60.9	0.68	II
Inadequate machinery availability	48.3	0.54	III
Due to risk felt over new technologies	47.8	0.53	IV
Shortage of labors	46.5	0.52	V
Insects, pests, and diseases	44.1	0.49	VI
Lack of extension related activities	43.9	0.49	VII
Irrigation insufficiency	36.9	0.41	VIII

Table 5. Regression analysis of dependent and independent/predictor variables.

Variables	Odds ratios						
	Chemical weed control	Insect control	Disease control	Seed replacement rate	Storage treatment	Seed treatment	Recommended variety
Agriculture Group	**3.194***	1.765	1.623	**3.721****	2.144	2.039	**2.775****
Agriculture technician	1.174	1.168	2.145	**3.795****	**2.974****	1.301	1.967
Training	**3.685****	2.295	**3.284****	1.006	1.439	**2.493***	**2.770***
Extension workers	1.168	**2.868****	2.352	-	1.781	1.760	1.349
Rice cultivated land	**1.046****	**1.029***	**1.029***	1.009	1.001	1.013	1.008
Summary statistics							
Number of observations	90	90	90	90	90	90	90
Log Likelihood	-46.112	-51.913	-46.817	-53.232	-54.364	-54.665	-51.289
LR Chi^2	**26.064*****	**18.754*****	**24.656*****	**17.592*****	**15.862*****	**14.323*****	**18.565*****
Prob>Chi^2	0.000	0.002	0.000	0.004	0.007	0.014	0.002
Pseudo R^2	0.344	0.253	0.328	0.237	0.216	0.197	0.252

*, **, *** represent level of significance at 10%,5% and 1% respectively.

Factors affecting the adoption of the recommended variety

The result showed the odd of using recommended variety by farmers having membership of agriculture group was 2.775 times the odds of using recommended variety by respondents not having membership of the agriculture group (*P<0.05*). The training had positively significant (*P<0.01*) impact on adoption of the recommended variety. It means that odds of adopting recommended variety for respondents who have received training were 2.770 times the odds for recommended variety being adopted by respondents that had not received training.

The amount of land cultivated is positively and significantly related to the adoption of various agriculture technologies (Tiwari *et al.*, 2008). Shamsudeen *et al.* (2018) reported those farmers who are involved in agriculture groups are more likely to adopt the production technologies. Mathur (1996) and Khating *et al.* (2018) reported that training is an important part of the extension strategy followed in the entire agricultural development projects. Those farmers who got training on improved agricultural technology are more willing to adopt new technologies than those who didn't get training (Ghimire and Huang, 2016). Access to extension service and advice from agriculture technicians have influence farmers in the adoption of improved production technologies to increase production (Ghimire *et al.*, 2015; Ransom *et al.*, 2003; Rogers, 1983; Barao, 1992) which is similar to findings of this research. Also, Kumar *et al.* (2020) found that various agriculture technologies are more likely to be adopted by farmers who have received training, have contact with agriculture technicians, have access to extension services and membership of agriculture groups which is in line with the findings from this study. Membership in agriculture related organizations helps farmers in the decision making process for the adoption of recommended production technologies (Subedi *et al.*, 2019). There is an association between extension service obtained by farmers and the adoption of improved rice varieties (Budhathoki and Bhatta, 2016). As the farm size increases the odds of adoption of improved varieties were found to be increased (Gairhe *et al.*, 2017). Similarly, Khanal (2016) found that the odds of adoption of IPM practice was more for those farmers who have access to agriculture technicians and extension workers. Exposure to demonstrations or training helped to increase the adoption of technologies or improved practices by raising the likelihood of receiving information about various technologies (Kumar *et al.*, 2020).

Conclusion

The cropping system in the study area was dominated by rice. The majority of the respondents still followed the traditional labor-intensive cultivation practices. The adoption of various improved production technologies had not been practiced properly. The majority of respondents didn't use any types of plant protection measures which might be a reason for not getting production at par its potential. Though having membership in agriculture group majority of respondents had poor contact with extension agents and had not received any training on improved rice production practices. This might be the reason for less adoption of practices beneficial for production. Training helps to enhance the knowledge and influence in the adoption of practices that result in increased rice production. Plans and policies must be developed by the concerned stakeholders so that farmers are influenced and encouraged to use better production practices than the existing ones to increase production. Mechanization is in the infant stage in the study site. The study area is covered entirely by rice in the rainy season. Hence, it has high potential for mechanization. People have started using reaper and combine harvester for harvesting and the majority of farmers use mechanical thresher for threshing. To increase mechanization in rice cultivation farm machinery in subsidized rates are demanded by respondents. Inadequate availability of fertilizers and input, Inadequate training, adequate availability of machinery availability, risk felt over new technologies were major constraints to the rice production technology. Effective strategies must be employed to overcome these problems. Extension works must be focused on changing the traditional way of cultural practices to improved modern ones and also focusing on post-harvest operations. Regular training, field visits, technical interactions, Farmers Field School should be conducted periodically and information about subsidies and various programs conducted by the governmental bodies should be disseminated properly among the farmers and other concerned beneficiaries. Policies and plans must be worked out so that farmers get inputs like fertilizers, seed easily on required time and the marketing of the product should also be made easy. The establishment of a postharvest center might be a possible solution.

ACKNOWLEDGEMENTS

We would like to acknowledge Agriculture and Forestry University for funding this study. We are thankful to Mrs. Sanju Rimal Upadhyay (Senior Agriculture Officer, Rice Super zone, Kanchanpur), site supervisor, and Mr. Kul Prasad Dawadi (Chief, Seed Laboratory, Bagmati province), member supervisor for their guidance and support. We wish to express my sincere appreciation and profound gratitude to Mr. Ram Hari Timilsina (Asst. Prof., Department of Agricultural Extension and Rural Sociology, AFU, Rampur) for his guidance and support in the study.

Disclosure Statement

The author declares there are no conflicts of interest regarding the publication of this manuscript.

Funding

This study has not received direct funding from other sources.

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