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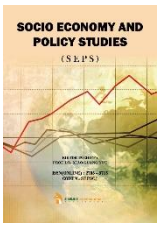

RESEARCH ARTICLE

ADOPTION OF RECOMMENDED PRODUCTION PRACTICES IN RICE PRODUCTION IN FARMERS' FIELDS AT JANAKPURDHAM SUB-METROPOLITAN OF NEPAL

Santosh Bhandari[a*], Saroj Sapkota[a], Saroj Khanal[a], Chetan Gyawali[b], Rejina Khanal[c]

[a] Faculty of Agriculture, Agriculture and Forestry University, Rampur, Chitwan, Nepal.
[b] National Rice Research Institute, Nepal Agricultural Research Council, Hardinath, Dhanusha, Nepal.
[c] Ratnanagar 01, Bakulahar, Chitwan, Nepal.
**Corresponding author email: santoshbhandari4556@gmail.com*

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ABSTRACT

Rice yield has been substantially facing a negative yield slope since times. Higher production of rice can be achieved by promoting the adoption of recommended production practices among rice-growing farmers in Nepal. A study was carried out in the summer (May/June) of 2019 to assess the adoption status of recommended production practices among rice-growing farmers of Janakpurdham-17 & 18 (Only two local bodies of Janakpurdham sub-metropolitan city under thematic working areas of Rice Zone, Prime Minister Agriculture Modernization Project of Nepal). The results analysis showed that most respondents were male (80%). Many respondents were in the adult age group (44%) followed by senior citizens (34%). Most of them were illiterate (68%), had a medium household size, and had a low level of income. The average landholding size was found to be 0.9546 ha. Many of the respondents were not affiliated with the farmers' groups and did not receive any sort of training. Most respondents were found to be adopters of recommended rice production practices except for the recommended age of seedlings. The Chi-square test showed that farmer group membership and training had a positive and significant relationship with the adoption of recommended production practices. Also, the income of farmers was positively correlated with the adoption of irrigation sources. Major sources of knowledge about rice cultivation among the respondents were found to be neighbors, relatives, fairs and exhibitions, and non-governmental organizations. Lack of better irrigation facilities, poor seed quality, lack of agriculture loans, and disease, and insect pest problems were the major constraints faced by the farmers in rice cultivation.

KEYWORDS

Level of adoption, recommended production practices of rice, constraints in paddy production, rice growing farmers, adoption index of rice recommended practices

1. INTRODUCTION

Rice (*Oryzae sativa* L.) is a perennial cereal grass belonging to the family Graminae. Altogether, there are about 23 species of rice, but only two species have been known for their wide domestication and commercial value. These two species are *Oryzae sativa* (Asian rice) and *Oryzae glaberrima* (African rice). Globally, rice ranks second to wheat in terms of area harvested, but in terms of importance as a food crop, rice provides more calories per hectare than any other cereal crop (Anand and Kamaraj, 2017). In Nepal, rice ranks first both in terms of area cultivated, production, and livelihood of people (Corporate Development Division, 2015). With 138 kg consumed per person, rice accounts for 52% of all cereal consumption in Nepal and 16% of the country's agricultural GDP (Yadav and Chaudhary, 2017). Rice is a significant staple crop in Nepal. Four decades of trend research for rice cultivation and area both reveal rising trends of 0.59 and 1.75 percent, respectively (CDD, 2015). More than 1, 700 rice landraces are reported in Nepal growing from 60 to 3,050 MASL (Mallick, 1981).

The total area, production, and yield of rice in Nepal are 14,69,545 ha, 51,51,925 MT, and 3506 kg/ha respectively (Ministry of Agriculture and Livestock Development, 2018/19). Terai (the Gangetic plains), mid-hill, and high hill are the three distinct agricultural areas where rice is grown, with individual shares of 68, 28, and 4% (Gauchan et al., 2014). Dhanusha is one of the prime centers for cereal production located in the Terai region of Nepal. The total area of the district is 1180 square kilometers. The area, production, and yield in the fiscal year 2016/17 in the Dhanusha district were 35,200ha, 1,21,100 Mt, and 3.44 Mt/ha respectively (Ministry of Agriculture and Livestock Development, 2016/17). The main varieties of rice cultivated in this region are Lalka basmati, Sabitri, Hardinath-1, Ram Dhan, Swarna sub-1, Sukkha 1, 2, and 3. The maximum land area is under the rain-fed condition and few are fed with irrigation occasionally.

Rice production in Nepal is low for a number of reasons. Low levels of fertilizers, delay in seedling transplantation, insufficient irrigation capacity, poor soil fertility, a lack of better varieties, and a sparse application of enhanced production techniques are a few of the main causes of low yield. Two-thirds of country's rice fields are rain-fed, and the majority of them are stressed out by drought and flooding during the monsoon months, leading to low yields and considerable unpredictability in the amount of rice produced (Gauchan et al., 2012). Rice production has not been very promising throughout the years in Nepal. This is partly attributed to the inadequate or nil adoption of recommended rice cultivation practices, like recommended varieties and fertilizers. Farmers use local varieties that are planted in the same land time and again without adding fertilizers, the practice that has left most of the nation's soils with low fertility.

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It has been noted that inorganic fertilizer is crucial to reversing the decline in soil fertility at the low level of soil nutrients (Ahmed and Sanders, 2001). However, other alternatives such as farmyard manure and green manures are available to many farmers in quantities that are insufficient to resolve nutrient deficiencies (Ahmed and Sanders, 2001). Everywhere else in the world where crop yields have been substantially increased, inorganic fertilizer complemented with other agronomic practices like the use of improved seed varieties, spacing, and weeding has been noted as a basic component in increasing crop production and productivity (Ahmed and Sanders, 2001). Because of the reduced seed rate requirement and disease-free character of the high-quality vigorous seeds, fresh replacement of quality seed of enhanced variety boosts yields while also lowering production costs. Utilizing high-quality seeds also improves the effectiveness and production of other crucial inputs like fertilizers, moisture, and workforce (Gauchan et al., 2016).

Both sustainability in agriculture and greater harvests depend on varietal diversity. Crop diversity and species combination can reduce disease and pest proliferation by fostering functional diversity (Finckh et al., 2000). The recently developed National Seed Vision (2013–2025) of the Government of Nepal seeks to increase seed replacement rate by producing quality seeds of improved high yielding adaptation and mitigation varieties and hybrids accessible. This is done in recognition of the significance of quality seeds of improved varieties for enhanced agricultural production and ensuring the nation's food security (MoAD, 2013).

1.1 Objective of Study

1.1.1 General Objective

To study the adoption of recommended production practices in rice production.

1.1.2 Specific Objectives

- To access the adoption of the recommended dose of chemical fertilizers.
- To observe the influence of independent factors on the adoption of selected recommended rice production technology.
- To explore the major constraints faced by farmers on rice production in the area.

2. METHODOLOGY

2.1 Sample and Sampling Technique

A list of rice-growing farmers from each local area of the rice zone was prepared separately which was provided by the rice zone, PMAMP, Dhanusha. As per the list, the total household number of Janakpurdham-17 was recorded as 213 and that of Janakpurdham-18 as 238, which was somewhat similar. This was used as a sampling frame to select the respondent farmers. Twenty-five respondents (households) were randomly selected from each area through the lottery method. Thus, the total sample size was 50.

2.2 Research Design

After multiple visits to the six working areas of the rice zone, the area of study was selected. Then, the literature about the study area was collected and reviewed. This helped a lot in stating the pressing problems of the area. Appropriate methods and methodology were identified and tested for efficiency. Shortly afterward, primary data were obtained from the week-long field survey starting from May 30 to June 4 of 2019, while secondary data were collected from academic and non-academic literature. Finally, the analysis of raw data was performed with the help of Ms-Excel and SPSS.

2.3 Data and Data Types

2.3.1 Preliminary Survey

Pre-survey field visits were conducted to gather preliminary information regarding the demographic, socio-cultural, and topographical settings of the site. This information was used in the preparation of questionnaires and in designing a sampling framework.

2.3.2 Key Informant Interview

To develop further ideas about the study site, informal discussion, and interview with key informants was done. Model farmers, teachers, senior elders, co-operative staff, and other knowledgeable persons were taken as the key informants. The interview was focused on the previous farming practices, application of modern technology, cultivation practices among the different groups of farmers, and production of rice comparing traditional and improved production strategies.

2.3.3 Primary Data Collection

2.3.3.1 Questionnaire Survey

The questionnaire was prepared with deliberate attention taking consideration of information from the key informant survey and pre-survey visits of the study site. The questionnaire survey was focused on the adoption of recommended production practices of rice that are practiced by the farmers. Detailed information about the household, socio-economic status, adopted recommended practices, benefits of the adoption of improved production technology, etc. was discussed in the questionnaire. The questionnaire was used to collect information from the randomly selected farmers of the rice zone area.

2.3.3.2 Focus Group Discussion (FGD)

One comprehensive focus group discussion (FGD) was conducted at the study site after completing the questionnaire survey with the help of a checklist to verify the result obtained from the field survey, to assess the level of adoption of identified practices recommended in rice production, and to discuss the strategies to increase the adoption of recommended rice practices in rice zone area of Janakpurdham sub-metropolitan. In the FGD, participants were local farmers, and all ethnic groups and gender were included. However, most of the randomly selected female farmers didn't participate in the survey due to social and gender-related issues. So, only a few of the females participated in the study and the rest were substituted with males.

2.3.4 Secondary Data Collection

Secondary data were obtained from District Agriculture Development Office (DADO) annual reports, newsletters, bulletins and relevant articles, libraries and information office, Department of Agriculture, Ministry of Agriculture and Cooperatives (MoAC). The local political leaders, working agencies, and local government were the sources of secondary data.

2.4 Data Analysis

The collected primary data were coded, entered, and put forward for analysis. SPSS and MS-EXCEL were used for the analysis of data. Descriptive statistics such as frequency and percentage were calculated to determine the distribution of the study variables. Chi-square was used to test the significant difference between variables under investigation.

2.5 Chi-Square Test or Test of Independence

To study whether variables were independent or associated with each other; the chi-square test was applied (Pearson, 1893).

$$\chi^2 = \sum \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

Where χ^2=Chi-square

O_{ij} = observed frequency of each ijth term

E_{ij}= indicates the expected frequency of ijth term

i= 1, 2, 3……. r

j= 1, 2, 3……. k

This was tested at 0.05 level of probability for different degrees of freedom.

3. RESULTS

3.1 Distribution of Farmers According to the Socio-Economic Characteristics of The Respondents

The socio-economic factors associated with the adoption of rice technology included in this study were age, sex, education, religion, family size, family income, landholding size, and farmer group membership. These were described and compared according to the respondents' involvement in technology adoption.

Table 1: Distribution of Farmers According to the Socio-Economic Characteristics of the Respondents				
S. N	**Socio-economic characteristics**	**Frequency**	**Percentage**	**Standard deviation**
1.	Age			11.823
(i)	Young (below or equal to 30 years)	2	4	1.41
(ii)	Youth I (31-45 years)	9	18	4.22
(iii)	Youth II (46-60)	22	44	4.42
(iii)	Senior (above 60 years)	17	34	4.35
2.	Sex			21.21
(i)	Male	40	80	
(ii)	Female	10	20	
3.	Education level			15.82
(i)	Illiterate	34	68	
(ii)	Less than SLC	13	26	
(iii)	SLC and above	3	6	
4.	Religion			19.79
(i)	Hindu	39	78	
(ii)	Muslim	11	22	
5.	Family size			6.1
(i)	Small (below 8)	21	42	1.24
(ii)	Medium (8-15)	21	42	2.18
(iii)	Large (above 15)	8	16	5.23
6.	Total household members			43.13
(i)	Total female	233	44.2	3.28
(ii)	Total male	294	55.8	3.69
7.	Family income (Cash annually in thousand)			16.82
(i)	Low (<50 thousand)	30	60	8.76
(ii)	Medium (50-100 thousand)	18	36	8.013
(iii)	High (>100 thousand)	2	4	7.77
8.	Landholding size (In hectare)			0.74
(i)	Small (<0.5)	14	28	0.107
(ii)	Medium (0.5-1.5)	27	54	0.28
(iii)	Large (>1.5)	9	18	0.58
9.	Farmer group membership			14.14
(i)	Membership	15	30	
(ii)	Non-membership	35	70	

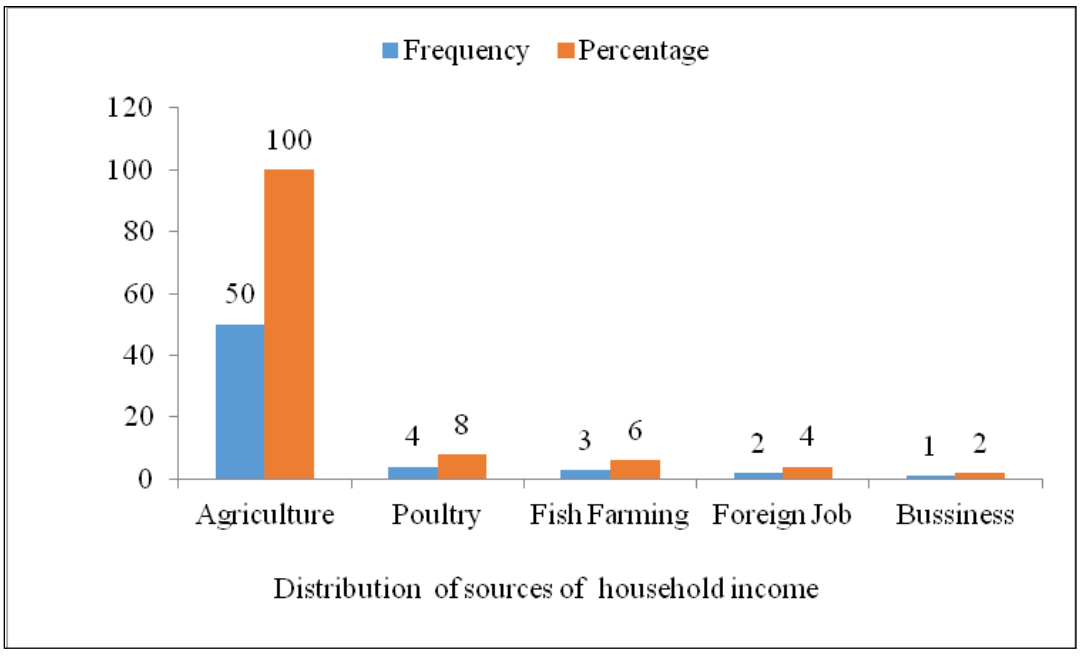

Figure 1: Distribution of respondents by primary and secondary income source (Source: Field Survey, 2019)

Agriculture and livestock were the main sources of livelihood of the farmers in the study area. Apart from these sources, poultry, fish farming, foreign jobs, and businesses were also among other sources of income to earn their livelihoods.

3.2 Description of Extension-Related Factors

The extension-related factors described in this study were training (related to rice cultivation) and the frequency of extension agent contact.

3.2.1 Farmer's Participation in Training

Table 2: Distribution of Respondents Based on Training Pattern.

Farmer's participation in training	Frequency	Percent
Training received	2	4.0
Training not received	48	96.0
Total	50	100.0

Source: Field Survey, 2019

3.2.2 Availability of Extension Service

Table 3: Distribution of Respondents Based on The Availability of Extension Service

Availability of extension service	Frequency	Percent
Once a week	2	4.0
Twice a month (Fortnightly)	5	10.0
Once a month	9	18.0
Never	34	68.0
Total	50	100.0

Source: Field Survey, 2019

3.2.3 Cropping Pattern

Rice's dominant cropping pattern was found to be very common in the study area. The study revealed that all the respondents followed the same cropping pattern of Rice-wheat-pulse in the study site.

3.2.4 Adoption of Improved Rice Production Technology

The major components of rice cultivation practices recommended so far in the study area were taken into consideration in determining the farmers' adoption level. They were improved varieties, seed rate, age of seedlings, number of seedlings per hill, recommended dose of manures and fertilizers, weeding, insects-pest, and disease management practices.

3.2.5 Coverage of Improved Varieties

The recommended varieties included Lalka basmati, Sabitri, Hardinath-1, Ram Dhan, Swarna sub-1, Sukkha 1, 2, and 3. The majority of respondents (72%) were found using recommended varieties whereas 28% of the respondents' used non-recommended varieties of rice. Involvement in the farmer group may be the reason for the adoption of recommended variety among the respondents.

3.2.6 Seed Rate

The recommended seed rate of rice is 45-50 kg/ha, as recommended by NARC. It was found that most of the respondents (54%) used the recommendation seed rate.

3.2.7 Age of Seedlings

The recommended age of rice seedlings is 21-28 days as recommended by NARC. Table 4 reveals that a minority of the farmers of the study area used 21-28 days aged rice seedlings for transplantation. This points out that many farmers do not have proper knowledge regarding the right time of transplanting the seedlings.

Table 4: Adoption of Improved Rice Production Technology

S. N	Recommended production technologies	Frequency	Percentage
1.	Improved varieties		
(i)	Adopter	36	72
(ii)	Non-adopter	14	28
2.	Seed rate		
(i)	Adopter	27	54
(ii)	Non-adopter	23	46
3.	Age of seedling		
(i)	Adopter	13	26
(ii)	Non-adopter	37	74
4.	Number of seedling per hill		
(i)	Adopter	29	58
(ii)	Non-adopter	21	42
5.	The recommended dose of chemical fertilizers		
(i)	Urea		
a)	Adopter	12	24
b)	Non-adopter	38	72
(ii)	Potash		
a)	Adopter	5	10
b)	Non-adopter	45	90
(iii)	Micronutrient		
a)	Adopter	43	86
b)	Non-adopter	7	14
6.	Method of weeding		
(i)	Manual only	-	-
(ii)	Manually + chemically	47	94
(iii)	Chemical only	3	6
7.	Insect pest management and disease control		
(i)	Adopter	49	98
(ii)	Non-adopter	1	2
8.	Method of harvesting		
(i)	Adopter	50	100
(ii)	Non-adopter	-	-
9.	Method of storage		
(i)	Locally made bins and sacks	39	78
(ii)	Godowns	11	22
10.	Productivity of rice		
(i)	less than or equal to 3.6	22	44
(ii)	3.6-3.75	22	44
(iii)	greater than 3.75	6	12

Source: Field Survey 2019

3.2.8 Number of Rice Seedlings Per Hill

The recommended number of rice seedlings per hill is 2-3, as suggested by NARC. Table 4 reveals that most of the respondents used 2-3 seedlings per hill transplanting. Adoption of the recommended number of rice seedlings per hill was due to knowledge of the respondents about the actual no. of seedlings per hill to increase yield.

3.2.9 Recommended Dose of Chemical Fertilizers

Recommended dose of fertilizer for rice cultivation is 100:30:30 kg NPK ha^{-1} i.e 190 kg urea, 65 kg DAP, 50 kg potash. Only a few of the respondents were found using the recommended dose of DAP.

3.2.10 Urea

Urea is the source of nitrogen, used as a fertilizer. The majority of the respondents used an intermediate amount of urea below the recommended dose. Out of the total respondents, 24% of the respondents used full dose and 54% of the respondents used 70-80% of the recommended dose of urea while 22% of the respondents used 60% of the recommended dose of urea. The majority of respondents used an intermediate dose of urea the reason that FYM and green manures were mandatorily incorporated into the soil at the time of final land preparation covering some of the nitrogen requirements of the plant.

3.2.11 Potash

Potash fertilizer is a source of potassium. The majority of the respondents used a low amount of potash below the recommended dose. Out of the total respondents, 26% of the respondents were non-adopter (Nil), 10% of the respondents were higher adopters (full dose), 12% of the respondents were medium adopters (two-third) and 52% of the respondents were Low adopters (one-third). Low or no adoption of potash was due to the unavailability of potash during planting time as well as lack of knowledge among the respondents about the physiological benefit of potash against insect pests and diseases.

3.2.12 Use of Micronutrient

Zinc is an essential plant nutrient required for several biochemical processes in rice crops, including chlorophyll production and membrane integrity. Table 4 reveals that the majority of the respondents (86%) used micronutrient (Zinc) and 14 % did not use any form of micronutrients. Higher adoption of zinc was due to the availability of zinc during planting time as well as the knowledge of the respondents about Zinc (Protection of rice plant from Khaira disease).

3.2.13 Method of Weeding

Table 4 reveals that the majority of the respondents (94%) used glyphosate initially and manual weeding shortly afterward. The minority of the respondents (6%) did not apply manual weeding at all.

3.3 Insect-Pests and Disease Management

Insect-pests and disease management is also one of the important practices for rice cultivation. Blast and Khaira were the major diseases of rice in the study site. Likewise, Stem borer, Rice gundhi bug, Armyworm, etc. were major insect-pests. There was relatively more infestation of insect-pests and diseases because the study area was located in the Terai region where the climate is tropical. At the same time, a minority of the farmers did not use pesticides, micronutrients, and insecticides to control insect pests and diseases in their fields. Table 4 reveals that 98% of respondents adopted insect-pest management and disease control practices and only 2% of respondents had not adopted such type of measure.

3.3.1 Method of Harvesting

The recommended method of harvesting rice in Dhanusha is a manual method of harvesting. All the respondents (100%) used a manual method of harvesting. It was found that the method of harvesting used by the farmers was as per recommendation. The manual method of harvesting was due to the unavailability of reapers for harvesting as well as cost implications.

3.3.2 Method of Storage

It was found that about 78% of the respondents used locally made bins and sacks for the storage of harvested grains near their residence. Generally, farmers use locally made bins for storing grains for a longer period and sacks for storing rice to be sold within a short period.

3.4 Productivity of Rice in the Study Area

Table 4 reveals that the majority of the respondents (88.0%) had productivity of less than 3.75 Mt ha^{-1} followed by 12 % of respondents with high productivity greater than 3.75 Mt ha^{-1}. The result indicates that the minority of the respondents had better productivity of rice.

3.5 The Influence of Independent Factors on The Adoption of Selected Recommended Rice Production Technology

3.5.1 Age

It has been observed that, compared with younger farmers, the probability of adoption is lower among older farmers because of their planning horizons (Ervin, 1981). A negative relationship is therefore hypothesized between age and the adoption of recommended fertilizer packages (Chianu and Tsujii, 2005). The results also indicate that farming experience does not matter in the adoption as age increases, it was expected that farmers become conservative (Chilot et al., 1996). Table 5, 6, and 7 provide a summary of the study results.

3.5.2 Association Between Farmers' Age and Adoption of Recommended Seed Rate

Figures in parentheses indicate an expected frequency.

Chi-Square (χ^2 Cal) =0.52 (χ^2 tab) =7.8 P-value =0.91 df=3 Nonsignificant at 0.05 level of probability

This result signifies that the association between the age of farmers and the recommended seed rate used by them is statistically non-significant. It means there is no association between the age group of farmers and the recommended number of seeds used by them.

3.5.3 Association Between Age and Adoption of Recommended Age of Seedling Used for Transplanting.

Figures in parentheses indicate an expected frequency.

Chi-Square (χ^2 Cal) =1.48 (χ^2 tab) =7.81 P-value 0.68 df=3 Nonsignificant at 0.05 level of probability

This result signifies that the association between the age of farmers and the recommended age of seedlings used for transplanting by them is statistically non-significant. It means there is no association between the age group of farmers and the recommended age of seedling used for transplanting.

Table 5: Distribution of respondents According to Their Age and Adoption of Recommended Seed Rate (N=50)

Seed rate	Age of respondents				Total
	15-30	31-45	46-60	>60	
Adopter	1 (0.84)	3 (3.78)	9 (9.24)	8 (7.14)	21 (21)
Non adopter	1 (1.16)	6 (5.22)	13 (12.76)	9 (9.86)	29 (29)
Total	2 (2)	9 (9)	22 (22)	17 (17)	50 (50)

Table 6: Distribution of Respondents According to their Age and Adoption of Recommended Age of Seedling Used for Transplanting (N=50)

Age of seedling	Age of respondents				Total
	15-30	31-45	46-60	>60	
Adopter	1 (0.52)	3 (2.34)	6 (5.72)	3 (4.42)	13 (13)
Non adopter	1 (1.48)	6 (6.66)	16 (16.28)	14 (12.58)	37 (37)
Total	2 (2)	9 (9)	22 (22)	17 (17)	50 (50)

3.5.4 Association Between Age and Adoption of Recommended Rice Variety

Figures in parentheses indicate an expected frequency.

Chi-Square (χ^2 Cal) =5.04 (χ^2 tab) =7.81 P-value 0.168 df=3 Nonsignificant at 0.05 level of probability

This result signifies that the association between the age of farmers and the recommended rice variety used by them is statistically non-significant. It means there is no association between the age group of farmers and the recommended rice variety used by them.

3.5.5 Farmers' Education Level

It is expected that educated respondents can make better decisions to adopt recommended production practices than non-educated ones. With the high level of education of the respondents, most farmers in the study area are likely to adopt recommended rice production practices. The findings regarding the relationship between education and the adoption of selected recommended production technology are summarized in Tables 8, 9, and 10.

3.5.5.1 Association Between Farmers' Education Level and Adoption of Recommended Seed Rate

Figures in parentheses indicate an expected frequency

Chi-Square (χ^2 Cal) =6.91 (χ^2 tab) =5.99 P value 0.031; df =2 significant at 0.05 level of probability

This result shows that the association between the education level of farmers and the recommended seed rate used by them is statistically significant. It means there is a close association between the education level of farmers and the recommended amounts of seed used by them.

Table 7: Distribution of Respondents According to Their Age and Adoption of Recommended Rice Variety (N=50)

Recommended Rice Variety	Age of respondents				Total
	15-30	31-45	46-60	>60	
Adopter	2 (1.44)	7 (6.48)	18 (15.84)	9 (12.24)	36 (36)
Non adopter	0 (0.56)	2 (2.52)	4 (6.16)	8 (4.76)	14 (14)
Total	2 (2)	9 (9)	22 (22)	17 (17)	50 (50)

Table 8: Distribution of Respondents According to Their Level of Education and Adoption of Recommended Seed Rate (N=50)

Seed rate	Education status			
	Illiterate	Below SLC	SLC and above	Total
Adopter	10 (14.28)	9 (5.46)	2 (1.26)	21
Non adopter	24 (19.72)	4 (7.54)	1 (1.74)	29
Total	34	13	3	50

3.5.5.2 Association Between Farmers' Education Level and Adoption of Recommended Age of Seedling Used for Transplanting

Figures in parentheses indicate an expected frequency.

Chi-Square (χ^2 Cal) =9.92 (χ^2 tab) =5.99 P-value 0.006 df =2 significant at 0.05 level of probability

This result signifies that the association between the education level of farmers and the recommended age of seedlings used for transplanting by them is statistically significant. It means there is a proximity in the relationship between the education level of farmers and the recommended age of seedlings used for transplanting by them.

3.5.5.3 Association Between Farmers' Education Level and Adoption of Recommended Rice Variety

Figures in parentheses indicate an expected frequency.

Chi-Square (χ^2 Cal) = 3.62 (χ^2 tab) =5.99 P-value 0.16 df=2 non-significant at 0.05 level of probability

This result signifies that the association between the education level of farmers and recommended rice variety used by them is statistically non-significant. It means there is no association between the education level of farmers and the recommended rice variety used by them.

3.5.6 Farmer Group Membership

3.5.6.1 Association Between Farmers Group Membership And Adoption of Recommended Seed Rate

Figures in parentheses indicate an expected frequency.

Chi-Square (χ^2 Cal) =12.70 (χ^2 tab) =3.84 P value 0.0003 df=1 Significant at 0.05 level of probability

This result signifies that the association between farmers involved in farmers groups and the recommended seed rate used by them is statistically significant. It means there is a close association between farmers participating in training and the recommended seed rate used by them.

Table 9: Distribution of Respondents According to Their Level of Education and Adoption of Recommended Age of Seedling Used for Transplanting (N=50)

Age of seedling	Education status			
	Illiterate	Below SLC	SLC and above	Total
Adopter	6 (8.84)	4 (3.38)	3 (0.78)	13 (13)
Non adopter	28 (25.16)	9 (9.62)	0 (2.22)	37 (37)
Total	34	13	3	50 (50)

Table 10: Distribution of respondents according to their level of education and adoption of recommended rice variety (N=50)

Recommended Variety	Education status			
	Illiterate	Below SLC	SLC and above	Total
Adopter	26 (24.48)	7 (9.36)	3(2.16)	36 (36)
Non adopter	8 (9.52)	6 (3.64)	0(0.84)	14 (14)
Total	34 (34)	13 (13)	3 (3)	50 (50)

Table 11: Distribution of respondents according to their farmer group membership and adoption of recommended seed rate (N=50)

Seed rate	Distribution of respondents		Total
	Non-membership	Membership	
Adopter	9 (14.7)	12 (6.3)	21
Non adopter	26 (20.3)	3 (8.7)	29
Total	35	15	50

3.5.6.2 Association Between Farmers Group Membership and Adoption of The Age of Seedling Used for Transplanting

Figures in parentheses indicate an expected frequency.

Chi-Square (χ^2 Cal) =4.75 (χ^2 tab) =3.84 P value 0.029 df=1 Significant at 0.05 level of probability

This result signifies that the associations between farmers involved in the farmers' groups and recommended age of seedlings used by them for transplanting are statistically significant. It means there is a close association between farmers involved in farmers' groups and the recommended age of seedlings used by them for transplanting.

3.5.6.3 Association Between Farmers Group Membership and Adoption of Recommended Rice Variety

Figures in parentheses indicate an expected frequency.

Chi-Square (χ^2 Cal) =2.28 (χ^2 tab) =3.84 P value 0.13 degree of freedom=1 non-significant at 0.05 level of probability

This result signifies that the associations between farmers involved in farmers' groups and recommended rice variety used by them are statistically non-significant. It means there is no significant association between farmers involved in farmers' groups and the recommended variety used by them.

Table 12: Distribution of Respondents According to Their Farmer Group Membership and Adoption of Recommended Age of Seedling Used for Transplanting (N=50)

Age of seedling	Distribution of respondents		Total
	Non-membership	Membership	
Adopter	6(9.1)	7 (3.9)	13
Non adopter	29 (25.9)	8 (11.1)	37
Total	35	15	50

Table 13: Distribution of Respondents According to Their Farmer Group Membership and Adoption of Recommended Rice Variety (N=50)

Recommended variety	Distribution of respondents		Total
	Non-membership	Membership	
Adopter	23 (25.2)	13 (10.8)	36 (36)
Non adopter	12 (9.8)	2 (4.2)	14 (14)
Total	35 (35)	15 (15)	50 (50)

3.5.7 Farmer's Participation in Training

3.5.7.1 Association Between Farmers' Participation in Training and Adoption of Recommended Seed Rate

Figures in parentheses indicate an expected frequency.

Chi-Square (χ^2 Cal) =4.41 (χ^2 tab) =3.84 P value 0.03 df=1 non-significant at 0.05 level of probability

This result signifies that the association between farmers participating in training and the recommended seed rate used by them is statistically significant. It means there is a close association between farmers who participated in training and the recommended seed rate used by them.

3.5.7.2 Association Between Farmers' Participation in Training And Adoption of Recommended Age of Seedling Used for Transplanting

Figures in parentheses indicate an expected frequency.

Chi-Square (χ^2 Cal) =11.64 (χ^2 tab) =3.84 P value 0.0006 df =1 Significant at 0.05 level of probability

This result signifies that the association between farmers participated in training and recommended age of seedling used for transplanting by them is statistically significant. It means there is a close association between farmers participating in training and the recommended age of seedling used for transplanting by them.

3.5.7.3 Association between farmers' participation in rice training and adoption of a recommended variety

Figures in parentheses indicate an expected frequency.

Chi-Square (χ^2 Cal) =0.43 (χ^2 tab) =3.84 P value 0.50 degree of freedom =1 Statistically non-significant difference at 0.05 level of probability

This result signifies that the association between farmers participating in training and the recommended variety used by them is statistically non-significant. It means that there is no association between farmers' participation in training and the recommended variety used by them. This signifies that the association had no positive effect in the adoption of the recommended variety of rice.

3.6 Reason for Variety Preference

Among the different reasons for variety preference, the important reason used by the farmers for rice cultivation was fine grain followed by higher yield. The main variety of rice adopted by the respondents was found to be Lalka Basmati, which is fine-grained rice.

Table 14: Distribution of Respondents According to Their Participation in Rice Training and Adoption of Recommended Seed Rate (N=50)

Seed rate	Distribution of respondents		Total
	Training not received	Training received	
Adopter	17 (18.48)	5 (2.52)	21
Non adopter	27 (25.52)	1 (3.48)	29
Total	44	6	50

Table 15: Distribution of Respondents According to Their Participation in Rice Training And Adoption of Recommended Age of Seedling Used For Transplanting (N=50)

Age of seedling	Distribution of respondents		Total
	Training not received	Training received	
Adopter	8 (11.44)	5 (1.56)	13
Non adopter	36 (32.56)	1 (4.44)	37
Total	44	6	50

Table 16: Distribution of Respondents According to Their Participation in Rice Training And Adoption of Recommended Rice Variety (N=50)

Recommended variety	Distribution of respondents		Total
	Training not received	Training received	
Adopter	31 (31.68)	5 (4.32)	36
Non adopter	13 (12.32)	1 (1.68)	14
Total	44	6	50

Table 17: Reason for Variety Preference by The Farmers for Rice Cultivation		
Reason for variety preference	Index	Rank
More straw	7.4	IV
Higher yield	7.7	II
Normal yield and more straw	7.5	III
Low yield and more straw	3.12	VIII
Fine-grain	8.7	I
More milling percentage	3.94	VII
Disease resistance	7.22	V
Insect pest resistance	6.3	VI

Source: Field Survey, 2019

3.7 Source of Knowledge Used by The Farmers for Rice Cultivation.

Farmers gained knowledge of rice cultivation from different sources, which has been presented in Table 18.

3.8 Major Constraints Faced By Farmers On Rice Cultivation.

There are many constraints for farmers in rice cultivation. This study attempted to find some of them as perceived by the farmers. The following were the major constraints associated with rice cultivation.

3.8.1 Irrigation

Among the different inputs required for rice cultivation, irrigation is the most critical factor. Lowland rice requires a certain water level to be met for its vegetative growth under submerged conditions. Lack of proper irrigation sources has always been a major constraint for low productivity in major rice-growing areas of Nepal. In the site-specific study at two wards of Janakpurdham, it was reported that only 9 out of 50 respondents had access to underground and boring water sources, whose annual income was higher than NRs 30000.

Table 18: Sources of Knowledge Used by The Respondents Friedman Test Was Used for Mean Ranking. Score-1 Being the Least Important Source of Knowledge and 10 Being the Most Important.		
Sources of information	Mean	Rank
Neighbors	9.44	I
Relatives	9.42	II
Fair and exhibition	7.54	III
NGO	6.72	IV
Agriculture Service Centre	6.40	V
Radio	5.04	VI
Agro-vet	4.07	VII
Published materials	3.16	VIII
Television	2.21	IX
Email, internet	1.00	X

Source: Field Survey, 2019

Table 19: Constraints on Rice Production by the Farmers		
Constraints	Mean	Rank
Irrigation	8.66	I
Seed Quality	7.59	II
Agriculture loan	6.86	III
Insect and pest	4.96	IV
Marketing	4.95	V
Fertilizer	4.36	VI
Disease, insect	3.48	VII
Storage	2.16	VIII
Technology	1.98	IX

Source: Field Survey, 2019

Irrigation management	Number of respondents (Percentage)				
	Annual income below NRs 30000	Annual income (NRs 30000-60000)	Annual income (> NRs 60000)	Total	Chi-square test ($p< 0.05$)
Rainfed	8	29	4	41	
Underground water/Boring irrigated	0	5	4	9	7.556*
Total	8	34	8	50	

Source: Field Survey, 2019

4. Discussion

The study was conducted in the two local bodies of Janakpurdham sub-metropolitan city, which is currently under the thematic working premises of Rice Zone, Dhanusha, Prime Minister Agriculture Modernization Project, Nepal. In the study, it was found that the majority of the respondents (80%) were male since females didn't actively participate in the survey. The finding is supported by the publication of the District Agriculture Development Office. Although females predominantly have control over the agriculture sector, most of the females hesitate to participate in surveys due to social and gender-related issues (District Agriculture Development Office, 2016/17). The majority of respondents (78%) followed Hindu religion. The district profile also showed that the dominant religion in the district is Hinduism (District Agriculture Development Office, 2016/17). The literacy rate of the study area was found to be 32% whereas the literacy rate of Dhanusha is 50.44% (Central

Bureau of Statistics, 2015). The average size of the family in the study area was 10.54, which is bigger than the district average i.e., 5.46 and the national average i.e., 4.88 (District Agriculture Development Office, 2016/17; Central Bureau of Statistics, 2015).

The study also revealed that all of the respondents followed the rice-wheat-pulse cropping system instead of the rice-wheat-maize cropping system. Maize was substituted for a pulse in the cropping system because of its restorative property in the soil which is beneficial for the subsequent crop (District Agriculture Development Office, 2016/17). The majority of the respondents had productivity of rice less than 3.75 $Mtha^{-1}$. The average rice productivity of the study area was 3.687 Mt ha^{-1} whereas the district average is 3.05 Mt ha^{-1} and the national average is 3.369 Mt ha^{-1} (District Agriculture Development Office, 2016/17). Farmers well acknowledged that glyphosate is a broad-spectrum herbicide and is used to control types of weeds. So, they used glyphosate at the time of final land preparation to ensure that the field is free from all types of weeds and weed seeds. It was found that few farmers practiced pest management practice. The majority of the farmers in the study area did not have technical knowledge about pest management as well as pesticides were expensive and not available in time. However, people were fully aware of the availability of pesticides, micronutrients, and insecticides, and the right amount of dose to apply in their field.

In the analysis of extension-related services, the results showed that there is no significant relationship between age and the adoption of recommended cultivation practices that are in line with the studies in which it was found that there is no relationship between age and adoption of recommended production technology (Mattee, 2009). [https://youtu.be/RQUuqbzQVsY]. Similarly, in the other study, it was found that the age of the farmer was not associated with the adoption of improved agricultural practices (Bose and Dasgupta, 1962). The findings are also supported by CIMMYT which contends that the adoption of a given innovation may not be strictly related to age (CIMMYT, 1993). Similarly, the results of the study also indicated that the adoption of recommended production practices is positively correlated with the active participation of farmers in training and organizations. In a similar finding, it was reported that training is an important part of the extension strategy followed in the entire agricultural development projects. Be it the training of the farmers of that of extension professionals that training is imperative for better performance (Mathur, 1996). This finding is also supported by past studies in which it was reported that participation in social system organization is positively related to the adoption of an innovation (Rogers and Shoemaker, 1971). Lack of access to improved cultivation knowledge through training was found to be a common cause for poor farming conditions among the majority of farmer respondents.

Meanwhile, the education level of farmers was positively correlated with the adoption of recommended production practices of rice except for rice variety. Education improves human capital, farm management capacity, and the ability to understand and adopt recommended agricultural practices (Bezuayechu, Yigezu, Gezahegn, Jabbar, & Paulos, 2002). It is expected that better-educated farmers are more likely to adopt recommended agricultural practices than less-educated farmers (Nina, 1993).

5. Conclusion

Several conclusions were derived from the study. The majority of respondents were males, middle-aged, and belonging to Yadav, Muslim, Sudi, and Teli ethnic groups. About one-third of the respondents had membership in the group. The majority of respondents had poor contact with extension agents for seeking information on recommended rice production practices therefore leading them to use old methods and seed varieties of the crop in the area. A tiny fraction of the respondents from the area were found to have received trainings. The farmers' characteristics i.e. age, education, membership pattern, and training were associated with the adoption of recommended rice production practices. Training and organizational membership had a significant relationship with following recommended practices of rice. (i) Organizational membership and recommended seed rate, (ii) Organizational membership and recommended age of seedling, and (iii) Farmer's participation in rice training and recommended age of seedling. Training helps to enhance knowledge, skill and tries to bring the desired changes. When the farmers are united in the group, they feel secure and will have more exposure to the extension workers'/change agents. Ultimately, it results in an increased level of technology adoption including adoption of improved seed varieties, insect pest management and disease control, method of harvesting, and method of storage. The vast majority of participants used cultivars that were highly recommended. The most adopted variety of rice in the study area was found to be Lalka Basmati/Sona mansuli (improved and recommended variety). It was found that the farmers preferred rice variety with long grains followed by higher yield. The major sources of knowledge used by the farmers were neighbors, relatives, fairs and exhibitions, NGOs, and Agriculture service centers. The adoption of improved rice technology was largely constrained by poor irrigation facilities, not enough availability of quality seeds, difficulty to access agricultural loans, insect-pest problems, marketing, and insufficient fertilizers.

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Authors' Contribution

SS and CG helped in questionnaire preparation and manuscript revision, SK partly helped in data analysis, RG, PA, RK, and RD helped in cumulative revision, and SB was involved in questionnaire preparation, surveying, data analysis, and manuscript preparation.

Conflict of Interest

The authors declare that the work presented in this manuscript is genuine work done and there is no conflict of interest regarding the publication of the article.

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