



Adoption level of improved wheat production technology in wheat-superzone, Kailali, Nepal

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ABSTRACT

The study was conducted to assess the impact of Prime Minister Agriculture Modernization Project (PM-AMP) on the level of adoption of improved wheat production practices among beneficiaries and non-beneficiaries of wheat superzone of Kailali district, Nepal in 2019. A total of 80 households, 50 beneficiaries of superzone and 30 non-beneficiaries were selected using simple random sampling technique and interviewed using a semi-structured interview schedule. Descriptive statistics, independent sample t-test, Chi-square test and multiple linear regression model were used for data analysis using SPSS and MS-Excel. Pearson Chi-square test revealed the significant difference between beneficiaries and non-beneficiaries in access to extension agent and participation in training. Use of recommended variety and top-dressing of nitrogen fertilizer were found to be the most adopted practices while the use of recommended fertilizer dosage, irrigation practices and mechanization were found most ignored. The study showed a significant difference between beneficiaries and non-beneficiaries in the adoption of recommended variety, annual seed replacement, top-dressing of nitrogen fertilizer, recommended irrigation practice and weed management practices. The average adoption index was significantly higher for beneficiaries (0.4760) compared to non-beneficiaries (0.3367). The average wheat yield of the study area was 2.384 t ha⁻¹ and the average yield of beneficiaries (2.549 t ha⁻¹) was found to be higher than non-beneficiaries (2.109 t ha⁻¹). Multiple linear regression revealed that access to extension agent, disease control, adoption of treated seeds, mechanization, top-dressing of nitrogen fertilizer, amount of farmyard manure and urea were the major factors which determined the yield of wheat. Shortage of fertilizers was identified as the major problem. Among beneficiaries of superzone, 4% were reported to be highly satisfied, 54% were satisfied and 42% were dissatisfied with the activities of superzone.

Keywords: Adoption index, beneficiaries, cultivation technology, Nepal, non-beneficiaries, wheat



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1 Introduction

Agriculture is the major source of livelihood and employment of Nepalese people. Though agriculture's contribution to the national economy is dwindling, its share on Gross Domestic Production (GDP) was

27.6% in the fiscal year 2017/18 (MoF, 2018). Wheat contributed 7.1 % in agricultural GDP following rice (20.575%) as well as the vegetable (9.69%) and followed by maize (6.88%) during the fiscal year 2017/18 (Sharma, 2018).

Wheat (*Triticum* spp.) belongs to the family Gramineae (grass family). This crop is the most widely cultivated cereal crop in the world. Wheat is cultivated in 21% area of land and accounts for 17% of total cereal production (Sharma, 2018). Wheat was cultivated in 703,992 ha of land in fiscal year 2018/19 and the production was 2,005,665 metric tons with the productivity of 2.849 tons ha⁻¹ (MoALD, 2020). In most of the urban areas in the country, the use of baked leavened bread, cakes, and biscuits are increasing at faster rate creating higher demand of wheat flour and the higher deficit of flour in the country (Sharma and Chauhan, 2003).

Ministry of Agricultural Development (MoAD) has launched the 10 years Prime-Minister Agriculture Modernization Project (PM-AMP). The MoAD has envisaged pockets, blocks, zones and superzones for agriculture products to address the fragmentation of arable land, which is considered to be a major barrier for agriculture commercialization and mechanization in the country (PMAMP, 2014). As per the MoAD, at least 10 ha of land is needed to identify it as 'pocket area'; 100 ha to be considered a 'block'; 500 ha to be termed as 'zone', while a 'superzone' would make up of 1,000 ha of area. Wheat Superzone, Kailali is one of such superzone established in 2017 A.D (2073 B.S.) for specialization and commercialization of wheat in that region. Wheat superzone not only assists in mechanization and commercialization, but it also provides several technical assistance to the farmers through its technicians and specialists. It also aims to enhance the livelihood and economy of the region through a transformation in wheat cultivation and production technology (What Superzone, 2018a). But little is known about the perception of farmers towards the activities of superzone and its impact on the farm level. It is, therefore, necessary to know how far PMAMP, Project Implementation Unit (Wheat Superzone) has been able to promote the adoption of improved wheat cultivation practices in the area.

Adoption is a decision of "full use of an innovation as the best course of action available" and rejection is a decision "not to adopt an innovation" (Rogers, 2003). An individual may decide to discontinue the use of innovation for a variety of personal, institutional or social reasons one of which could be the availability of an idea or practise that is better in satisfying his/her needs (Smit and Skinner, 2002). Aggregate adoption over all farms will be a gradual process (Smit and Skinner, 2002). Most of the studies about the diffusion of agricultural technology assume that the cumulative rate of adoption over time follows an S-shaped logistic function that is a slow start, followed by the phase of progressive adoption, before turning into an asymptotic convergence toward the maximum level (CIMMYT, 1993). The pattern of adoption of innovation varies according to the type of crop, the location and the specific innovation (Ban and Hawkins, 1996).

Thus this study was deemed necessary and was undertaken. This study attempts to determine the factors associated with improved wheat cultivation adoption, level of adoption of technology by beneficiaries of superzone compared to non-beneficiaries.

2 Materials and Methods

2.1 Study site

Kailari rural municipality, Gauriganga municipality and Ghodaghodi municipality were purposively selected for the study to achieve the fore mentioned objectives. The main criteria for selecting these sites were due to the presence of domain areas of wheat superzone of PM-AMP and the project was operating here since 2017. Additionally, there was potential for agriculture development due to fertile land and most people were solely involved in farming as their main source of income (What Superzone, 2018b).

2.2 Sample and sampling technique

The study was carried out within the Wheat superzone of Kailali district. A total of 80 wheat-growing farmers were randomly selected and interviewed using a semi-structured questionnaire. Among 80 respondents, 50 were the members of farmer's group enlisted in the wheat superzone since the inception in 2017 and were categorized as beneficiaries while rest 30 were the farmers who were not associated with superzone and were categorized as non-beneficiaries.

2.3 Research instrument and design

The different households were selected by simple random sampling method. Appropriate methods and methodology were identified and the site was selected for conducting the survey. Then primary data were obtained from the field survey while secondary data was collected from published and unpublished works of literature.

2.4 Preliminary survey

A preliminary survey was conducted on 10 households to gather preliminary information regarding the demographic, socio-cultural, and topographical settings of the site. This information was used in preparing questionnaires and designing a sampling framework.

2.4.1 Key Informant Interview (KII)

A total of 15 interviewees were selected for their first-hand knowledge about the subject matter. The selected ones were progressive farmers, members of

the executive committee of the superzone, local leaders, social workers and other concerned stakeholders. Their knowledge and perspective on different aspects of wheat cultivation and the wheat superzone were noted and elaborated later on. The information collected was more reliable and contextual.

2.4.2 Questionnaire survey

The questionnaire survey was focused on the various improved technologies that were practiced by the farmers. The detail information about the improved technology adopted and benefits by the adoption of improved production technology regarding the production and marketing potential of the wheat were interviewed.

2.4.3 Focus group discussions (FGD)

The representatives from the farmer's group and cooperatives who were also local wheat-growers participated in FGD. People from all ethnic groups and gender participated in the discussion. A group of about 25 persons was formed. The FGD was conducted after questionnaire survey with the help of checklist to verify the result obtained from a questionnaire survey, to know about the technologies adopted and the factors governing adoption process and problems of adopting the technology.

2.5 Field observation and verification

Field observation was done at different times at the site to witness the situation which was assistive to validate the information got from the household survey.

2.6 Variables and their measurement

2.6.1 Dependent variable

The dependent variable in this study is recommended wheat production practices. Seven cultivation practices are taken into consideration for this study. Adoption level was categorized into three groups based on adoption index value, which was calculated by the following mathematics.

Adopter = "1" value for each parameter

Non adopter = "0" value for each parameter

Now adding the value gained by the farmer in seven parameters and divided by the total number of the parameter (7).

$$AI = \sum_i^n \frac{V_i}{n} \quad (1)$$

where, AI = Adoption Index.

Based on this adoption index value, farmers were categorized into three groups. Categorization was based on the following:

<0.2668 (lower than (Mean-S.D)): Low level adopter

0.2668-0.5806 (Mean AI±S.D): Medium level adopter

>0.5806 (Higher than (Mean+S.D)): High level adopter

2.6.2 Adoption of recommended improved varieties

Major recommended varieties of wheat in this area were Bijaya, Aaditya, Tilattoma, Banganga, NL-971, BL-1022, BL-1135. Those who adopted these varieties were considered as adopters and those using hybrids, Indian and local varieties were considered as non-adopters.

2.6.3 Adoption of seed rate

A recommended seed rate of wheat for this area is 4-5 kg kattha⁻¹ (120-150 kg ha⁻¹). Farmers using 4-5 kg seeds kattha⁻¹, were considered as recommended seed rate adopter whereas who used more than or less than that was considered as non-adopter.

2.6.4 Adoption of recommended time of sowing

Recommended time of sowing for wheat for this area is from last week of Kartik to the second week of Mangsir (month of November) (DADO, 2015). Those who sowed their seed during this time were considered as adopter else they were considered as non-adopter.

2.6.5 Adoption of seed treatment

Treatment of seed was required for the protection of wheat crop from various seed-borne and soil-borne diseases. Chloropyriphos, Thiram, Endosulphan, Carboxin were the chemicals for seed treatment (What Superzone, 2018a). Those farmers who treated their seeds or use pre-treated seeds were considered as adopter and others were considered as non-adopters.

2.6.6 Adoption of the recommended seed replacement rate

If seeds were replaced annually and old seeds from last year were not used, the yield of crop increases significantly in all crops. The seed replacement rate of at least 25% should be maintained (What Superzone, 2018b). So those who replace their seeds annually or at least have 25% seed replacement rate were categorized as adopters and others were categorized as non-adopters

2.6.7 Adoption of recommended irrigation

For the wheat, two to five irrigations were recommended at different critical stages of growth (What Superzone, 2018a). So, those farmers who applied at least two irrigations were considered as adopters and those who don't do so were considered as non-adopters.

2.6.8 Adoption of recommended fertilizer dosage

In Nepal, the blanket recommendation of fertilizer dosage for the wheat crop in the irrigated region was 100:50:25 kg NPK per hectare while the recommendation for the non-irrigated region was 50:50:20 kg NPK ha⁻¹. The most appropriate way to fulfill this recommendation, in the irrigated area was the application of 350-450 kg kattha⁻¹ (10355.03-13313.61 kg ha⁻¹) FYM, 2.2 kg kattha⁻¹ (65.089 kg ha⁻¹) of Urea, 3.6 kg kattha⁻¹ (106.509 kg ha⁻¹) of DAP and 1.3 kg kattha⁻¹ (38.462 kg ha⁻¹) of MOP (Wheat Superzone, 2018). Those who had applied this dosage were considered as adopters and those who had not were considered as non-adopters.

2.6.9 Adoption of top-dressing practice

Nitrogen fertilizers were costly agricultural inputs. With the top dressing and by splitting the doses of nitrogen, we can maximize the nitrogen use efficiency and reduce the loss of the nitrogen to the environment⁻¹. Those who top-dress Nitrogen fertilizer in the wheat crop at least once after the irrigation were considered as the adopters and those who did not practice top dressing were considered as non-adopters.

2.6.10 Adoption of recommended weed management practice

Two to three hand weeding or use of appropriate herbicide for weed control was recommended for the wheat crop. The appropriate type of herbicide for the control of weed was also recommended. 2, 4-D was recommended for broad-leaved weeds and Sulphosulphuran for narrow-leaved weeds of wheat⁻¹. Those farmers who used appropriate herbicides for weed management or perform 2-3 hand weeding were categorized as adopters of recommended weed management practice while others were called non-adapters.

2.6.11 Adoption of mechanization in harvesting

Mechanization is one of the main areas where Wheat Superzone has prioritized. This helps to reduce drudgery, cost and time of farm operation and play a crucial role to increase production and productivity of a farm⁻¹. Those who harvested wheat crop using

combine harvester or reaper and ploughed using tractor were considered as adopters while others were considered as non-adopters.

2.7 Data analysis and the statistical model

All the quantitative data were entered in the MS-Excel and Statistical Package for Social Science (SPSS) and the results were analyzed.

2.7.1 Descriptive analysis

Descriptive statistics such as mean, frequency and percentage were used to summarize the variables and to describe the study area.

2.7.2 Statistical analysis

Test statistics like t-test and chi-square test were used to analyze the data. T-test was used to find the differences in various continuous variables between the farmers who were beneficiaries and non-beneficiaries of Superzone. The Chi-square test was used to analyze the difference between categorical factors with beneficiaries and non-beneficiaries.

2.7.3 Chi-square test

Chi-square test was used to test the significant difference between variables under investigation.

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

where, χ^2 = Chi-square, O_{ij} = observed frequency of each ij th term, E_{ij} = indicates the expected frequency of ij th term, $i = 1, 2, 3 \dots r$, $j = 1, 2, 3 \dots k$. This was tested at 0.1 level of probability for different degree of freedom.

2.7.4 T-test

T-test was used to evaluate if there were any significant differences in every single attribute between the beneficiaries and non-beneficiaries of wheat Superzone. This test was used to evaluate whether there was a significant difference between continuous variables or not. The basic hypothesis is that the variances differ and that two independent samples exist where observations are normally distributed (Newbold, 1991).

2.8 Multiple linear regression model

Proposed equation of the multiple linear regression model was

$$Y_{\text{yield}} = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_{14} X_{14} \quad (3)$$

where, Y_{yield} = Yield of the crop (kg katha^{-1}), α = intercept made of regression plane, X_1, X_2, \dots, X_{14} represents different variables described above, and $\beta_1, \beta_2, \dots, \beta_{14}$ represents their respective coefficients (Table 1).

3 Results and Discussion

3.1 Adoption of recommended practices

3.1.1 Adoption of recommended varieties

Out of 80 wheat cultivating households, 90% cultivated recommended Nepali improved variety, 2.5% cultivated local variety and 10% cultivated Indian variety. Bijaya variety was the most popular variety among the farmers and was cultivated by 33 households followed by Aaditya (18 households) and Gautam (16 households). Similarly, Nepali improved varieties like NL-971 and Tilattoma were cultivated by 13 and 1 household, respectively. HD-2967 was the most popular Indian variety cultivated by 5 households followed by PBW-343 (2 households) and PBW-393 (1 household). Since only cultivators of Nepali improved varieties can be considered as adopters of recommended improved variety, among the sampled households, 88.75% were the adopters and 11.25% were non-adopters. Among beneficiaries, 84% were adopters of recommended improved variety while 16% weren't. Similarly, among non-beneficiaries 96.7% were adopters and 3.3% were non-adopters. Since, beneficiaries are more inclined towards the use of Indian variety instead of recommended Nepali variety, compared to non-beneficiaries; the adoption of recommended improved variety is lower among beneficiaries. The difference between the adoption of improved variety among beneficiaries and non-beneficiaries is significant at 10% level of significance (Table 2). Farmers use varieties that are outdated and are prone to various diseases and pests which also have decreased productivity (Bossuet et al., 2019). Past conventional breeding demonstrates that social and economic constraints can impede the adoption of promising new crop varieties (Melinda and De Groote, 2003).

3.1.2 Adoption of recommended seed rate

The 60% of the studied households were non-adopters while the rest 40% were the adopters. Among beneficiaries 38% were adopters and 62% are non-adopters while for beneficiaries 43.3% were adopters and 56.7% were non-adopters (Table 3). The average seed rate of the sampled household was $5.710 \text{ kg katha}^{-1}$ ($168.935 \text{ kg ha}^{-1}$) which is higher than the recommended seed rate. It was found that the average seed rate of beneficiaries was $5.253 \text{ kg katha}^{-1}$ ($155.414 \text{ kg ha}^{-1}$) while that of non-beneficiaries was

$6.473 \text{ kg katha}^{-1}$ ($191.509 \text{ kg ha}^{-1}$). The difference in seed rate between these two groups was significant at 1% level of significance. The seed rate was higher for the non-beneficiaries because non-beneficiaries had poor knowledge about the seed rate and they farm on poor quality soil with low germination. Another reason reported was that they own marginal lands near forests where the seeds were sown are eaten by wild birds and animals (Table 4).

3.1.3 Adoption of recommended seed sowing time

Seed sowing time can have an impact on the yield of wheat crop. Those households who cultivate at the recommended seed sowing time were considered to be the adopters while others were non-adopters. Among the sampled households, 81.25% were adopters while 18.75% were non-adopters. In the case of beneficiaries, 86% are adopters while 14% are non-adopters. In the case of non-beneficiaries, 73.3% of households were adopters and rest 26.7% were non-adopters of recommended seed sowing time (Table 5).

3.1.4 Adoption of the recommended seed replacement rate

Of the total household studied, 26.25% were adopters and 73.75% were non-adopters 40% and 60% of beneficiaries were considered to be adopters and non-adopters respectively. While among non-beneficiaries 3.3% were adopters and 96.7% were non-adopters. The difference in adoption between beneficiaries and non-beneficiaries was found to be significant at 1% level of significance (Table 6).

3.1.5 Adoption of treated seeds or use of seed treatment

Though seed treatment by farmers themselves using chemicals before sowing was not reported in the study, use of pre-treated seeds was prevalent in the study area. Overall, there were 31.3% adopters and 68.7% non-adopters of this practice. Among the beneficiaries, 42% of the household had adopted while 58% had not adopted this practice. Among non-beneficiaries, 13.3% had adopted this practice while 86.7% had not adopted it. The difference in adoption of treated seeds between beneficiaries and non-beneficiaries was found to be significant at 10% level of significance (Table 7).

3.1.6 Adoption of recommended fertilizer dosage

Recommended fertilizer dosage was not adopted by any wheat cultivating household in the study area. Of the entire sampled household, 76.25% were found to use FYM while 23.75% used no FYM at all.

Table 1. Description of the variable in a multiple linear regression model affecting yield in the study area, 2019

Variable	Description of variable	Type of variable	Expected sign
Yield	Yield of wheat	Continuous	
Wheat training	Training in wheat cultivation (yes=1, no=0)	Dummy	+
Number of irrigation	Number of irrigation	Continuous	+
Access to extension agent	Access to extension agent (yes=1, no=0)	Dummy	+
Pest control	Pest control (yes=1, no=0)	Dummy	+
Disease control	Disease control (yes=1, no=0)	Dummy	+
Adoption of treated seeds	Adoption of treated seeds (yes=1, no=0)	Dummy	+
Adoption of mechanization	Adoption of mechanization (yes=1, no=0)	Dummy	+
Adoption of topdressing	Adoption of the top dressing of N fertilizer (yes=1, no=0)	Dummy	+
Amount of FYM	Amount of FYM	Continuous	+
Amount of MOP	Amount of MOP	Continuous	+
Amount of DAP	Amount of DAP	Continuous	+
Association with WSZ	Association with Wheat Super Zone (yes=1, no=0)	Dummy	+/-
Total land	Total landholding	Continuous	+/-

FYM: Farmyard Manure, MOP: Muriate of Potash, DAP: Diammonium Phosphate, WSZ: Wheat Super Zone

Table 2. Distribution of household according to the adoption of the recommended variety in the study area, 2019

Variable	Overall (N=80)	Beneficiaries (n=50)	Non-beneficiaries (n=30)	χ^2 value	P value
Adopters	71 (88.75)	42 (84.0)	29 (96.7)	3.013*	0.083
Non-Adopters	9 (11.25)	8 (16.0)	1 (3.3)		

Figures in parentheses represents percentage. * indicates 10% level of significance

Table 3. Distribution of household according to the adoption of recommended seed rate in the study area, 2019

Variable	Overall (N=80)	Beneficiaries (n=50)	Non-beneficiaries (n=30)	T-value	P-value
Adopters	32 (40)	19 (38)	13 (43.3)	0.222	0.637
Non-adopters	48 (60)	31 (62)	17 (56.7)		

Figure in parentheses represents percentage

Table 4. Average seed rate used among beneficiaries and non-beneficiaries in the study area, 2019

Variable	Overall (N=80)	Beneficiaries (n=50)	Non-beneficiaries (n=30)	Mean difference	T-value	P-value
Average seed rate (kg kattha ⁻¹)	5.71 (168.935)	5.253 (155.414)	6.473 (191.509)	-1.22	-2.937***	0.004

*** indicates 1% level of significance, 1 ha=29.5858 Kattha, Figures in parentheses represents kg ha⁻¹

Table 5. Distribution of household according to the adoption of recommended seed sowing time in the study area, 2019

Variable	Overall (N=80)	Beneficiaries (n=50)	Non-beneficiaries (n=30)	χ^2 -value	P-value
Adopters	65 (81.25)	43 (86.0)	22 (73.3)	1.975	0.16
Non-adopters	15 (18.75)	7 (14.0)	8 (26.7)		

Figures in parentheses represents the percentage

Table 6. Distribution of household according to the adoption of recommended seed replacement rate in the study area, 2019

Variable	Overall (N=80)	Beneficiaries (n=50)	Non-beneficiaries (n=30)	χ^2 -value	P-value
Adopters	21 (26.25)	20 (40)	1 (3.3)	13.021***	$P \leq 0.01$
Non-adopters	59 (73.75)	30 (60)	29 (96.7)		

Figures in parentheses represents the percentage. *** indicates 1% level of significance

Table 7. Distribution of household according to the adoption of treated seeds in the study area, 2019

Variable	Overall (N=80)	Beneficiaries (n=50)	Non-beneficiaries (n=30)	χ^2 -value	P-value
Adopters	Adopters	25 (31.25)	21 (42)	7.172*	0.07
Non-adopters	Non-adopters	55 (68.75)	29 (58)		

Figures in parentheses represents the percentage. *** indicates 1% level of significance

Table 8. Distribution of household according to use of Farmyard manure in the study area, 2019

Variable	Overall (N=80)	Beneficiaries (n=50)	Non-beneficiaries (n=30)	χ^2 -value	P-value
Use of FYM	61 (76.25)	39 (78)	22 (73.3)	0.225	0.635
No use of FYM	19 (23.75)	11 (22)	8 (26.7)		

Figure in parentheses represents the percentage

Table 9. Amount of manures and fertilizers used among beneficiaries and non-beneficiaries in the study area, 2019

Variable	Overall (N=80)	Beneficiaries (n=50)	Non-Beneficiaries (n=30)	Mean difference	T-value	P-value
FYM (kg kattha ⁻¹)	139.62 (4130.769)	145.632 (4308.639)	129.6 (3834.32)	16.032	0.576	0.566
Urea (kg kattha ⁻¹)	4.225 (125)	4.268 (126.272)	4.154 (122.9)	0.114	0.239	0.812
DAP (kg kattha ⁻¹)	3.77 (111.538)	3.798 (112.367)	3.722 (110.118)	0.759	0.191	0.849

1 ha = 29.5858 kattha, Figures in parentheses represents kg ha⁻¹

Table 10. Distribution of household according to the adoption of top-dressing of nitrogen fertilizers in the study area, 2019

Variable	Overall (N=80)	Beneficiaries (n=50)	Non-beneficiaries (n=30)	χ^2 -value	P-value
Adopters	75 (93.75)	50 (100)	25 (83.3)	8.889***	0.003
Non-adopters	5 (6.25)	0 (0.0)	5 (16.7)		

Figures in parentheses represents the percentage. *** indicates 1% level of significance

Among beneficiaries, 78% were found using FYM, while 22% were found not using it while among non-beneficiaries, the user of FYM was 73.3% while rest 26.7% were not the user of FYM in the wheat field ((Table 8). The average amount of Farmyard manure used by the sampled household of the study area was 139.620 kg kattha⁻¹ (4130.769 kg ha⁻¹). The average amount of FYM used by beneficiaries was 145.632 kg kattha⁻¹ (4308.639 kg ha⁻¹) and by non-beneficiaries was 129.60 kg kattha⁻¹ (3834.320 kg ha⁻¹). The average amount of Urea used in the study area was 4.225 kg kattha⁻¹ (125.0 kg ha⁻¹). The beneficiaries used 4.268 kg kattha⁻¹ (126.272 kg ha⁻¹) while the non-beneficiaries used 4.154 kg kattha⁻¹ (122.9 kg ha⁻¹). The average amount of Diammonium Phosphate (DAP) used by the studied households was reported to be 3.77 kg kattha⁻¹ (111.538 kg ha⁻¹). The use of DAP was 3.798 kg kattha⁻¹ (112.367 kg ha⁻¹) for beneficiaries and 3.722 kg kattha⁻¹ (110.118 kg ha⁻¹) for non-beneficiaries ((Table 9). Mazhar (2016) identified that the farmers are not using the right amount of FYM has the maximum technology adoption gap.

3.1.7 Adoption of top dressing practice of nitrogen fertilizer

Of the total sampled household, 93.75% were found to be adopting top dressing while 6.25% were not adopting the top dressing practice. Among beneficiaries, 100% were adopting the top dressing while only 83.3% of non-beneficiaries adopted it. The difference between beneficiaries and non-beneficiaries in terms of adoption of top-dressing was found to be significant at 1% level of significance ((Table 10).

3.1.8 Adoption of recommended irrigation practice

Overall only 10% had adopted the recommended irrigation practice. Among beneficiaries, 16% had adopted the recommended irrigation practice while none of the non-beneficiaries had done so. The difference between beneficiaries and non-beneficiaries in terms of adoption of recommended irrigation practice was significant at 5% level of significance ((Table 11).

3.1.9 Adoption of recommended weed management practice

Overall, 28.7% of the household of the study were adopters and the rest of them were non-adopters. Among beneficiaries, 38% were adopters while rest was non-adopters. Similarly, among non-beneficiaries, only 13.3% were adopters and the rest was non-adopters. The difference between beneficiaries and non-beneficiaries in terms of adoption of recommended weed management practice was significant at 5% level of significance ((Table 12).

3.1.10 Adoption of mechanization

Overall, only 18.8% of farming household had adopted mechanization in the study area while the rest of others hadn't. Among beneficiaries, 22% had adopted mechanical harvesting while only 13.3% among non-beneficiaries had adopted mechanization on harvesting ((Table 13).

3.2 Adoption Index

The average Adoption Index for the study area was 0.4237, while the average adoption index of the beneficiaries was 0.4760 and of non-beneficiaries was found to be 0.3367. The mean difference between beneficiaries and non-beneficiaries was significant at 1% level of significance ((Table 14). Irrigation facilities, landholding size, access to credit, and distance to chemical fertilizer store have a major impact on technology adoption by farmers (Raut et al., 2011).

3.3 Categories of adopters

All the sampled households were categorized into low-level adopters, medium level adopters and high-level adopters. Those households with Adoption Index (AI) lower than 0.2668 were categorized as low-level adopters, those with AI between 0.2668 and 0.5806 were considered as medium level adopters and those with higher than 0.5806 were categorized as high-level adopters. Among all the sampled household, 13.8% were low-level adopters, 57.6% were medium level adopters and 18.8% were high-level adopters. Among beneficiaries, 4% were low-level adopters, 72% were medium level adopters and 24% were high-level adopters. While among beneficiaries, 30% were low-level adopters, 60% were medium level adopters and 10% were high-level adopters. The difference between beneficiaries and non-beneficiaries in terms of categories of adopters was found to be significant at 1% level of significance ((Table 15).

3.4 Wheat yield

The average yield of the studied household was found to be 2.384 tons ha⁻¹ while it was 2.549 t ha⁻¹ for beneficiaries and 2.1090 t ha⁻¹ for non-beneficiaries. The mean difference in yield between the beneficiaries and non-beneficiaries was found to be significant at 1% level of significance ((Table 16). In terms of productivity, it exceeds Kanchanpur district which has productivity of 2.56 t ha⁻¹ while Kailali has productivity of 3.12 t ha⁻¹ (MoALD, 2020). The average productivity of Kailali was lower than that of beneficiaries and higher than that of non-beneficiaries of the study area. Adoption of improved production practices enhances the production and productivity of crop (Uzonna and Qijie, 2013).

Table 11. Distribution of household according to the adoption of recommended irrigation practice in the study area, 2019

Variable	Overall (N=80)	Beneficiaries (n=50)	Non-beneficiaries (n=30)	χ^2 -value	P-value
Adopters	8 (10)	8 (16)	0 (0)	5.333**	0.021
Non-adopters	72 (90)	42 (84)	30 (100)		

Figures in parentheses represents the percentage. ** indicates 5% level of significance

Table 12. Distribution of household according to the adoption of weed management practice in the study area, 2019

Variable	Overall (N=80)	Beneficiaries (n=50)	Non-beneficiaries (n=30)	χ^2 -value	P-value
Adopters	23 (28.75)	19 (38)	4 (13.3)	5.569**	0.018
Non-adopters	57 (71.25)	31 (62)	26 (86.7)		

Figures in parentheses represents the percentage. ** indicates 5% level of significance

Table 13. Distribution of household according to the adoption of weed management practice in the study area, 2019

Variable	Overall (N=80)	Beneficiaries (n=50)	Non-beneficiaries (n=30)	χ^2 -value	P-value
Adopters	15 (18.75)	11 (22)	4 (13.3)	0.924	0.336
Non-adopters	65 (81.25)	39 (78)	26 (86.7)		

Figures in parentheses represents the percentage

Table 14. The average adoption Index between beneficiaries and non-beneficiaries in the study area, 2019

Variable	Overall (N=80)	Beneficiaries (n=50)	Non-beneficiaries (n=30)	Mean difference	T-value	P-value
Adoption Index	0.4237 (1.569)	0.476 (0.147)	0.3367 (0.132)	0.13933	4.238***	$P \leq 0.01$

Figures in parentheses represents standard deviation. *** indicates 1% level of significance

Table 15. Distribution of household according to categories of adopters in the study area, 2019

Variable	Overall (N=80)	Beneficiaries (n=50)	Non-beneficiaries (n=30)	χ^2 -value	P-value
Low level adopters	11 (13.75)	2 (4.0)	9 (30.0)	11.578***	0.003
Medium level adopters	54 (67.50)	36 (72.0)	18 (60)		
High-level adopters	15 (18.75)	12 (24.0)	3 (10)		

Figures in parentheses represents the percentage. *** indicates 1% level of significance

Table 16. Average wheat yield between beneficiaries and non-beneficiaries in the study area, 2019

Variable	Overall (N=80)	Beneficiaries (n=50)	Non-beneficiaries (n=30)	Mean difference	T-value	P-value
Avg. yield ($t\ ha^{-1}$)	2.384 (0.729)	2.549 (0.704)	2.109 (0.696)	0.44	2.716***	0.008

Figures in parentheses represents standard deviation. *** indicates 1% level of significance

Table 17. Determinants of wheat yield in the study area, 2019

Variables	Coefficients	Std. error	t	P> t
Wheat training	0.239	0.297	0.8	0.425
Number of irrigation	0.034	0.174	0.2	0.842
Contact with extension agent	0.343	0.196	1.75*	0.085
Pest control	-0.102	0.142	-0.72	0.476
Disease control	0.313	0.148	2.11**	0.039
Adoption of treated seeds	0.38	0.149	2.54**	0.013
Adoption of mechanization	0.365	0.206	1.77*	0.082
Adoption of the top dressing of nitrogen fertilizer	1.01	0.258	3.92***	0
Amount of FYM	0.001	0.001	2.14**	0.036
Amount of MOP	-0.435	0.209	-0.21	0.836
Amount of DAP	0.403	0.493	0.82	0.417
Amount of Urea	0.085	0.387	2.19**	0.032
Association with Superzone	-0.115	0.143	-0.81	0.422
Total land	0.002	0.002	1.04	0.302
Constant	0.244	0.326	0.75	0.456

*, ** and *** indicates 10%, 5% and 1% level of significance respectively

Table 18. Problems associated with wheat production in the study area, 2019

Problems	Index value	Rank
Unavailability of fertilizers	0.78	I
Disease, pest and weed attack	0.75	II
Lack of mechanization	0.67	III
Lack of quality seeds	0.58	IV
Lack of irrigation facility	0.55	V

Table 19. Satisfaction level of beneficiaries with Wheat Super Zone, Kailaki, 2019

Level of Satisfaction	Frequency	Percentage
Highly satisfied	2	4
Satisfied	27	54
Dissatisfied	21	42

3.5 Determinants of wheat yield

The yield of wheat was regressed with different factors which were expected to affect the wheat yield. The coefficient of determination tells us how well the sample regression line fits the data. The R^2 of the model was 0.656 for the yield of wheat. It indicates that 65.6% of the variation in the yield was explained by the explanatory variables in the model. The adjusted R^2 was found to be 0.582. There were 14 explanatory variables in the model. Among them, 7 variables were found to be major determinants significant at a different level of significance. Access to extension agent had a positive impact on yield and was statistically significant at 10% level of significance. When a farmer has contact with extension agent, yield increases by 0.419 ton ha⁻¹ keeping other factors constant. Disease control was found to have a positive impact on yield and was statistically significant at 5% level of significance. In the case of disease control the yield increases by 0.313 ton ha⁻¹ keeping other factors constant.

Adoption of treated seed was found to have a positive impact on yield and was statistically significant at 5% level of significance. If a farmer adopts seed treatment, the yield increases by 0.380 t ha⁻¹ keeping other factors constant. Adoption of mechanization was found to have a positive impact on yield and was statistically significant at 10% level of significance. The yield of wheat was higher for adopters of mechanization compared to non-adopters by 0.365 t ha⁻¹ keeping other factors constant. Adoption of the top dressing of Nitrogen fertilizer had a positive impact on yield and was statistically significant at 1% level of significance. When one farmer adopts the practice of top-dressing of N-fertilizer, his yield increases by 1.01 t ha⁻¹ keeping other factors constant. Amount of FYM was found to have a positive impact on yield and was statistically significant at 5% level of significance. On addition of 1 kg of FYM, the productivity increases by 1 kg ha⁻¹ keeping other factors constant. Similarly, the amount of urea was also found to have a positive impact on the yield of wheat and was statistically significant at 5% level of significance. On addition of 1 kg of Urea, the productivity increases by 85 kg ha⁻¹ keeping others factor constant.

Other variables studied didn't affect the yield significantly. Among them, training on improved wheat cultivation, number of irrigation, amount of DAP and total landholding were found to have a positive impact on wheat yield. NARC (2002) also emphasizes the need for training and orientation program to enhance productivity which supports our result. While, the variables like the association with wheat superzone, amount of MOP and pest control was found to have a negative impact on wheat yield ((Table 17).

3.6 Problems associated with wheat production

There are many problems associated with wheat production. The study attempted to find some of them as perceived by the farmers. The study showed that the major problem faced by farmers was the unavailability of fertilizers followed by disease, pest and weed attack, lack of mechanization, lack of quality seeds and lack of irrigation facility ((Table 18). Kumar (2001) identified different problems such as high cost of inputs, adulteration of seeds, shortage of chemical fertilizers and insecticides and pesticides. The unfavourable climatic condition like drought, excessive rainfall, flooding and hailstone also effect in the production of the wheat (Paymard et al., 2018).

3.7 Satisfaction with wheat superzone

Out of 50 beneficiaries interviewed, 4% were highly satisfied with the service of wheat superzone, 54% were satisfied and 42% were dissatisfied with the service of superzone ((Table 19).

4 Conclusions

The study revealed that most of the household used improved Nepali variety 'Bijaya' which was found to be the most popular variety in the study area. Beneficiaries use a greater amount of seed than non-beneficiaries with no significant difference. More beneficiaries were found to replace seed annually than non-beneficiaries. Beneficiaries are more likely to treat their seed or use pre-treated seed compared to non-beneficiaries. No difference was found in terms of use of FYM between beneficiaries and non-beneficiaries. Similarly, no difference was found in the amount of FYM, Urea and DAP between beneficiaries and non-beneficiaries. The higher number of beneficiaries was found to adopt the top-dressing practice and adopt irrigation practice compared to non-beneficiaries. There was no difference in adoption of mechanization between beneficiaries and non-beneficiaries. Recommended variety, the practice of top dressing of nitrogen fertilizer were the most widely adopted production practices among both beneficiaries and non-beneficiaries while recommended fertilizer dosage, recommended irrigation and mechanization in harvesting were least adopted practices among both groups. Other recommended practices had medium level adoption among both groups except the practice of annual seed replacement which was ignored by non-beneficiaries. Adoption index was found to be higher for the beneficiaries than non-beneficiaries. Beneficiaries were found to be more likely to adopt the recommended wheat cultivation practice compared to non-beneficiaries. The

difference was seen between beneficiaries and non-beneficiaries in categories of adopters. More beneficiaries were found to be high-level adopters compared to non-beneficiaries and lesser number of the low level of adopters were found among beneficiaries compared to non-beneficiaries. Similarly, there were more medium level adopters in beneficiaries than non-beneficiaries. Average wheat yield of the study area was found to be 2.384 t ha⁻¹. The yield was higher for beneficiaries (2.549 t ha⁻¹) compared to non-beneficiaries (2.109 t ha⁻¹). Access to extension agent, disease control, adoption of treated seeds, adoption of mechanization, adoption of top-dressing, amount of FYM and amount of Urea were found to be the major determinants of the wheat yield which were significantly associated with yield. As per the study, the major problem faced by farmers was a shortage of fertilizers followed by disease, pest and weed infestation, limited mechanization, lack of quality seeds and lack of irrigation facility. In terms of beneficiaries' perception towards wheat superzone, least was reported highly satisfied, just more than half were reported satisfied and just more than two-fifths were reported dissatisfied with activities of Wheat Superzone.

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Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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