Archives of Agriculture and Environmental Science 7(4): 577-584 (2022)
https://doi.org/10.26832/24566632.2022.0704015

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 of improved wheat varieties at Kanchanpur, Nepal

Ashmita Bhatta[1*], Akash Gupta[1] and Pankaj Prashad Joshi[2]

[1]Agriculture and Forestry University (AFU), Rampur, Chitwan, NEPAL
[2]Department of Agronomy, AFU, Rampur, Chitwan, NEPAL
[*]Corresponding author's E-mail: bhattashmita25@gmail.com

ARTICLE HISTORY

Received: 08 October 2022
Revised received: 15 December 2022
Accepted: 19 December 2022

Keywords

Subsidy
Extension services
Indexing
Regression

ABSTRACT

Usage of improved varieties raises the crop yield. To assess the adoption status of improved wheat varieties in the Kanchanpur district, this study investigated the varietal coverage of wheat along with factors affecting the adoption of improved varieties. A pre-tested interview schedule was administered to interview 90 randomly selected wheat-producing households in Bhimdutta, Bedkot and Dodhara Chandni (Mahakali) municipality. A binary logistic regression was used for triangulating the effect of different variables on the adoption of improved wheat varieties. Besides, descriptive statistics and indexing were also applied. The findings revealed that 80.97% of the area was under improved varieties, two-thirds of which were released varieties. In addition, of the released varieties, Vijay had the highest area coverage (27.97%), followed by Aditya (19.47%), Gautam (18.76%), NL971 (16.42%), BL4341 (13.65%) and others (3.73%), respectively. Further, the adoption of improved wheat varieties was found to be significantly driven by input subsidy (5% level) and access to extension services (10% level). Nevertheless, the adoption was impeded by problems namely; timely unavailability of improved variety seeds followed by lack of knowledge about improved varieties, unavailability of improved variety seeds in local markets, high cost of seeds and poor quality of seeds respectively, as identified and ranked by indexing. In light of these findings, input subsidies to the smallholding farmers, regular advisory and extension services along with participatory training programs relevant to the adoption of improved practices and timely availability of improved seeds are suggested to increase the adoption of improved wheat varieties among the farmers.

Citation of this article: Bhatta, A., Gupta, A., & Joshi, P. P. (2022). Adoption of improved wheat varieties at Kanchanpur, Nepal. *Archives of Agriculture and Environmental Science*, *7*(4), 577-584, https://dx.doi.org/10.26832/24566632.2022.0704015

INTRODUCTION

Wheat is the third most important cereal crop after rice and maize in terms of acreage and production in Nepal (MoALD, 2022). It is a key source of protein in developing countries. Being a major winter cereal crop, more than 80% of it is grown in a Rice-Wheat cropping pattern (Kandel *et al*., 2018) in Nepal. It is grown in all three agroecological regions of the country. However, the Terai region contributes up to 60% of the total production. The area, production and productivity of wheat in Nepal in the fiscal year 2020/21 were 711,067 ha, 2,127,276 tons and 2.99 ton/ha respectively (MoALD, 2022). The production of wheat saw a massive rise after the introduction of semi–dwarf varieties in the 1960s in Nepal (Morris *et al*., 1992) - almost doubling the productivity. However, the yield potential has not been fully met as evidenced by a yield gap of 3.0 ton/ha in wheat between research and farmers' field (Basukala and Rasche, 2022).

Furthermore, the current yield is well below than the neighboring countries; India (3.37 ton/ha) and China (5.48 ton/ha) (Kharel *et al*., 2021; Ramadas *et al*., 2019). Also, the wheat cultivated area is on a decreasing trend (Figure 1). Therefore, a large part of the food demand in developing countries like Nepal needs to be sourced through vertical expansion (FAO, 2009;

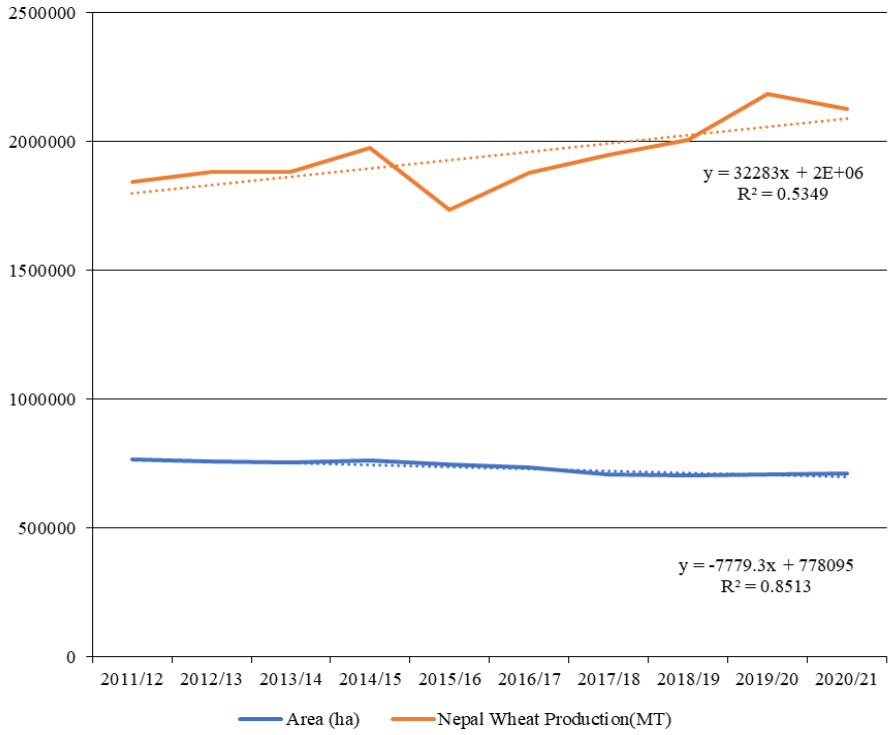

Figure 1. *Trend of wheat acreage and production in Nepal.*

Sharma *et al*., 2014). The involvement of modern technologies in agriculture seems to be a way to enhance food and economic security in developing countries (Chandio and Jiang, 2018) like Nepal. Improved crop variety is one such technology having the potential to increase production manifold.

Improved crop varieties are responsible for a 50 - 90% global crop increase along with being a major strategy for increasing agricultural productivity (Danso-Abbeam *et al*., 2018). However, only 33% of farm households in Nepal use improved crop varieties (CBS, 2012). Forty-three improved wheat varieties have been released so far in Nepal, 26 out of which are recommended for the Terai region (MoALD, Agriculture and Livestock Diary, 2022). Thirteen wheat varieties have been denotified, leaving only 30 of them for cultivation (Timsina *et al*., 2018). However, smallholder farmers in rural areas prefer traditional varieties to improved varieties (ICARDA, 2022) . It is scientifically proven that the usage of new improved seeds increases the yield of crops by 20 – 25 %, which can be extended to 35 – 45% by improving the management practices of the crop (Srivastava, 2018). But, in Nepal, the informal seed system contributes nearly 90% of the total seed supply (LI-BIRD, 2017) and farmers save seeds from their produce for the next year. The use of traditional varieties is adding to the increased yield gap of wheat. This situation demands a strong extension system providing improved seeds to the farmers along with information about their importance thus lessening the yield gap.

National Wheat Development Program under National Agricultural Research Council (NARC) has been developing abiotic and biotic stress-resistant cum high-yielding improved wheat varieties since its establishment, most of which are recommended for Terai region. Adoption of disease and drought-resistant improved wheat varieties suitable to the given climate can help in increasing the productivity of wheat (Subedi *et al*., 2019). It is imperative to investigate the status of coverage of such improved varieties in major wheat growing areas to provide relevant recommendations for increment in the adoption. Similarly, the factors affecting the adoption of improved varieties of wheat need to be studied to better address them. Also, major problems associated with adoption of improved wheat varieties have not been explored extensively in the academic literature. This study aims to fill these research gaps by examining the adoption of improved varieties of wheat in the Kanchanpur district, located in the Terai region of Nepal.

MATERIALS AND METHODS

Study area, sample size and data collection

The study was conducted in Kanchanpur district, which was selected purposively for two reasons. Firstly, it is one of the emerging major wheat-producing districts of the country. And secondly, realizing the potential of the district for wheat production, the Prime Minister Agriculture Modernization Project (PMAMP) has declared the district as the Wheat Zone intending to increase the productivity of wheat along with its commercialization. Further, three municipalities namely Bhimdutta municipality, Bedkot municipality and Dodhara Chandni (Mahakali) municipality (Figure 2) were purposively selected because these were the major wheat growing regions of the district. A population of 851 farmers was sampled randomly to draw a working sample of 90 farmers using Rao soft calculator. Out of the total sample size; 45, 14 and 31 samples were allocated to Bhimdutta, Bedkot and Dodhara Chandni municipalities respectively using proportionate sampling. The farmers were categorized into two categories as adopters and non–adopters; adopters being users

of improved varieties and non–adopters being users of traditional varieties, to compare the relevant socio–demographic variables. The primary data was collected through an interview schedule using semi-structured questionnaires which were pretested before the survey. The primary data covered socio-demographic information along with information related to the adoption of improved wheat varieties. Furthermore, one Key Informants Interview was done to validate the information so collected. Similarly, relevant works of literature were referenced for secondary data. The collected data was then analyzed using MS Excel (2019) and STATA (version 14.2).

Determination of factors affecting the adoption of improved wheat varieties

Farmers have an option to use either improved or traditional wheat varieties. The choice of the adoption is therefore binary. Given this binary nature, binary logistic regression was used to determine factors affecting adoption of improved varieties. The model was used to identify the determinants of the probability of adoption of improved varieties. The model was used at once for the eight independent variables (Table 1) identified. Firstly, the significance of the variables was tested with logistic regression and the marginal effect after logistics was studied to draw consequent interpretation. The likelihood of farmers adopting improved varieties is a non-linear function of regressors. The model used is of the form Pr (Y=1) = (Xi) where Pr (Y = 1) represents the probability of adopting improved varieties with the change in X variable. The statistical description of the different variables used in this model is shown in Table 1.

Problems associated with the adoption of improved varieties

To inquire about the major problems associated with the adoption of improved variety in wheat production, the indexing/ scaling technique was used and the index was calculated. The weighted indexes were calculated and the problems were ranked by using five-point scales based on their responded frequencies comparing the most serious to least serious problems. The formula that was used to determine the index for the intensity of various problems is given below:

$$\mathbf{I_{prob} = \sum (Si*Fi/N)}$$

where, I_{prob} = index value for severity or intensity of the problem
$\sum$= summation
S_i = scale value at i^{th} intensity
F_i = frequency of the i^{th} intensity
N= total no. of the respondents = $\sum f_i$
Where, I_{prob} = index, $0 < I < 1$

Tiwari *et al.* (2021) also used the above formula to identify the problems of maize production in Sindhupalchowk district, Nepal.

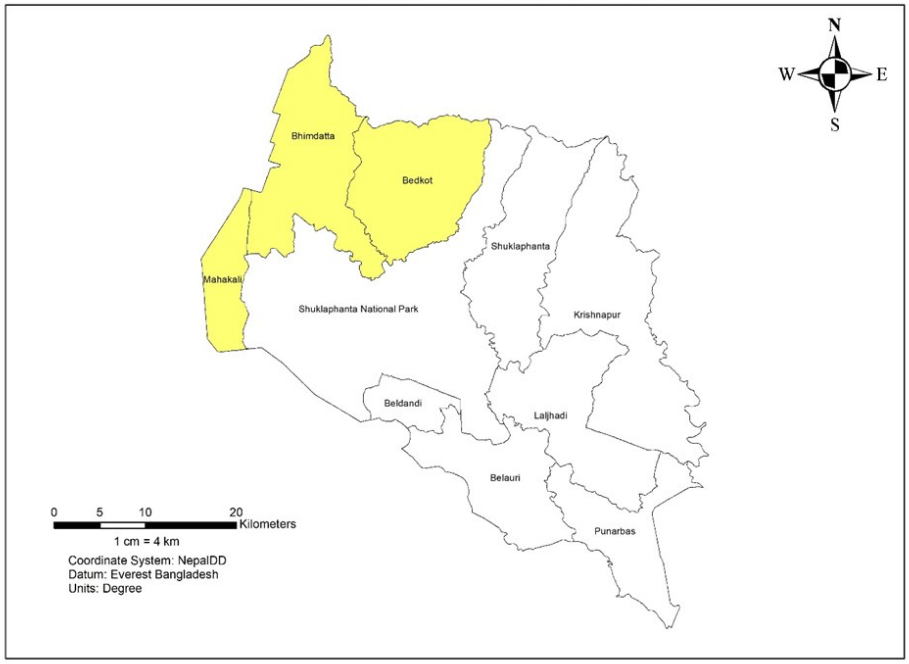

Figure 2. *Showing study location in Kanchanpur district, Nepal.*

Table 1. Statistical description of the variables used in binary logistic regression model.

Variables	Description of the variable	Value
subsidy	Government subsidy obtained for production inputs	If subsidy provided = 1, otherwise = 0 (Dummy)
access	Access to extension services	If had access = 1, otherwise = 0 (Dummy)
affiliation	Affiliation to agricultural organization	If had affiliation = 1, otherwise = 0 (Dummy)
inagr	No. of family members involved in agriculture	Persons (in number)
t_whe_cl_kattha	Total wheat cultivating land	Kattha (in number)
farm_exp_yrs	Years of farming experience	Years (in number)
hh_gender	Gender of household head	Males = 1, otherwise = 0
familysize	Number of family members	Persons (in number)

RESULTS AND DISCUSSION

Socio-demographic characteristics of wheat farmers and productivity of varietal types

Socio-demographic characteristics of the surveyed wheat farmers are presented in Table 2. Among the total 90 wheat farmers, 69 were adopters (users of improved varieties) and 21 were non -adopters (users of traditional varieties). Most of the farm families were found to be headed by males. Similarly, 85.56% of the farmers were affiliated with farmers' organizations, most with cooperatives. Majority of such farmers were found to be adopters. Likewise, most of the farmers with access to extension services were adopters and only 38.89% of total farmers fall into that group. Similarly, 64.44% had access to credit services; majority of whom were adopters. Most adopters were also from the groups who has information about improved varieties and were found to be 74.44% of total farmers. Finally, 87.78% of farmers who had access to improved variety seeds were also dominated by adopters. Adoption was significantly associated with affiliation with organizations at 1% level. Membership in farmers' organizations benefits farmers with subsidized improved seeds, credit at lower interest rates, informative training along with an opportunity for resource pooling. Moreover, it acts as an important medium for the diffusion of innovation. Abda (2022) in his research revealed that the adoption decision regarding improved wheat varieties is significantly and positively affected by cooperative membership at 1% level. Likewise access to services such as extension and credit, which was found to be significantly associated with the adoption of improved wheat varieties (1% level), considerably drives the adoption because it is crucial for smallholders having minimum resources as well as expertise. A past study by Wossen *et al.* (2017) had established that extension access has a positive and significant effect on technology adoption, the effect being stronger for smallholder farmers with credit access.

Another variable that was significantly associated with improved variety adoption at 1% level was input subsidy. This is plausible because the subsidy which is mostly provided for improved seeds enables the users to get the improved seeds of national variety at half the price. Similarly, both information about and access to improved varieties were significant to adoption of improved wheat varieties (1% level) inferring informed farmers having access to the improved technology go for adoption. There was no significant difference between adopters and non-adopters regarding characters like age of household head, family size and total wheat cultivated land. However, the land owned by adopters was significantly higher than that of non-adopters at 10% level. It can be inferred that farmers who own a large sized land tend to adopt improved varieties as Hu *et al.* (2022) also found out that farmers with larger farms are more willing to adopt improved technologies. The average distance to the market was found to be 5.34 km and was significantly more for non–adopters than that of adopters at 10% level. Kumar *et al.* (2020) found that the adoption of improved technologies and practices is significantly driven by improved access to markets. This might explain why farmers away from the markets chose not to adopt improved varieties. The productivity of improved variety of wheat was found to be significantly higher than that of traditional varieties at 1% level. This is because improved varieties can better utilize inputs such as fertilizers and irrigation and are also selected for resistance to diseases and insect pests. Olasoji and Egbetokun (2017) in their research also found an increment in yield upon the usage of improved seeds of maize as compared to farm-saved seeds.

Table 2. Socio-demographic characteristics of wheat farmers and productivity of varietal types.

Categorical variables		**Total (N=90)**	**Adopters (N=69)**	**Non–adopters (N=21)**	**Chi– square value**
Gender of household head	Male	72 (80.00)	60 (57.14)	12 (86.96)	8.944**
	Female	18 (20.00)	9 (42.86)	9 (13.04)	
Affiliation with	Farmer groups	23 (25.56)	11(15.94)	12 (57.14)	17.0754***
	Cooperatives	54 (60.00)	49 (71.01)	5 (23.81)	
	None	13 (14.44)	9 (13.04)	4 (19.05)	
Access to services	Extension services (1=yes)	35 (38.89)	34 (49.28)	1 (4.76)	13.4234***
	Credit services (1=yes)	58 (64.44)	46 (66.67)	12 (57.14)	
Input subsidy (1=yes)		46 (51.11)	45 (65.22)	1 (4.76)	23.5490***
Information availability about improved varieties (1=yes)		67 (74.44)	62 (89.86)	5 (23.81)	36.9144***
Accessibility to improved variety seeds (1=yes)		79 (87.78)	66 (95.65)	13 (61.90)	17.0912***
Continuous variables		**Total (N=90)**	**Adopters (N=69)**	**Non – adopters (N=21)**	**t-value**
Age of household head (Years)		44.59±11.5	45.03±11.4	43.14±12.04	-0.6555^{ns}
Family size (Persons)		6.4±2.96	6.41±3.14	6.38±2.36	-0.0335^{ns}
Owned land (kattha)		13.35±12.60	14.41±12.47	9.86±12.71	-1.4597*
Total wheat cultivated land (kattha)		20.51±21.44	21.64±22.48	16.76±17.54	-0.9130^{ns}
Productivity (ton/ha)		2.2±1.12	2.4±1.16	1.5±0.65	-3.388***
Average distance (km)		5.34±4.12	5.02±3.71	6.4±5.22	1.3594*

***, ** and * implies level of significance at 1%, 5% and 10% respectively. Source: Field survey, 2022

Varietal coverage and trend analysis of wheat

More than 80% of the wheat cultivated area was found to be grown with improved varieties and the remaining 19.03% was grown with traditional varieties. The total area cultivated with improved varieties was dominated by released varieties (66.92%) followed by Indian varieties (33.08%). Vijay (27.97%) was found to be the largest used released improved variety, followed by Aditya (19.47%), Gautam (18.76%), NL971 (16.42%), BL4341 (13.65%) and others (3.73%). Out of the total area covered by improved varieties of Indian origin, 54.56% was covered by unknown varieties while HD2967 covered 32.22% and PBW343 covered 13.22%. This was in line with the findings of Bhatt *et al.*, (2020) who stated that HD-2967 was heavily imported from India for its high yield and tillering capacity by farmers of Kailali. The type of wheat variety used by farmers for the past 5 years was traced out and it was found that the use of traditional varieties is in a downward trend and the use of improved varieties is in an upward trend. Since the year 2020, a decrease in the use of traditional varieties and an increase in the use of improved varieties was found. This could be addressed to various private and public subsidies on improved seed and other inputs as well as to the programs of the recently established wheat zone.

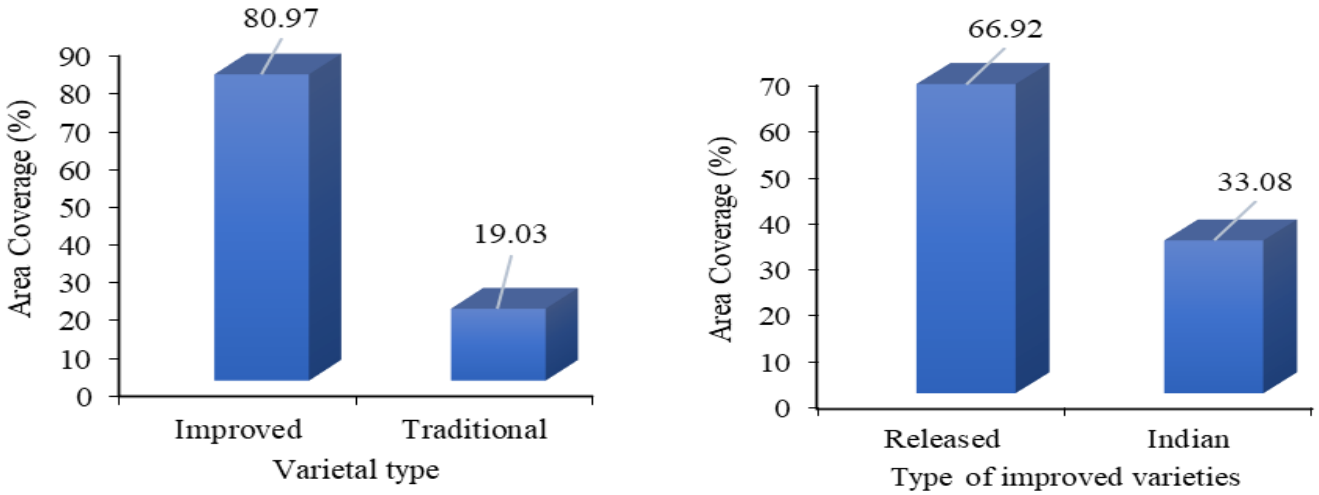

Figure 3. *Area coverage of wheat varietal types in study area (Source: Field survey, 2022).*

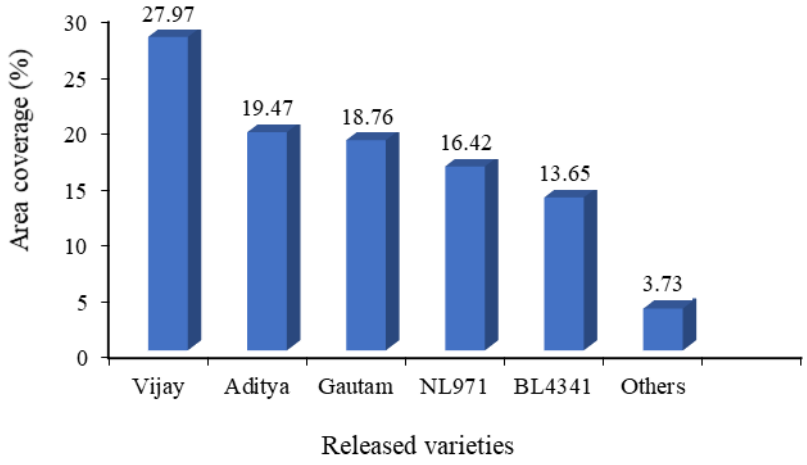

Figure 4. *Area coverage of released varieties in study area (Source: Field survey, 2022).*

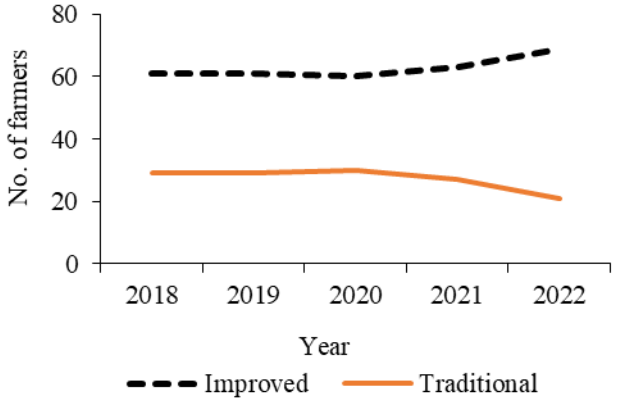

Figure 5. *Trend of varietal use in study area (Source: Field survey, 2022).*

Table 3. Factors affecting adoption of improved varieties in wheat.

Variable	dy/dx	Std. Err.	z	P> |z|	[95% C.I.]		X
subsidy*	.2813846	.10462	2.69***	0.007	.076338	.486431	.511111
access*	.1418686	.07287	1.95*	0.052	-.000961	.284698	.388889
affiliation*	.0260352	.0446	0.58	0.559	-.06137	.11344	.422222
inagr	.004767	.01621	0.29	0.769	-.027013	.036547	3.5
t_whe_cl_kattha	.0005067	.00103	0.49	0.623	-.001515	.002529	20.5056
farm_exp_yrs	-.0008733	.00193	-0.45	0.650	-.004649	.002903	25.2526
hh_gender*	.1675326	.1441	1.16	0.245	-.114893	.449959	.8
familysize	-.0036458	.01063	-0.34	0.732	-.024485	.017193	6.4

(*) dy/dx is for discrete change of dummy variable from 0 to 1. *** & * imply level of significance at 1%, 5% and 10% respectively.

Summary statistics	
Number of observation (N)	90
Log likelihood	-26.91954
LR chi^2(8)	43.95
Prob>chi^2	0.00000
Pseudo R^2	0.45
Predicted probability	0.94

Table 4. Problems associated with adoption of improved varieties of wheat.

Problems	Adopters		Non – adopters		Overall	
	Index value	Rank	Index value	Rank	Index value	Rank
1.Unavailability of improved variety seeds in local markets	0.66	II	0.67	II	0.66	III
2. Timely unavailability of improved variety seeds	0.75	I	0.61	III	0.72	I
3. High cost of seeds	0.57	IV	0.64	IV	0.59	IV
4. Lack of knowledge about improved varieties	0.65	III	0.91	I	0.71	II
5. Poor quality of seeds	0.35	V	0.2	V	0.32	V

Source: Field survey, 2022

Identification of factors affecting the adoption of improved varieties

A binary logistic regression model was used to identify the factors affecting the decision to adopt improved wheat varieties where the binary response of the 90 respondents was coded as; adopters = 1 and non-adopters = 0. The Wald test (LR chi^2) revealed that the model has good explanatory power at the 1% level. This means, all the independent variables included in the model jointly influence the probability of the adoption of improved wheat varieties by the farmers. The binary model estimated the pseudo R^2 to be 0.45 which implies the variables included in the model explain 45% of the probability of farmers' decision to adopt or not to adopt improved wheat varieties. Similarly, the binary logistic regression analysis showed that the two variables: input subsidy and access to extension services significantly affect the decision to adopt improved wheat varieties (Table 3). Furthermore, to interpret the model, the marginal effects were obtained from the regression coefficients as shown in Table 3. It was found that farmers who received a subsidy in inputs are 28.14% more likely to adopt improved varieties of wheat than those who didn't. This was significant at 1% level of significance (Table 3). Government subsidies cut off the production costs bearded by farmers due to inputs by 50%, which is a strong encouragement for farmers. Most of the farmers were found to have received the input subsidies on improved variety seeds, thereby increasing the adoption among the recipients. The findings of Subedi *et al.*, (2019) were in line with this finding, revealing that farmers who received government subsidies in inputs are 17% more likely to adopt improved wheat varieties developed after the NARC establishment than those who didn't. Similarly, access to extension services was found to be significant and positively influencing the adoption of improved varieties at 10% level of significance. It was revealed that farmers who had access to extension services were 14.19% more likely to adopt improved varieties as compared to the farmers who didn't. Access to extension services means access to demonstration trials, participation in training and regular meetings with extension agents. This allows the farmers to be familiar with improved technologies. Moreover, frequent extension visits increase the rate of their diffusion. Therefore, access to extension services increases adoption. In addition, Siyum *et al.* (2022) also found out that the frequency of extension visits significantly and positively affects the probability of adoption of improved bread wheat production technology, increasing the probability by 4.96% upon an increment of extension contact. Also, Chandio and Jiang (2018) on their research concluded that 1% increase in extension contact increases the probability of adoption of improved varieties of wheat by 0.02%. Similarly, extension visit was also found to be affecting the adoption of modern varieties in maize at 5% level (Upadhyay *et al.*, 2018).

Problems associated with adoption of improved varieties of wheat

The wheat farmers were asked to rank the major problems associated with the adoption of improved varieties. Overall, the timely unavailability of improved variety seeds (I = 0.72) was found to be the major problem. Dessalegn *et al*. (2022) had also found differential access to timely and adequate seeds of improved varieties as a major challenge in the adoption of improved legume varieties. Similarly, lack of knowledge about improved varieties (I = 0.71), unavailability of improved variety seeds in local markets (I = 0.66), high cost of seeds (I = 0.59) and poor quality of seeds (I = 0.32) were the second, third, fourth, and fifth most important problems respectively, as shown in Table 4. Particularly for adopters, the timely unavailability of improved variety seeds (I = 0.75) was found as a major problem. Similarly, the same for non-adopters was a lack of knowledge about improved varieties (I = 0.91).

Conclusion

As the study revealed, most of the wheat cultivated area in Kanchanpur is under improved varieties and since Vijay, Aditya, Gautam, NL971 and BL4341 are the most used released improved varieties, it can be concluded that farmers are using NARC-developed varieties that are notified as well as recommended for Terai region; a good practice so far. Furthermore, the trend analysis illustrated that there is an increment in the use of improved varieties of wheat while showing a decline in the use of traditional varieties since the year 2020; thanks to increasing subsidies by different institutions as well as the programs of PMAMP wheat zone. This highlights the key role of public institutions in influencing adoption-related decisions. Similarly, two–third of improved varieties are national varieties while the rest are of Indian origin. Therefore, the concerned stakeholders need to focus on further coverage and dissemination of national varieties. Subsidy for inputs, especially focusing on seeds, should be encouraged for the adoption of improved varieties as it is affecting the farmers' decisions remarkably. Furthermore, the number of extension visits and contact between farmers and extension agents should be strengthened to promote the adoption of improved seeds and practices in farmers' fields. Timely unavailability of quality seeds, lack of knowledge, high cost and poor quality of improved variety seeds were found to be the major setbacks for the farmers willing to adopt. Hence, the concerned public and private stakeholders should ensure timely access to improved variety seeds to increase their coverage while knowledge-based trainings on improved practices need to be provided. In addition, to address the immediate needs, the availability of improved seeds of proper quality at a subsidized cost in local markets should be assured to increase overall wheat productivity.

ACKNOWLEDGEMENTS

We would like to acknowledge PMAMP and AFU for providing the platform of Learning Entrepreneurial Experience (LEE) Internship program, without the institutional and financial support of which, this study could not have been possible. Similarly, we extend our sincere gratitude towards the Technical Officer of the National Maize Research Program (NMRP) Mr. Damodar Gautam for helping us in data analysis.

REFERENCES

Abda, N. (2022). Adoption of Improved Wheat Varieties by Wheat Producers in the Bale Zone of Ethiopia. *International Journal of Agricultural Extension and Rural Development Studies*, 1-19.

Basukala, A. K., & Rasche, L. (2022). Model-Based Yield Gap Assessment in Nepal's Diverse Agricultural Landscape. *Land*.

Bhatt, P., Bist, P., & Ojha, L. N. (2020). Farmers' Preferences of Improved Wheat Varieties in Wheat Subsector Kailali, Nepal. *International Journal of Applied Sciences and Biotechnology*, 432-436.

CBS. (2012). *National Population and Housing Census 2011*. Kathmandu, Nepal: Government of Nepal, National Planning Commission Secretariat.

Chandio, A. A., & Jiang, Y. (2018). Factors influencing the adoption of improved wheat varieties by rural households in Sindh, Pakistan. *AIMS Agriculture and Food*, 216-228.

Danso-Abbeam, G., Bosiako, J. A., Ehiakpor, D. S., & Mabe, F. N. (2018). Adoption of improved maize variety among farm households in the northern region of Ghana. *Cogent Economics and Finance*.

Dessalegn, B., Asnake, W., Tigabie, A., & Le, Q. B. (2022). Challenges to Adoption of Improved Legume Varieties: A Gendered Perspective. *Sustainability*.

FAO. (2009). FAO Expert Meeting. 24 - 26 June 2009 on "How to feed the world in 2050". Rome.

Hu, Y., Zhang, Z., & Wang, J. (2022). Farm size and agricultural technology progress: Evidence from China. *Journal of Rural Studies*, 417-429.

ICARDA. (2022). *ICARDA Science For Resilient Livelihoods In Dry Areas*. Retrieved from ICARDA website: https://www.icarda.org/research/innovations/improved-crop-varieties

Kandel, M., Bastola, A., Sapkota, P., Chaudhary, O., Dhakal, P., Chalise, P., & Shrestha, J. (2018). Analysis of Genetic Diversity among the Different Wheat (Triticum aestivum L.) Genotypes. *Türk Tarım ve Doğa Bilimleri Dergisi*, 180-185.

Kharel, M., Ghimire, Y. N., Timsina, K. P., Adhikari, S. P., Subedi, S., & Paudel, H. K. (2021). Economics of production and marketing of wheat in Rupandehi district of Nepal. *Journal of Agriculture and Natural Resources*, 238-245.

Kumar, A., Takeshima, H., Thapa, G., Adhikari, N., Saroj, S., & Karkee, M. (2020). Adoption and diffusion of improved technologies and production practices in agriculture: Insights from a donor-led intervention in Nepal. *Land use Policy*.

LI-BIRD, & The Development Fund. (2017). *Farmers' Seed Systems in Nepal: Review of National Legislations*. Pokhara, Nepal.

MoALD. (2022). *Agriculture and Livestock Diary*. Hariharbhawan, Lalitpur: Agriculture Information and Technology Center.

MoALD. (2022). *Statistical Information on Nepalese Agriculture*. Kathmandu, Nepal: Planning & Development Cooperation Coordination Division, Statistics and Analysis Section.

Morris, M. L., Dubin, H. J., & Pokhrel, T. (1992). *Returns to Wheat Research in Nepal. CIMMYT Economics Working Paper 92-04*. Mexico: CIMMYT.

Olasoji, J., & Egbetokun, O. (2017). Assessment of Farmers' Saved Seed and Improved Seed on Maize Productivity in South Western Nigeria. *Journal of Experimental Agriculture International*, 1-7.

Ramadas, S., Kiran, K. T., & Singh, G. P. (2019). Wheat Production in India: Trends and Prospects. In F. Shah, Z. Khan, A. Iqbal, M. Turan, & M. Olgun, *Recent Advances In Grain Cropa Research*. Intechopen.

Sharma, I., Tyagi, B. S., Singh, G., Venkatesh, K., & Gupta, O. P. (2014). Enhancing wheat production- A global perspective. *Indian Journal of Agricultural Sciences*, 3-13.

Siyum, N., Giziew, A., & Abebe, A. (2022). Factors influencing adoption of improved bread wheat technologies in Ethiopia: empirical evidence from Meket district. *Heliyon*.

Srivastava, A. K. (2018). Seed replacement for boosting food grains production in Dhanbad district of Jharkand. *Journal of Pharmacognosy and Phytochemistry*.

Subedi, S., Ghimire, Y. N., Adhikari, S. P., Devkota, D., Shrestha, J., Poudel, H. K., & Sapkota, B. K. (2019). Adoption of certain improved varieties of wheat (*Triticum aestivum* L.) in seven different provinces of Nepal. *Archives of Agriculture and Environmental Science* , 404-409.

Timsina, K. P., Ghimire, Y. N., Gauchan, D., Subedi, S., & Adhikari, S. P. (2018). Lessons for promotion of new agricultural technology: a case of Vijay wheat variety in Nepal. *Agriculture & Food Security*.

Tiwari, G., K.C., C., Thapa, P., & Shrestha, A. (2021). Socio-economic analysis of open pollinated improved and hybrid maize production in Sindhupalchok district of Nepal. *Journal of Agriculture and Natural Resources* , 130-139.

Upadhyay, N., Ghimire, Y., Sharma, B., Acharya, Y., Gairhe, S., & Sapkota, S. (2018). Factors affecting adoption of maize varieties in Nepal. *Journal of the Institute of Agriculture and Animal Science*, 39-45.

Wossen, T., Abdoulaye, T., Alene, A., Haile, M. G., Feleke, S., Olanrewaju , A., & Manyong , V. (2017). Impacts of extension access and cooperative membership on technology adoption and household welfare. *Journal of Rural Studies*, 223-233.