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Determinants of Improved Wheat Variety Adoption in Horo District, Oromia Region, Ethiopia

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Abstract

Wheat is the higher-ranked valuable cereal crops grown in Horo district mainly for improving households' income and food security. Despite Horo district is high potential for wheat production, wheat improved technology adoption is far behind in the area. The objective of this study is therefore to identify determinants of improved wheat varieties adoption and their likelihood influence on improved wheat varieties' adoption in Horo district, based on data generated from 151 random sampled farm households. The probit model result depicts that educational level, non/off-farm income, having variety information, access extensions and credit services, increase the likelihood of improved wheat varieties adoption. Whereas, remoteness from output market, decrease the adoption of improved wheat varieties. Furthermore, the findings of the study shows that shortage of improved wheat variety supply, lack of credit, timely availability and poor resistance to disease of improved wheat variety, cost of fertilizer, and improved wheat variety seed are the main constraints hampering improved wheat variety adoption. Accordingly, providing farmers with capacity building training on agricultural related improved technology adoption, expanding and promoting agricultural inputs' credit, improving frequency of extension visits, creating reliable information and awareness about improved farm technology, and expanding infrastructures like rural road networks and timely agricultural inputs supply will increase farmers' decision to adopt improved wheat varieties in the area.

Keywords

Adoption, Binary Probit, Improved Wheat Varieties, Smallholders

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1. Introduction

Agriculture appears to be the mainstay of the Ethiopia economy through offering employment opportunity for more than 70% of the population (The World Factbook) [22]. Agriculture accounts for 34.9% to the Gross Domestic Product (GDP) of the country NBE (National Bank of Ethiopia) [17].

Cereal crops production comprises the major share in the Ethiopian economy. From the total of cultivated land in the country, wheat land area covers estimated to 73% while it provides employment opportunity for about 60% of rural people, and more than 60% of the total caloric intake of the country's population (Brasesco, Asgedom, Sommacal, & Casari) [4]. Wheat is one of the major cereals produced in the country as it provides around 15% of the caloric intake for more than 90 million population FAO (Food and Agriculture Organization) [8]. Likewise, wheat is the fourth main cereal crop cultivated by nearly 5 million smallholder farmers, which is estimated to 35% of wheat farmers in the country CSA (Central Statistics Agency) [6]. Ethiopia is the second major wheat producer, next to South Africa in sub-Saharan Africa (FAO) [9].

Despite the fact that the Ethiopia has a potential to produce

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surplus wheat and increasing its production and yield is one of the priority plan of Ethiopian government's food security, still the country is net wheat importer and wheat self-insufficient (Samuel, Haile, & Kalkuhl) [19]. To reverse these several endeavors have been made to realize self-sufficient in wheat production in the country. For example, 74 varieties of bread wheat and 34 varieties of durum wheat were made to available for production until 2016 in the country (Goshu, Degu, & Oluwole) [11]

Conversely, still the productivity is low and there is high yield gap currently observed in wheat sector in the country (Mann & Warner) [16]. The average wheat yields of the country were 13 and 32% lower than Africa's and world average wheat yields respectively (FAO) [8]. Further compared to the best performing African countries like Zambia, wheat output per hectare in Ethiopia is solely around one-third of Zambia for 2017 production season (Brasesco, Asgedom, Sommacal, & Casari) [4]. Similarly, given elevation, weather situations, topography, and crop health conditions in wheat production different districts gain 9.8 to 86.5% of their potential wheat yield in the country (Mann & Warner) [16]. The average yield gap in recently released varieties is 36 for bread wheat and 29 for durum wheat in the country (Goshu, Degu, & Oluwole) [11]. The low productivity of the wheat yield is largely due to low adoption of improved technologies of high yielding varieties and utilization traditional varieties of wheat by smallholder farmers in Ethiopia in general (Shiferaw, Kassie, Jaleta, & Yirga) [20]. More specifically, the performance of wheat in the study area lower than regional and national average yields i.e. average wheat yields for the zone, regional and national were found to be 23.81, 29.65 and 26.75 quintals per hectare during the production year of 2016/17 CSA (Central Statistics Agency) [7]. However, adoption for modern technologies in wheat production are the principal limiting factors and barriers which limit not to meet such broad goal of the country (Brasesco, Asgedom, Sommacal, & Casari) [4].

There are studies on the potential impact of improved wheat variety adoption that confirmed the paramount importance of the technology adoptions for smallholder farmers in various aspects. For instance, a research on the effect of improved wheat varieties on farm households in Ethiopia found that adoption can significantly benefit household and improve food security (Shiferaw, Kassie, Jaleta, & Yirga) [20]. Similar study conducted in rural Uganda realized that adoption may significantly enhance earnings from crop and decrease poverty (Kassie, Shiferaw, & Muricho) [15]. However, their finding is general as they were conducted at national level that may or may not applicable for specific area. Other studies assessed factors affecting improved maize varieties adoption and its influence on farm productivity and smallholders' wellbeing for related crop (Ahmed, Geleta, Tazezea, & Andualema) [1]. There are also studies on determinants of improved wheat variety adoption for specific study areas (Solomon, Tesema, & Bekele) [21] and Hagos & Hadush) [13]. To the best of our knowledge, there has not been any study on factors affecting improved variety adoption in Horo district specifically and wheat improved technology adoption seems to overlook by researchers.

This study is conducted in Horo district of Oromia region in Ethiopia, where high potential for wheat production and wheat has been the mainstay for several poor smallholders for a century, but where wheat productivity is stagnant, improved technology adoption is far behind. In addition to this, factors contributing to the low adoption rate is not yet clear and literatures also scarce on factors deriving improved wheat varieties adoption in the area. Therefore, it is valuable identify the factors that govern adoption of improved wheat varieties of the smallholders at district level helps as an input for policy measures. Thus, this study is designed to analyze factors affecting adoption of improved wheat varieties and their intensity in improved wheat variety adoption and challenges of improved wheat varieties adopters in Horo district, where previous studies hardly exist in the area.

2. Research Methodology

2.1. Description of the Study Area

This study was undertaken in Horo District. The district is situated at center part of Horo GuduruWollega Zone, in Oromia Regional sate. Shambu, the administrative town of the district is located at 314 km from capital city of the region, Finfine (Addis Ababa) in West direction. The district has 11 farmer associations *kebeles* (Horo District Agriculture and Rural Development Office) [14]. The district shares boundary with Abay Commen district in the south east, by Jardega Jarte in the North West and Jima Ganati district in the south west [14]. Based on the population census projection of CSA (Central Statistics Agency) [5], the district had the total population of 106127 of whom 52791 male and 53336 were female in 2019.

The district is divided into three agro ecology zones, that is highland 49.8%, mid-highland 48.96% and lowland 1.24% respectively. The district experiences adequate rainfall, with mean annual rain fall of 1550 mm. The maximum and minimum rainfall of the district is 1794.4 mm and 787 mm respectively. The elevation of the district ranges from 1450 to 2844 meter above sea level and its mean temperature

oscillates between 12.4 to 24.6 degree Celsius. Figure 1 blow displays the study area map.

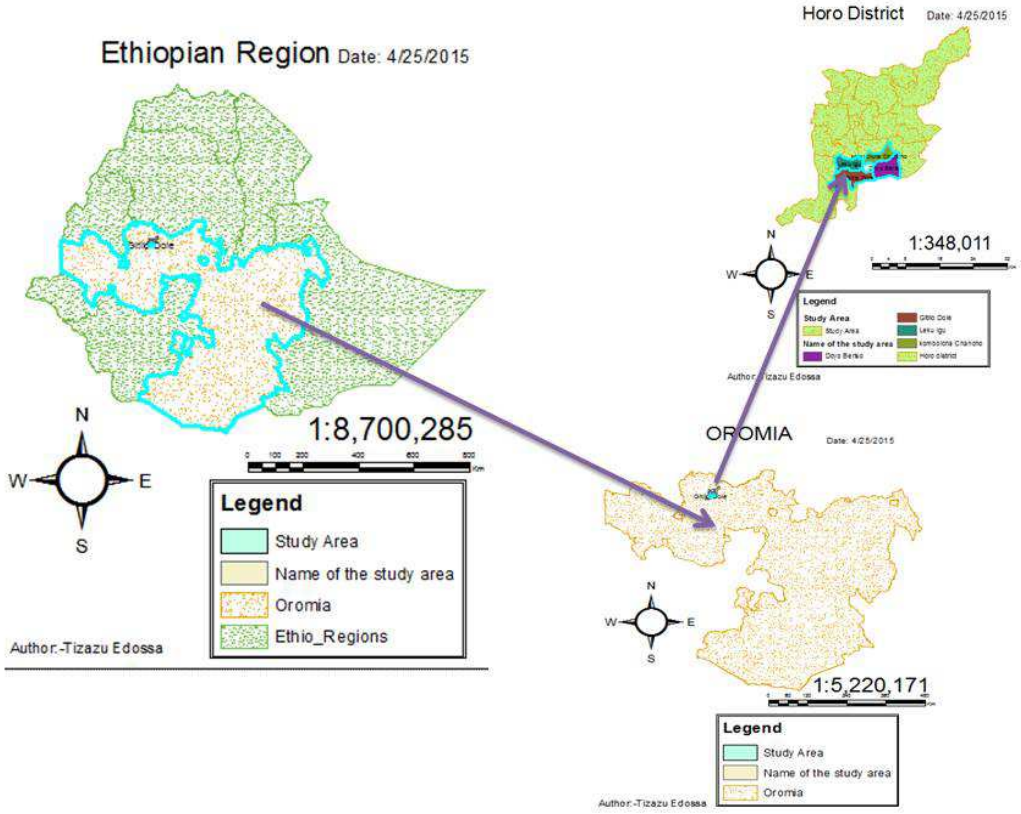

Figure 1. Map of the study area.

2.2. Types, Sources and Methods of Data Collection

For the success the study, primary was supplemented with secondary data collected from different sources. The primary data were obtained from a total of 151 sample households and 15 key informants by using structured and semi-structured questionnaires. Accordingly, important information involving household features (family sizes, age, sex, farming experience, educational level, etc.), plot size, livestock ownership, access to input information and credit, frequency of extension contact, improved wheat varieties adoption, yield data for different crop types, access to infrastructure, perception about improved wheat varieties inputs costs and yield were collected for 2019 production season with aid of structured questionnaires designed for this study.

The questionnaires were managed by trained four enumerators who were familiar with the communities as well as experienced enough in data collection under close supervision of the researchers. Prior to the formal survey implementation, the questionnaires were pre tested on 15 randomly selected farm household to increase the precision of the data. Accordingly, important factors that could have been missed from the study were included and some redundant variables were removed from the questionnaires.

Furthermore, the key informants' interview was carried out with intentionally chosen persons comprising of five village leaders, model farmers, and agricultural experts. As a result, the general information concerning improved wheat production and technology adoption and overall constraints were assessed by researchers by using checklist developed for these purposes. To complement the primary data, secondary data was obtained from different unpublished and published sources, official reports and personal communications.

2.3. Sampling Techniques and Sample Size

The researchers have followed two-stage sampling technique in selecting sample households. In the first step, 4 *kebeles* namely: Gitilo-dale, Kombolcha-chancho, Abe-Dulecha and Akaji-sebat were selected randomly from 11 wheat producing *kebeles*. In second stage, sample wheat farm households were designated randomly keeping the proportion of wheat farm households within each sample *kebele* as indicated in Table 1. Likewise, the sample sizes were decided based on a simplified formula provided by Yamane (1967). The formula was specified as below.

$$n = \frac{\mathrm{N}}{1+\mathrm{N}\,(e)^2} \quad (1)$$

Where n represents the sampled smallholder wheat farm households, N represents the total smallholder wheat farm households of the district, and e is the level of accuracy. The district had a total of 4739 smallholder wheat farm households HDARDO (Horo District Agriculture and Rural Development Office) [14]. By taking e as 8%, N = 4739, the desired sample size is equal to:

$$n = \frac{4739}{1+4739\,(0.08)^2} = 151.26$$

Hence, 151 respondents were selected randomly for this research.

Table 1. Sampled and Total Wheat Farm Households in Selected *Kebeles*.

Kebele	Total Households	Sampled Households
Gitilo-dale	1010	54
Abe-dulecha	544	29
Akaji-sebati	492	26
Kombocha-chancho	790	42
Total	2836	151

Source: HDARDO [14], 2019

2.4. Data Analysis

I used descriptive and inferential statistical, and econometric methods in analyzing the primary data collected from farm households. Descriptive statistics such as means, percentages, standard deviations, minimum, maximum and ranking were computed to explain different socio-economic characteristics of the sample households and challenges in improved wheat varieties adoption. Similarly, inferential statistics such as t-test for continuous variables, and chi-square test for dummy variables were employed to test statistical significance of farm households' characteristics between the improved wheat adopter and non-adopter groups.

Probit regression model was also employed to identify factors influencing the decision and intensity of improved wheat variety adoption of farm households. STATA (South Texas Art Therapy Association) version 14 was used to run probit regression model and compute descriptive statistics results. Prior to running the probit regression model the hypothesized predictor variables were tested for possible multicollinearity problems. Consequently, Variance Inflation Factor (VIF) was found to be below 10 for continuous regressor variables and Contingency Coefficient (CC) below 0.5 for dummy variables indicating that no sever problems of multicollinearity in model.

The two most popular functional forms used for adoption models are the probit and the logit models. Probit is the most appropriate model to govern the likelihood of new improved rice varieties adoption, (Gauchan, Panta, Gautam & Nepali, 2012) as cited by Ghimire, Wen-chi, & Shrestha [10]. Similarly, a probit model was employed to determine the probability of adopting improved wheat varieties for this study as follows.

$$U_i^* = X_i'\gamma + u_i \quad (2)$$

With $U_i = \begin{cases} 1\ if\ U_i^* > 0 \\ 0\ otherwise \end{cases}$

Where, U_i^* is the latent factor signifying the likelihood of the household's choice to adopt improved wheat varieties, and '1' is assigned if the farm household adopted improved wheat varieties, '0' otherwise. Xi′ stands for the regressors determining the adoption decision, γ represents a vector of coefficients to be estimated, and u_i is the disturbance term supposed to be independent and normally distributes as u_i~ N (0, 1).

The effect of the individual regressors on the choice of the farm household to adopt improved wheat varieties, the marginal effect (ME) of the regressors is estimated in the probit model Greene [12] This can be found by partial derivatives of likelihood of the household's choice to adopt improved wheat varieties per unit change in the independent variable as specified below.

$$\text{ME} = \frac{\partial U_i^*}{\partial X_i} \quad (3)$$

Relying on the fore-mentioned explanation and previous research experiences, the independent variables were selected, specified and fitted into a probit model as follows:

$$U_i = \gamma_o + \gamma_1 X_1 + \gamma_2 X_2 + \ldots..\gamma_n X_n + u_i \quad (4)$$

Where:

U_i represents the adoption of improved wheat varieties

X_1 to X_n are the independent factors involved in the model

γ_o to γ_n represent parameters to be estimated,

u_i represents disturbance term

Table 2 below displays the expected sign of explanatory variables on the adoption of improved wheat variety.

Table 2. Description of the explanatory variables.

Variables Name	Description	Measurement	Expected sign
Sex	Sex of the household head	1 if male and 0 otherwise	+
Education	Level of formal education of the household head	Years of schooling	+
Family size	Number of household memberships	Number	
Experience	Household head's experience in farming	Years	+
Non/Off-farm income	Whether household participated in off/non-farm activities or not	1 if yes and 0 otherwise	+
Livestock	Livestock owned by a household	Tropical Livestock Unit	-
Extension	Contact between the household head and extension agent during production season	Number	+

Variables Name	Description	Measurement	Expected sign
Farm size	Amount of cultivated land that a household owned	Hectare	+
Distance to market	The remoteness of the household to the closest market	Kilometer	-
Perceptions on yield	Whether household head perception is positive towards improved wheat variety or not	1 if positive and 0 otherwise	+
Perception on Cost	Whether household head perception is cheap towards improved wheat variety cost or not	1 if cheap and 0 otherwise	+
Variety information	Whether household accessed to improved wheat variety information or not	1 if accessed and 0 otherwise	+
Credit	Whether household accessed to credit or not	1 if accessed and 0 otherwise	+

3. Results and Discussions

3.1. Descriptive and Inferential Statistics Results

As shown in Table 3 in terms of education, family size, farm size, livestock, distance from market, extension, farm experience, variety information, perception on cost, and credit improved wheat adopters and non-adopters are considerably unlike. However, in sex and perception towards yield, there is no meaningful difference among the two counterparts. Furthermore, Table 3 presents the mean differences and t-test results of continuous independent variables, and percentage and chi square test for dichotomous independent variables.

Table 3. Characteristics of the respondents.

Continuous independent variables	Adopter (N = 94)	Non-adopter (N = 57)		
	Mean	Mean	Mean difference/t-test	t- value
Education	9.76	7.33	2.42***	5.07
Family size	7.29	8.37	-1.08***	-2.59
Farm size	4.97	4.06	0.92***	3.19
Livestock	14.88	12.51	2.37***	2.72
Distance from market	3.63	4.71	-1.07***	-3.51
Extension	11.88	6.96	4.92***	6.65
Experience	29.32	25.12	4.20**	2.37

Binary explanatory variables	Description	Adopter (N = 94)		Non-adopter (N = 57)		X^2 value
		No.	%	No.	%	
Sex	Male	90	0.96	55	0.96	0.052
Variety information	Accessed	49	0.52	15	0.26	9.681***
Non/Off-farm income	Participated	86	0.91	12	0.21	77.682***
Perceptions towards yield	Positive	26	0.28	11	0.19	1.341
Perception on cost	Cheap	53	0.56	24	0.42	2.895*
Credit	Accessed	52	0.55	6	0.11	28.885***

*, ** and *** significant at 10, 5 and 1%, respectively.
Source: Own survey computation, 2020

3.2. Determinants of Improved Wheat Variety Adoption

To identify the explanatory variables that have influence on adoption of improved wheat varieties (IWVs) along with their likelihood effects on adoption decision of the farm households, a probit regression model was used. Seven continuous and six binary independent variables were included in the estimation of the probit model.

The Wald test (LR chi^2) of the model is significant at 1% level (Table 4), indicating that all the independent variables involved in the model together impact wheat farm households' probability of adoption of improved wheat varieties. Also, the results disclosed that the number of schooling years of the household head, access to varieties information, distance from output market, non/off-farm income, frequency of extension contact and access to credit were statistically significant with prior expectation signs (Table 4).

Level of education (EDUCLEVEL) or the number of schooling years was significant at 1% level of significance and positively associated to the adoption of improved wheat varieties. The marginal effect of 0.089 for level of education implies that with the increase in number of schooling years of the household head by a year, the likelihood of adoption of improved wheat varieties increases by 8.9%, other things being kept constant (Table 4). The study result is similar to Ghimire, Wen-chi, & Shrestha [10] that showed education is an important factor affecting positively the adoption of improved rice varieties in Central Nepal. The result implies that education enhances farmer's awareness towards the new technologies. This might be justified as education helps farmers easily process information so that they can quickly adopt the new technology.

Access of variety information (AVINFO): The estimated coefficient for the access to improved wheat variety information was positive and significant at the 5% level of

significance (Table 4). The marginal effect of access to variety information, 0.326, signifies that the probability of those households who accessed to improved variety information was 32.6% higher than those households who didn't access to varieties information in adopting IWVs, keeping other variables the same. The result is similar with the finding of Shiferaw, Kassie, Jaleta, & Yirga [20] that showed that accessing variety information positively and significantly influence farmers' decision in favor of improved wheat variety adoption. This may be associated with having variety information prior to production time helps the farmers to be aware about the advantage of IWVs adoption so that those farmers who have accessed variety information have better chances to adopt IWVs.

Non/Off-farm income (NOFI) was positively and significantly interrelated with adoption of IWVs at 1% significance level (Table 4). The marginal effect of non/Off-farm income, 0.644, shows that the probability of those households who engaged in non/off-farm operations were 64.4% higher than those households who didn't engage in non/off-farm activities in adopting improved wheat varieties (IWVs), keeping other variables constant. The finding is analogous to the study result by Olalekan and Simeon [18] which designated participation in off-farm operation has a positive impact on the adoption of new technology. This can be explained as, the households who involved in off-farm activities are capable to have additional earning to buy factors of production. As a result, participation in non/off-farm activities enhance the adoption of improved wheat variety.

Distance or from output market (DISOMRT) was negative and significant at 5% significance level. The marginal effect of distance from output market, -0.075, implies that with the increase in distance of households' home from output (wheat produce) market by one km, the probability of adoption of improved wheat varieties decreases by 7.5%, ceteris paribus (Table 4). The finding of the result is in agreement with the scholar findings of Nefo, & Seboka [3] and Beshir, Emana, Kassa, & Haji [2]. The result can be justified as proximity to output market facilitates easy sale of the outputs and reduces marketing costs. Consequently, it encourages farm households' adoption of IWVs.

Frequency of extension-contact (FREXT) was positively and significantly associated to households' adoption decision of IWVs in the study area at 1% level of significance (Table 4). The marginal effect of the frequency of extension contact, 0. 053, suggests that with the increase in frequency of extension contact by one day, the likelihood of households' adoption of improved wheat varieties increase by 5.3%, ceteris paribus. The finding of this result is an analogous to Yemane [24]. Farmers who have regular contact with extension agents are more likely to adopt IWVs than those who had no/less access to extension advice since extension contact help them access to information about IWVs benefits.

Access to credit (ACREDIT) was positively and significantly related with adoption of IWVs at 5% significance level (Table 4). The marginal effect of access to credit, 0. 460, shows that the probability of those households who accessed to credit were 46.0% higher than those households who didn't access to credit in adopting IWVs, keeping other variables constant. The finding is analogous to Wondale, Molla, & Tilahun [23]. The result might be explained as, households who have accessed to credit may have sufficient money to purchase improved wheat variety seeds along with necessary inputs as per a recommendation. Consequently, it helps them IWVs adoption.

Table 4. Binary probit model result (n=151).

Independent Variables	Coef.	Marginal Effect	Std. Err.	z	P>z
SEX	-2.003	-0.230	1.270	-1.580	0.115
EDUCLEVEL	0.308|***	0.089	0.113	2.730	0.006
FAREXP	0.026	0.008	0.024	1.070	0.284
AVINFO	1.245**	0.326	0.505	2.470	0.014
FAMSIZE	-0.144	-0.041	0.100	-1.440	0.151
NOFI	2.080***	0.644	0.443	4.690	0.000
FARMSIZE	0.054	0.016	0.145	0.370	0.708
DISOMRT	-0.262**	-0.075	0.125	-2.100	0.036
FREXT	0.185***	0.053	0.054	3.430	0.001
ACREDIT	2.006**	0.460	0.800	2.510	0.012
PERYIELD	0.222	0.061	0.479	0.460	0.642
PERCOST	-0.675	-0.192	0.549	-1.230	0.220
TLU	-0.003	0.001	0.051	-0.070	0.947
_cons	-2.957*		1.784	-1.660	0.097
Number of observations		151.000			
LR chi^2 (13)		148.19***			
Prob > chi^2		0.000			
Pseudo R^2		0.7403			
Log likelihood		-25.992749			

*, ** and *** significant at 10, 5 and 1%, respectively.
Source: Own survey computation, 2020

3.3. Constraints in Improved Wheat Variety Adoption

Table 5 summarizes constraints with related to improved wheat varieties production that hamper the adoption decision of improved wheat varieties in the study area. Based on the survey result about 28.48% of the respondents prioritized shortage of improved wheat variety seed supply as their major constraints hindering adoption of improved wheat variety. The rest constraints are ranked in order of their severity as, lack of credit, cost of fertilizer, cost of improved wheat variety, and poor resistance to disease -from the highest to the lowest (see Table 5).

Table 5. Constraints of improved yielding wheat varieties' adoption.

Types of Constraints	Number	Percentage
Shortage improved wheat variety supply	43	28.48%
Lack of credit	32	21.19%
Cost of fertilizer	28	18.54%
Cost of improved wheat variety	23	15.23%
Timely unavailability of improved wheat variety	13	8.61%
Poor resistance to disease	12	7.95%
Total	151	100.00%

Source: own survey data, 2020

4. Conclusion and Recommendations

4.1. Conclusion

The use of improved agricultural technologies mainly improved wheat varieties is considered to be the most imperative input for the success of increased agricultural productivity and market supply of grain wheat of smallholders in Ethiopia. This study was initiated to fill the gap of information on what factors drive adoption of improved wheat varieties, and constraints hindering improved variety adoption in Horo district. Consequently, this study addressed factors driving farmer's participation in improved wheat varieties adoption along with their likelihood influence on farmers' decision of adoption and the major challenges farmers facing in improved wheat varieties adoption.

The results of study confirmed that the probability of adoption choice of improved wheat varieties was highly associated to several factors, which need due consideration. Accordingly, the result of the probit model showed that the independent variables such as level of educational of the household head, access to varieties information, non/off-farm income, extension service, and credit services were found to be crucial factors, positively and significantly affecting adoption of improved wheat varieties, whereas distance from the nearest output market was found to have a significant and negative effect on the adoption decision of improved wheat varieties.

Furthermore, the descriptive analysis result showed that shortage of improved wheat variety supply, lack of credit, cost of fertilizer, cost of improved wheat variety seed, timely unavailability and poor resistance to disease of improved wheat variety the main constraints hampering improved wheat variety adoption in the study area.

4.2. Recommendations

Based on results of descriptive statistics and the econometrics models, recommendations are suggested for policy and development intervention activities to promote adoption of improved wheat varieties. Therefore, the following recommendations were generalized based on results of this study:

Educational level of the farmers played significant role in improved wheat variety adoption. Hence, offering capacity building training on improved wheat verities adoption packages to the wheat farmers may promote and improve adoption of improved wheat varieties. Accessing variety information and extension services were also crucial in adoption of improved wheat variety. Therefore, providing improved wheat varieties promotion and frequent extension services will improve the adoption of improved wheat varieties of farmers in the study area. Similarly, non/off-farm income and access to credit services played significant role in improved wheat variety adoption. Hence, providing agricultural inputs (like fertilizers and improved wheat seeds) on credit may enhance the participation of smallholder farmers particularly the poor. Finally, interlinking farmers in remote area to the output markets via rural infrastructural development like roads and timely agricultural inputs supply, facilitates farmers' adoption of improved wheat varieties in the study area.

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Competing Interests

The author declares no competing interests.

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