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Factors Influencing Adoption of Improved Seed Among Wheat Producing Smallholder Farmers' In West Gojjam Zone of Amahara Region, Ethiopia

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Abstract

Lower and/or inappropriate usages of improved agricultural technologies are among the major of causes for decline of production and productivity of wheat as compared to the potential in Ethiopia. This study aims to measure the status and extent of improved wheat technology adoption and identify its determinants among wheat producing smallholder farmers' in Sekela district of West Gojjam zone of Ethiopia. Multi-stage sampling techniques used to select 204wheat producing farmers. The study primarily used collected primary data for 2017/18 production year using structured questionnaire. In order to analyze the data, both descriptive statistics and econometrics techniques such as double hurdle model are applied. The result shows that family size, availability of oxen and attitude towards risk affected positively adoption status of wheat production. While, farming experience, and off-farm income affected the extent of improved wheat variety adoption. On the other hand, farm size and cultivated farm land affected negatively the extent of improved wheat varieties adoption. Based on the result, the study recommended that the above factors should be considered both at stages in evaluating strategies aimed at promoting wheat production and productivity of the study area.

Keywords: Improved wheat adoption; Double hurdle model; West gojjam zone and Ethiopia.

1. Introduction

The major challenges facing wheat productivity in Ethiopia is lower productivity as compared to its potentials. The national wheat productivity is during 2013/14 cropping season was 25.43Qt/ha. While, in 2015/16declined to 25.35 Qt/ha which shows 0.825.35 Qt/ha production lag as compare to the previous years .More recently, In 2016/17 copping season the average national yield of wheat is 26.75 Qt/ha which shows slight improvement to the previous years [1-3]. However, is the lowest yield as compared to the world average of 40 Qt/ha which is by far lower [4]. The low yield has made the country unable to meet the high demand, and the country remains net importer despite its good potential for wheat production. As a result, food insecurity and poverty are prevalent throughout the country over the last years.

Wheat is 2ndimportant cereal crop with annual production of about 3.43 million tons cultivated on area of 1.63 million hectares. It occupied about 13.49% of the total cereal area [4]. Moreover, Wheat is staple food crop for most households in rural and urban areas of Ethiopia especially in urban areas is wheat. It provides about 15% of the caloric intake for the country's over 90 million population [5], placing it second after maize. After South Africa, Ethiopia is the second largest wheat producer in Sub-Saharan Africa , yet the country is not self-sufficient in its wheat production and imports an average more than one million tons of wheat for the years 2006-2015 [6, 7]. In addition, wheat supplies about 40 percent of the total domestic production of the county [8]. Based on the estimates from [9] the country imported 1.39 million metric ton which is about 34 percent of the domestic production. On the other hand, the domestic consumption of wheat also increases by 2.1 million tons to 4.2 million tons over the last years. This implies there is huge demand and supply gap of wheat which is estimated about 60% yield gap [10].

Yield gap is the difference between potential farm yield (maximum yield) and actual farm yield (average farm yield), this gap results mainly from management practices, such as low input usage and lack of improved seed. Empirically, the highest smallholder farmers' wheat yield was 4,140 kg/ha, while the regional average was only 2,020 kg/ha. The difference is 2120kg/ha, to fill this gap improved technology play significant rule [3] wheat technologies use still remains very low as compared with maize i.e. total areas under improved seeds are 80% covered by maize, 12.1% covered by wheat seeds [3]. This shows wheat yield is low and unstable due to technical and socioeconomic constraints like weed competition, low soil fertility, rust, inappropriate use of improved varieties, high price of fertilizer and herbicides in required quantity and at the required time, and in adequate cash or credit to purchase inputs are the major constraints [11].Some scholars suggested such as Ahmed, *et al.* [12],the gap could be reduced through improving farm productivity which can be obtained through adopting productivity-enhancing technologies. Previous studies done on different parts of Ethiopia such as Mengistu [13] attempted to analyze the impact of agricultural technology adoption on wheat production and its effect on income of farmers such as Tesfaye, *et al.* [14], Birhanu [15], and Berihun, *et al.* [16]. However, specific particular studies in the study area are limited and hence this study aims

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To measure the status and extent and identify factors influencing the adoption of improved wheat varieties among wheat producing farmers in Sekela district of West Gojjam zone of Amahara region, Ethiopia.

2. Research Methodology

2.1. Description of Study Area

The study area is located in Amahara state, the north western Ethiopia. This study was under taken in Sekela district. This district is located between 10°59.25′N latitude and 36°55.30′E longitude .The District is bounded with the Mecha District in the north, Yilmana Densa District in the northeast, Burie District in the south, Jabi Tehinan District in the southeast, Awi zone in the west and the Quarit District in the east, at 460 km from Addis Ababa and 178 km from Bihar Dar. The area is the origin of River Abay. Based on Ethiopian [1] national census the district has a total population of 138,691of whom 69,018 are men and 69,673 women;A total of 29,908 households were counted in this district, resulting in an average of 4.64 persons in a household, and 29,093 housing units for thirty-two kebeles.

2.2. Sample Size and Sampling Techniques

Multi-stage sampling techniques used to select 204 sample wheat producing smallholder farmers. In the first stage, stratified sampling techniques were used to stratify thirty-two kebeles into two that is two urban kebeles and thirty rural-kebeles. In this study thirty rural kebeles had been purposively selected due to the fact that wheat producer kebeles which were target of population of the study. In second stage simple random Sampling techniques were used to select five representative kebeles among thirty kebeles. The selected five kebeles were: Gindatemem, Gumbila, Durashale, Gule and Abesken with total household of 3874 from total 27,456 housing units of thirty wheat producer kebeles of the district. In third stage, simple random sampling proportion to their total population size used to select household head from sample frame. A total of 204 sample wheat producing farmers determined based on Yamane [17] sample size estimation formula.

2.3. Methods of Analysis

I. Descriptive Statistics: to analyze the data various both simple descriptive statistics techniques such as mean, standard deviation, frequency and inferential statistics techniques such as t-test, F-test and chi-square test were applied.

II. Econometrics Model: the double hurdle model (DHM) was used for the analysis with the assumption that the status of adoption and the intensity adoptions are independently determined. In order to justify the use of this model, a restriction test was carried out where the log likelihood values are obtained from a separate estimation of Tobit, Probity and Truncated regression models. Based on the values obtained, the following likelihood ratio statistic had been computed using the formula below $\lambda = 2(\mathrm{LL}Probit + \mathrm{LL}Truncreg - \mathrm{LL}Tobit)$::

The test statistic (λ) has a chi-square distribution with degrees of freedom equal to the number of independent variables. The Tobit model would be rejected in favour of the double hurdle model if λexceeds the appropriate chi-square critical value [18]. If this is true DHM would be used in case it can control the reciprocal relationship between the two factors: adoption decision and use intensity [19].

1stHurdle adoption decision model:

The individual's adoption of technology is dichotomous, involving two mutually exclusive alternatives [20]. The study was adopted the Probit regression model to quantify the factors influencing the adoption decision of improved wheat varieties. The Probit model was ideal because of its ability to constrain the utility value of the decision to adopt variable to lie within zero and one, and its ability to resolve the problem of heteroscedasticity [21].The model specifically allows the factors that determine the adoption decision and intensity of adoption to be differ in independently [22].

First hurdle adoption equation (Di):

$$di^* = \alpha ixi + \mathcal{E}i \quad \text{.....} \quad \text{(A)}$$

$$Di = \begin{cases} 1, if\ di^* > 0 \\ 0, if\ di^* \leq 0 \end{cases} \quad \text{.....} \quad \text{(B)}$$

Where; di^* is latent choice of the adoption by the i^{th} smallholder farmers, αi is vector of unknown parameters, xi is a vector of explanatory variables which affect adoption decision, $\mathcal{E}$i is normally distributed error term with zero mean and constant variance (σ2), i = 1, 2, … n (n is the number of observation) and Di represents observable i^{th}farmers status to adopt improved wheat varieties, 1 if adopt 0, other-wise

2ndHurdle out- come model (intensity of adoption)

The second hurdle involves an outcome equation, which uses a truncated model to determine the level of adoption of improved wheat varieties in question. This model excludes part of sampled observation based on the value of the dependent variable. That is, the truncated regression uses observations only from farming households who reported positive and greater zero. The intensity of adoption is modeled as a regression truncated at zero that is lower limit zero, upper limit positive infinity [23]

A dependent variable that has a zero value for a significant fraction of the observation requires a truncated regression model because standard OLS results in a biased and inconsistent parameter estimates. The bias arises from the fact that if one considers only the observable observations and omits the others, there is no guarantee that the expected value of the error term would be zero [24].

Truncated model is expressed as follows:

$$Y^* = \beta Xi + \mu i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (D)$$

$$Yi = \begin{cases} Y^*, if \quad Di = 1 \; and \; Y^* \geq \mu \\ \quad 0, \; Di \leq 0 \; and Y^* < \mu \end{cases} \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (E)$$

Where; latent variable Yi* which is base for number of observation (i),β is a vector of parameters, Xi is a vector of explanatory variables hypothesized to affect intensity of technology adoption, μ representing threshold; minimum use of IWVS in the study area whereas i implies number of observation. Yi Represents observed use intensity of (IWVs) among small holder farmers. The decision of adoption of IWVs and how much of IWVs use can be jointly modeled if they are made simultaneously by small holder farmers, independently modeled if they are made separately, or sequentially modeled if one is made first and affects the other one as in the dominance model [25].

The independent double hurdle model assumes that the two error terms from the two hurdles are normally distributed and uncorrelated. This suggests that the two stage IWVs adoption decision and the intensity of adoption are done independently by the SHFs. Under the assumption of independency between the error terms $\mathscr{E}$**i** and μ**i** the model as originally proposed by Cragg [26] is equivalent to a combination of a truncated regression model and a univariate Probit model.

The double-hurdle model relies on the assumption of normality of the errors μi and $\mathscr{E}$i .If this assumption is not tenable, the ML estimates would be inconsistent. One way to accommodate the assumption of normality is by transforming the dependent and latent variables [27].The error terms, are distributed as follows:

$$\begin{Bmatrix} \tilde{\tilde{\mathcal{E}}} \approx N(0,1) \\ \mu \approx N(0, \sigma 2) \end{Bmatrix}$$

The model is said to be dependent model if there is a relationship between, the status of adoption and the intensity of adoption. This relationship can be expressed as follow

$$:\boldsymbol{p} = \frac{\boldsymbol{cov\mu i \mathcal{E} i}}{\sqrt{\boldsymbol{var(\mu i) var \mathcal{E} i)}}}$$

If ρ=0 and there is dominance (the zeros are only associated to non-adoption, not standard corner solutions) then the model decomposes into a Probit for adoption decision and truncated for the intensity of adoption of technology [25].

A simple test for the double hurdle modal against the Tobit model was examined. That is Tobit log- likelihood is the sum of the log-likelihood of the truncated as well as the probit models. Therefore, one simply has to estimate the truncated regression models; the Tobit model and the Probit model separately and use a likelihood ratio (LR) test. The LR statistic can be computed using [28]:

$$\Gamma = -2[lnLT - (lnLp + lnLTR)] \sim \chi 2\boldsymbol{k}$$

Where, Γ: test statics, LT =likelihood for the Tobit model; Lp =likelihood for the Probit model; LTR=likelihood for the truncated regression model; and k is the number of independent variables in the equations. If the test hypothesis is written as, H0: $\lambda = \frac{\beta}{\sigma}$ and H1:$\lambda \neq \frac{\beta}{\sigma}$Then, H0: was rejected on a prespecified significance level, if $\Gamma > x^2$k. and then DHM was used.

2.4. Definitions of Variables and Working Hypothesis

In the study area: different variables such as demographic, socio-economic, institutional and psychological variables were expected to influence the status and intensity of adoption.

Table-1. Description of variables, measurement and working hypothesis

Variables	Unit	Measurement	Expected Sign	Descriptions
Dependent variables: Di & ADIWVs				The status and intensity of adoption of improved wheat varieties
Di ADIWVs Independent	1 or 0 Kg per ha	Dummy Continuous		1 for adopter, 0 for non-adopter small holder farmers in the study area, Area devoted for improved wheat varieties that is kg per hectare
1.Sex	1 or 0	Dummy	-/+	1for male,0 for female house hold head
2.Off income	Birr	Dummy	+	1 for off-farm, 0 other sources
3. Fedu.	Number of year	Continuous	+	year of formal education for household head in year
4.Excota	1 or 0	Dummy	+	1 for use of extension service, 0 otherwise
5.Useofcredit	1or 0	Dummy	+	use of credit 1,0 otherwise in Ethiopian birr
6.Farmsize	Hectare	Continous	+/-	Total land own by smallholder farmers.
7.participation tech-evaluation	1or 0	Dummy	+	1 for Participation in technology evaluation ,0 otherwise
8. Family size	adult equivalent	Continous	+/-	Family size availability in small holder farmers in number.

9.tropical livestock	TLU	Continous	+	Number of livestock unit owned in the house hold.
10. HHexperi	Year	Continous	+	number of year house hold head use improved wheat varieties
11. DISTOMRT	Km	Continous	-	distance to impute market from small holder farmers residence
12. FPIWVS	Index	Perception	Favorable	Smallholder farmers' perception to the specific attributes of Recommended Agronomic practices and improved wheat varieties (IWVs).
13. Access oxen	1or 0	Dummy	+	1 for SHFs owns oxen ,0 other wise
14. AccessSM	1or 0	Dummy	+	1 for access to social media, 0 otherwise.
15. wclaoship	1 or 0	Dummy	+/-	1 for well cultivated land ,0 otherwise
16. Risk	1 or 0	Dummy	+/-	1 if early adopter, 0 otherwise
17. Useche-ferti	Kilogram	Continous	+	User of chemical fertilizer by smallholder farmers.
18. Soil fertility status	1 or 0	Dummy	+	1 for fertile soil, 0 other wise

3. Result and Discussions

3.1. Descriptive Statistic Results

The average education level of non-adopters and adopters of improved wheat varieties are found to be 1.89 and 2.03 years with standard deviation 3.48 and 3.22 respectively. The average education level is 2.01 with standard deviation of 3.25. The average Farming experience in years of the farmers is 23.40with standard deviation 11.70. The non-adopters and adopters mean farming. The average family size is 3.78with standard deviation of 1.57. Non-adopters and adopters mean is found to be 3.19 and 3.87 with standard deviation 1.57 and 1.56. The mean difference is statistically significant at 5%, meaning, there is mean difference between non-adopters and adopters of family size. The mean livestock in TLU is 3.73with 1.53. The non-adopters and adopters mean TLU is found to be 3.49 and 3.77 with standard deviation 1.20 and 1.57, respectively. The average Farm size in hectare is 1.35 with a standard deviation of 1.04. The non-adopters and adopters mean are found to be 1.94 and 1.38 with standard deviation 0.90 and 1.06, respectively. The mean distance from farmer home to input market in kilometer is 8.13 with standard deviation of 6.Standard deviation and mean distance of both non-adopters and adopters are found to be 6.38, 6.00, 8.80, and 8.03 respectively. The average use of chemical fertilizer is 171.45 with standard deviation of 104.85. While, the mean for non-adopters are 124.82, and adopters are 178.56, with standard deviation of 60.06, 108.46 respectively. The mean differences are statistically significant at 1% which indicates that the mean difference of use of chemical fertilizers between non-adopters and adopters of impede wheat verities as shown in (Table 2).

Table-2. Descriptive statistics for continuous variables

Characteristics	**None adopter**		**Adopter of IWVs**		**Total sample**	
Continous variables	**Mean**	**st.dev**	**Mean**	**st.dev**	**Mean**	**st.dev**
Education in (year)	1.889	3.479	2.028	3.220	2.009	3.246
Farming experience(year)	22.444	12.201	23.542	11.649	23.397	11.698
Family size(AE)	3.194	1.574	3.867	1.557	3.777**	1.571
Total livestock unit(TLU)	3.494	1.198	3.769	1.570	3.732	1.526
Farm size in(hectare)	1.194	.902	1.378	1.055	1.353	1.036
Distance to input market(km)	8.806	6.381	8.027	6.001	8.130	6.042
Use of fertilizers(kg)	124.815	60.056	178.559	108.458	171.45***	104.851

Note: ***, **, and * are statistically significant at 1%, 5% and 10%, respectively.
Source: Own survey result, 2018

From total 27 non-adopters 18.8% were female and 11.5% are male. In the case of 177 adopters of improved seed 81.2% are female and that of 88.5 % were male. The proportion (%) of female adopters and non-adopters as well as that of male adopters and non-adopters were not equal. 27 non-adopters17.6% hadn't off-farm income, whereas 10.1% had off-farm income. Among 177 adopters 82.4% had no off farm income and 89.9% had off-farm income. Regarding to non-adopters and adopters 25.6% and 74.4 % of sample respondents had no oxen, whereas 9.9%, 90.1% had oxen respectively. Availability of oxen had significant effect (relationship) on status of adoption in case the chi-square sign-value of this variable is significant at 1% level. In case of non-adopters18.3% had no extension contact whereas 11.1% had extension contact, in case of adopters 81.7% had no this access , whereas 88.9% had**.** Use of credit by household head in 9.9% non-adopters and 15% of adopters, the 1st did not use credit while the later use credit. Among adopters 90.1% of respondents did not use credit and 85% use credit. Regarding to this evaluation 14.8% of non-adopters and 85.2% of adopters did not participate in technology evaluation. In the same way 12.7% of non-adopters and 87.3% of adopters had participated in technology evaluation. Access of social

media are 17.8% for non-adopters and 82.2% adopters, both parts did not access social media whereas 9.6% of non-adopters and 90.4% of adopters are used access of social media. This access was statistically significant at 10% level of significant which implies that access of social media had significant relationship with status of adoption. Cultivated land ownership within 19.6% non-adopters and 80.4% adopters both did not have own cultivated land but 11.4% non-adopters and 88.6% adopters had their own cultivated land. Attitude towards risk among 22.8% non-users and 77.2% users all did not have attitude towards risk while 7.2% non-users and 92.8% of users had attitude towards risk. The chi-square sign-value of this variable was statistically significant which implies that attitude towards risk has significant relationship with adoption decision at 1% significant level. Soil fertility status within 14.9% of non-users and 85.1% of users both had infertile land. In otherwise 12.3% of non-adopters and 87.7% of adopters have fertile land for cultivation.

Table-3. Socio-economic, institutional and psychological trait for dummy variables

Dummy variables	Non-adopters		Adopters		Total sample		chi 2-value	Sign –value
	N	%	N	%	N	%		
Sex Female Male	9	18.8	39	81.2	48	100	1.66	0.197
	18	11.5	138	88.5	156	100		
Off-farm income	12	17.6	70	82.4	82	100	2.47	0.116
No	15	10.1	107	89.9	122	100		
Yes								
Availability of oxen	11	25.6	32	74.4	43	100	7.23	0.007***
No	16	9.9	145	90.1	161	100		
Yes								
Extension contact	11	18.3	49	81.7	60	100	1.924	0.165
No	16	11.1	128	88.9	144	100		
Yes								
Use of credit	7	9.9	64	90.1	71	100	1.081	0.298
No	20	15	113	85	133	100		
Yes								
Participation	8	14.8	46	85.2	54	100	0.160	0.690
technology evaluation	19	12.7	131	87.3	150	100		
No								
Yes								
Access of social media	16	17.8	74	82.2	90	100	2.894	0.089*
No	11	9.6	103	90.4	114	100		
Yes								
Cultivated land owner	9	19.6	37	80.4	46	100	2.072	0.150
ship	18	11.4	140	88.6	158	100		
No								
Yes								
Attitude towards risk	18	22.8	61		79	100	10.238	0.001***
No	9	7.2	77.2		125	100		
Yes			116					
			92.8					
Soil fertility status	11	14.9 16	63		74	100	0.269	0.604
No	12.3		85.1		130	100		
Yes			114					
			87.7					

Note: ***, **, and * are statistically significant at 1%, 5% and 10%, respectively.
Source: Own survey, 2018

Before running double hurdle model, tests were carried out against competing models;

Test of Hackman two stage model: Two step Heckman selection model was rejected in case: waldchi2 (18) =14.88, Pro>chi2 = 0.6701 .The pro>chi2 value was not significant as the regression output indicated, this indicates the model was not fit for status and intensity of adoption of improved wheat varieties among small holder farmers in the study area. As a result the data that were included in this model were not explained well. So, for status (adoption decision) and intensity of adoption analysis double hurdle model was employed after Tobit model test.

Test of Tobit model: The first step to analyze double hurdle model was Tobit model test through separate estimation of probit, truncation and Tobit itself. That is: Tobit model test

$\Gamma = -2[lnLT - (lnLp + lnLTR)] \sim \chi 2(k)\Gamma$: test statics, LT =likelihood for the Tobit model; LP =likelihood for the Probit model; LTR=likelihood for the truncated regression model; and k is the number of independent variables in the equations. LLTobit = -821.23, LLProbit = -62.66, LLTruncation = -725.75, this value was taken from separate estimation of each models.

$$\Gamma = -2[\ -821.23 - (—\ 62.66\ \ - 725.75)] \sim \chi 2(18)$$
$$\Gamma = -2(-821.23 + 788.41)$$
$$\Gamma = 65.64 \& \chi 2(18) = 9.39$$

$$\Gamma > \chi 2(k)\ i.e\ 65.64 > 9.39(from \chi 2\ table\ value)$$

The test statistic (Γ) is greater than a chi-square distribution with degrees of freedom equal to the number of independent variables (k=18). Therefore Tobit model was rejected in favour of the double hurdle model. The double hurdle model was carried out using a probit model to estimate the first hurdle and a truncated regression for the second hurdle. The best model for this analysis was Craggit model i.e the first tier: for adoption decisions while the second tier: for extent of adoption. As double hurdle model maximum likelihood estimates result show, Chi square overall = 49.055107, P overall = .0720544 is significant at 10% level. This indicates both stage taken together significantly explain the data and the joint significance of the explanatory variables that were used in two Double Hurdle model Results.

Household head experience: the experience of the respondent is positively and significantly influences the extent of improved wheat varieties (IWVs) adoption at 10% level of significant. For example, as the farmers experience increased by one year, the level of IWVs adoption increases by 0.209 kg/ha, being other variables constant. Moreover farmers with longer farming experiences in the production have gotten more knowledge and skill in the intensive production of the crop itself. So farmers who have more farming experience in the production adopt more than farmer with shorter farming experience. This may be due to relatively farmers who have Longer years of experience may develop the confidence in handling the risk lovers, skills in technology application and this variable consistent with the prior expectation, and in line with [11, 29-31] reports.

Family size: family size has positive contribution to the status of adoption at 10% probability level of significant. As the family size increase by one individual, the probabilities of IWVs adoption increase by 0.1784 see (Table 4) while keep constant other variables. In case family size refers to a total number of family members and the main sources of farm labor. Since technology adoption is labor intensive, farmers with large family size are expected to adopt more. So, larger family size is expected to increase the probability of adoption positively. This result agree with [31, 32] and go with the prior expectation.

Farm size in hectare: Regarding farm size, the results indicate that an increase in the farm size by a unit hectare decrease use intensity of improved wheat varieties by 3.169quintal per hectare, hold constant other variables. The negative impact of farm size on use intensity of IWVs can be justified in case of cost of inputs associated to cover larger farm size. The farmers with larger farm size encouraged to plant eucalypts tree (bair zaf in Amharic) which is less cost initially and lead to profit later for owners as compare IWVs and further, the farm size is a significant determinant of level of adoption at 5% probability level of significant.

Off-farm income: during winter season many smallholder farmers earn additional income by engaging in various off-farm activities. This is believed to raise their financial position to acquire new inputs such as improved wheat varieties' seeds, fertilizers and other input which is essential for production. If off- farm income increase from zero to one birr lead to increase the level of IWVs adoption by 5.010 amount, ceteris paribus other variables .Therefore, in this study, it is hypothesized that there was a positive correlation between the amount of off-farm income and adoption of IWVs at 5% probability level of significant, this relationship in line with [16, 33, 34], results and same with prior expectation below.

Availability of oxen: oxen positively influence the decision to participate in the status of adoption at 1% significance level. This implies that as the number of oxen owned by the respondent increased from zero to one, the probability of participating in the status of adoption increase by 0.896 being constant other variables. This is due to the fact that as oxen are the main source of traction power for the farmers, and the availability and increment in the number of oxen will increase the intensive and extensive production of improved wheat varieties. This result is the same as with [35] reports and the sign was same with previous expectation.

Well cultivated land ownership: Regarding to cultivated farm size, as the results indicate an increase well cultivated farm size from zero to one hectare, use intensity of improved wheat varieties decrease by 6.536quintal per hectare, being constant other variables. The negative impact of cultivated farm size on use intensity of IWVs could be in case of cost of inputs associated to cover larger cultivated farm size with improved technology rather farmers take as alternative local seeds to cover their cultivated land because local seed is less cost initially and familiars for users as compare IWVs ones. Further, the cultivated farm size is negatively determining the extent of adoption at 5% probability level of significant in the study district. This relationship was not go with prior expect see (Table 4).

Attitude towards risk: this variable has positive contribution to the status of adoption of improved wheat varieties at 5% probability level of significant see. If attitude towards risk change from laggards to early adopter, (risk averse to risk lover i.e from zero to one), the probability of adoption change by 0.6279, this contribution is similar with previous expectation, and this result agree with [36] reports. Smallholder farmers produce under very high levels of uncertainty induced by natural hazards as a result technology adoption also usually comes with uncertainties. Innovators and early adopters are perceived to be risk lovers while late adopters and laggards tend to be risk averse.

Table-4. Conditional independence double hurdle model results

	1st hurdle(probit) tier1		2nd hurdle(truncation)tier2	
Variables	**Marginal Effect**	**P>|z|**	**Marginal Effects**	**P>|z|**
FEDUINYE	.0124122	0.760	-.6341306	0.108
HHEXPERI	.0041015	0.757	0.2092401	0.080*
FAMISI	.1784923	0.089*	-.7208549	0.392
SEXHH	.2174163	0.488	-.7303279	0.804
TLU	-.0000348	1.000	-.3749661	0.680
FARMSI~A	-.0606639	. 0.709	-3.169333	0.031**
OFFFAIN	.3172805	0.242	5.010053	0.041**
AVAOXEN	.8969459	0.003***	-2.184691	0.496
EXCONTA	.2185756	0.441	-1.390667	0.601
DMRTKM	-.0172819	0.460	-.2386781	0.270
USECHFKG	.0019159	0.267	.0096735	0.417
USCREDIT	-.1547908	0.595	2.444012	0.335
PARTEVA	-.140861	0.650	-.8025235	0.771
ACCESM	.2685711	0.350	1.750151	0.496
LANOSHIP	.3144475	0.316	-6.536246	0.033**
ATITOWR	.6279606	0.018**	.4334294	0.866
PHHIWV	.1445217	0.287	.2477076	0.836
SFS	.0443236	0.875	.2081276	0.940

Note: ***, **, and * are statistically significant at 1%, 5% and 10%, respectively.
Source: Model result based on own survey, 2018

4. Conclusions and Recommendations

As double hurdle model result shows: family size, availability of oxen and attitude towards risk affect the status of adoption positively, under 1st stage independent double hurdle model while experience of farming, and off-farm income affect the level of improved wheat variety adoption positively 2nd stage independent double hurdle model as well as farm size in hectare and well cultivated farm land influence the extent of improved wheat varieties adoption negatively. Generally factors which influence farming households' decision to adopt improved wheat were unassociated with the decision variables in the second hurdle involving extent of improved wheat varieties. This result confirmed the relevance of the double hurdle model in this study. This implies that the two-stage decision of adoption and use intensity were done independently by respondents. Independent double hurdle model estimation assumes that the two error terms from the two hurdles are normally distributed and uncorrelated. The result of the model revealed that the error terms were uncorrelated.

Double hurdle model result shows that factors influencing adoption decision of improved wheat varieties are different from determinants of intensity of improved wheat varieties. This implies that addressing these core determinants with appropriate policy options could enable farmers to have the opportunity to adopt and intensify the use of improved wheat varieties. Therefore, it is important to consider both stages in evaluating strategies aimed at promoting the adoption and use of improved wheat verities. Moreover as double hurdle model result shows: family size, availability of oxen and attitude towards risk affect the status of adoption improved wheat varieties positively from 1st stage independent double hurdle model: therefore strengthening the existing: health services, skill of human power, livestock production system by providing better livestock feed (forage), and delivering target training will have to change small holder's attitude for technology adoption. And also household head experience in farming and off-farm income affect the level of improved wheat variety adoption positively from 2nd stage double hurdle model: So, it is better to develop experiences exchange: the lower experienced farmer with highly experience one through field visits to share idea for each other and developing in formal education for smallholder farmers about off-income activities will help to scale up their livelihood by branching out income sources.

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