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Determinants of Adoption of Wheat Row Planting: The Case of Wogera District, North Gondar Zone, Amhara Regional State, Ethiopia

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Abstract

Wheat is the fourth important cereal crop and its yield was low in Ethiopia. Adoption of improved technologies is one of the most promising ways to increase agricultural production and productivity. However; the adoption of new technologies was constrained by various factors. Therefore, this study was aimed analyzing determinants of adoption of wheat row planting in wogera district. The specific the objectives of this study were to identify factors affecting the adoption and intensity of wheat row planting; and to carry out relative cost benefit analysis on row planting against broadcasting technology on wheat production. Systematic random sampling technique was employed to select 154 wheat producers from three sample Kebeles in the study area. The study was used a cross sectional data collected from selected sample households through structured questionnaire interview schedule. Both descriptive and econometric methods were used to analyze the data. The survey indicates that 43% were adopters and 57% non-adopters of wheat row planting. Tobit model was applied to identify factors that affect adoption and intensity of wheat row planting. The output of Tobit regression model indicated that total of 14 explanatory variables 6 variables were found to be significant to affect the adoption of wheat row planting. The results of partial budgeting analysis showed that the adoption of row planting had profitable with the net change 2,859.13 birr per hectare. As a recommendation emphasis should be given to improve the adoption of row planting in the study area by focusing on the above mentioned variables.

Keywords: Adoption; Row planting; Tobit model

Introduction

The economies of Sub Saharan Africa (SSA) are dominated by persistent agriculture employing about half of the population. However, agricultural production and productivity in SSA is found to be low. Like in any SSA, agricultural sector holds a prominent position in Ethiopia [1,2]. The average wheat productivity in SSA is 1.7 tons/ha, nearly 50% below the world average [3]. Low agricultural productivity is attributed to a multitude of factors including population pressure which resulted in serious land degradation and small farm size, recurrent drought and lack of farm technology [4].

The agriculture sector is the most dominant aspect of the Ethiopian economy, accounting for nearly 43% of GDP, its employment generation 80% and nearly 70% of foreign export earnings [5]. In the crop production sub-sector, cereals were the dominant food grains. Within agriculture, 50% of the output of agricultural GDP comes from crop production whereas, 47% and 3% are from livestock and forestry respectively. Cereals are the major staple food crops both in terms of area planted and volume of production obtained. In 2013/14 main crop season, cereals were cultivated on 9.9 million hectares of land producing 22 million tons of food grains. This represented 79.38% and 85.81% of the total area and production of food grains in the country, respectively [4].

Among cereals, wheat was one of the most important cereal crops of the world and is a staple food for about one third of the world's population. Ethiopia is the second-largest wheat producer in Sub-Saharan Africa next to South Africa. It is the fourth important cereal crop with annual production of about 3.43 million tons cultivated on an area of 1.63 million hectares [4]. According to the CSA data, it occupies about 17% of the total cereal area in the country. However, its national average yield is about 21 quintals per hectare. This is low yield compared to global average of 40 quintals per hectare [6].

In Ethiopia, wheat is mainly produced in Oromia and Amhara Regions, with smaller quantities in Tigray and SNNPR Regions. There are 16 major wheat producing zones in these four regions. It is also one of the most important cereal crops in the Amhara National Regional State (ANRS), where it is grown as a source of food and cash. The total area of land wheat under cultivation in the region was 427,719.81 hectare, constituting 10% of the total cereal area. Average yield of wheat in the region was 15 quintal per hectares. Major wheat producing zones in the Amhara region are North Shewa, East Gojjam and South Wollo each of which produces more than one million quintals. The other remarkable zones in the production of wheat in the region are West Gojjam, South Gondar and North Gondar [7].

Improvement of agricultural productivity provides an important solution in addressing the problems of food insecurity and poverty, and enhancing the development of agriculture in Ethiopia [8,9]. A core goal of the government of Ethiopia within the framework of ADLI strategy is to raise crop yields through a centralized and aggressive extension-based push focusing on technology packages combining improved seeds, fertilizers, credit and better management practices [4]. One of the technologies in crop production introduced in the recent years is row sowing. It compared to broadcasting gives better yield as it allows better weeding and for better branching out and nutrient uptake of the plants and diminishes competition between seedlings. According to the Ministry of Agriculture and Rural Development row plantation on average increases production by 30% and reduces the amount of seed to one-fifth of existing seed use. It is significant

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increases in crop production require improved agronomic practices in addition to improved hybrids [10].

In fact, rapid population growth relative to food production and the scarcity of arable land necessitates the application of science based production technologies in agriculture. At present the agricultural policy of Ethiopia gives high priority to increasing food production through the promotion of improved production technologies among smallholders. In order to increase the production and productivity of agricultural output, the use of modern agricultural technologies are vital, out of which fertilizer, high yielding variety and row planting of crops are the most important technologies to increase the level of crop production [11].

Statement of the problem

The major challenge confronting most of developing countries such as Ethiopia is improving rural as well as urban food security and to stimulate underlying food system development. There is an ever increasing concern that it is becoming more and more difficult to achieve and sustain the needed increase in agricultural production based on extensification, because there are limited opportunities for area expansion [12]. Hence, improved agricultural technology adoption plays a significant role in increasing agricultural productivity, achieving food sufficiency and alleviating poverty among smallholder farmers. Currently, adoption of high yield variety seeds and improved production technologies in the country is on the top of the government’s agenda for the successful achievement of its five year plan, that is, Growth and Transformation Plan (GTP). Despite the release of different improved varieties, farmers are still planting the improved varieties in traditional way (broadcasting method) [13]. Agricultural extension activity is concerned with the promotion and scaling-up of wheat row planting. Row planting of wheat, barley and teff in the study area was beginning to promote in 2013/14 by extension agents. In this was the most common agricultural product in the area, extension agent’s advice to farmers that the width between rows should be approximately 30 cm. In 2015/16 cropping season wheat covered a total of 9,374 hectare of land from this 5,624 hectare was covered by row planting and other remaining was covered by broadcasting method [14]. Therefore, this study was initiated to analyze factors influencing the farmers' decision to adopting and non-adopting wheat row planting in study area. According to previous study Tolosa to identify factor influencing adoption of wheat row planting among smallholder wheat farmers in Oromia region. However, there were no earlier studies which investigated factor influencing intensity of wheat row planting and the cost and benefit of row planting technology adoption. Further, in the study area there is no empirical study conducted on determinants of adoption and intensity of wheat row planting. Hence, this study was intended to fulfill these information gaps on determinants of adoption of wheat row planting in the study area. In view of the stated problems this research work was addresses the following questions: What are the factors that affect adoption and intensity of wheat row planting technology by farmer, What are the cost and benefit difference of wheat production between row planting and traditional broadcasting methods?

Objective of the study

The general objective of the study was to analyze the determinants of adoption of wheat row planting in Wogera district.

The specific objectives of this study were:

1. To identify factors affecting the adoption and intensity of wheat row planting technology in the study area.
2. To carry out relative cost benefit analysis on row planting against broadcasting technology on wheat production.

Methodology

Description of study area

The agro-ecological classification of the Wogera district shows that 33% of the total area is classified as mid-land (woina-dega), 44% highland (Dega) and 23% as lowland (kola). The area is characterized by 25% as mountain, 50% as plateau, 10% as dissected gullies and 15% as undulation. It altitude about 1500 up to 3086 m.a.s.l and its average temperature range 18°C to 27°C and average rain fall are from 400 mm -700 mm. Type of soil in the area are 40% as red soil, 30% as black soil and 15% as brown and 15% as gray. This district is bounded or allocated on the south by Mirab Belessa, on the southwest by Gondar Zuria, on the west by Lay Armachiho, on the northwest by Tach Armachiho, on the north by Dabat, on the northeast by Jan Amora, and on the southeast by Misraq Belessa. The district covers a total area of 182126 sq km [14]. The two ethnic groups reported in Wogera were the Amhara (90.48%), and the Qemant (9.24%); all other ethnic groups made up 0.28% of the population. The total populations of the area 289,333 of whom 126,874 are male and 162,459 are female (Figure 1).

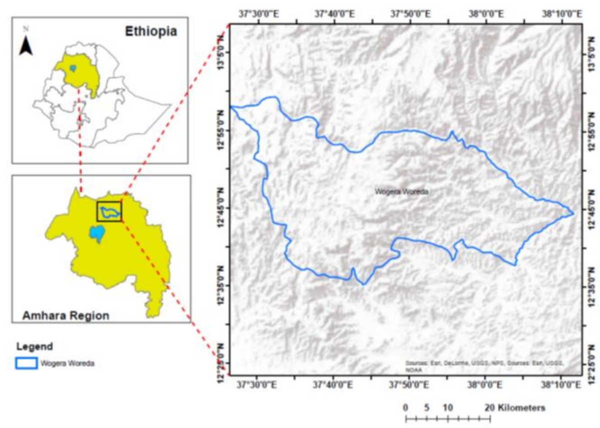

Figure 1: Location Map of Wogera District.

Sampling procedure and sample size

In this study three stage sampling technique were employed. It was used both purposive and random sampling techniques to draw a representative sample. In the first stage, from the 39 rural Kebeles administrations in Wogera distinct, 24 potential wheat producing Kebeles were purposively selected (Table 1). In the second stage, 3 Kebeles were randomly selected from potential wheat producing Kebeles. Finally, using the household list of the sampled Kebeles 154 sample farmers were selected by using systematic random sampling. The total sample size was distributed to each Kebeles based on the probability proportional to size sampling technique [15]. The sample size was determined by using the formula given that is:

$$n = \frac{Z^2 pqN}{(N-1)e^2 + Z^2 pq}$$

Where; n=sample size, z=2.576 at 99% confidence level, p (0.5)=proportion of the population, q=1-p, e (0.1) is the allowable error and N is the population size.

Kebeles	Total household of wheat producer	Sample size
Kossoya	1012	56
Dabre	580	32
Yesak Debre	1189	66
Total	2781	154
Source: own computation, 2016		

Table 1: Total number of households of the KAs and number of sample households from each Kebeles.

Source of data and method of data collection

Both primary and secondary data was collected from different sources to identify important variable that affect adoption and intensity of wheat row planting. Primary data were gathered from sample respondents using structured questionnaire interview schedule. The question prepared by English and translated into local language Amharic to make questions clear for the respondent and to facilitate data collection during household survey. Whereas the secondary data for this study were gathered from relevant published and unpublished materials from the woreda agriculture office, books, journals about adoption of technology. It is an important source of information because it indicates the past and the present data.

Method of data analysis

Data were entered into computer software for analysis. Both SPSS version 20 and STATA version 12 computer programs were used to process the data. Two types of analysis, namely: descriptive and econometric analyses were used for analyzing the collected data.

Descriptive analysis: Descriptive statistics such as percentage, frequency, mean and standard deviations were used. Descriptive statistics were helps to assess and analyses socioeconomic characteristics of farmers and their implications for adoption of wheat row planting and inferential statistics such as t-test and chi-square was used. In addition, the cost and benefit of wheat row planting technologies was analyzed by using the partial budget method.

Econometric analysis: The analysis of technology adoption was carried out following the concept depicted [16,17]. Adoption is measured in term of the probability and intensity of use by smallholder farmers. The probability of technology adoption refers to whether the household head adopt row planting for wheat production in 2016 production season. The intensity of wheat row planting adoption is estimated by calculating the proportion of cultivated land covered by these technologies of the total wheat cultivated land during 2016 production season.

Tobit model is used when the decision to adopt and intensity of agricultural technology adoption are assumed to be made jointly and factors affecting them are assumed to be the same [18]. In this study, improved agricultural technologies adoptions have censored distributions as considerable numbers of farmers are non-adopters. The censored distribution is a combination of continuous and discrete distributions because of the mass of observations at zero. Since the latent variable has a normal distribution, strictly positive values of technology adoption have a continuous distribution. The probability associated with latent variable values below or equal to the censoring point is summed to a single discrete value [19,20]. Following Amemiya and Johnston and Dandiro the Tobit model can be defined as:

$$y^* = \beta_0 + \beta_i Xi + ui \rightarrow 1$$

$$Y = y^* \quad if \beta_0 + \beta_i Xi + ui > 0$$

$$Y = 0 \;\; if\; \beta_0 + \beta_i Xi + u \leq 0$$

Where:

Y_i=is observed adoption wheat row planting for i^{th} farmer, was a continuous variable measured in proportion of land allocated for wheat row planting of the total wheat cultivated land.

y^*=is the latent variable and the solution to utility maximization problem of adoption of wheat row planting subjected to a set of constraints per household and conditional on being above certain limit, it is unobserved variable.

X_i=Vector of factors affecting adoption of wheat row planting,

B_i=Vector of unknown parameters, and

U_i=is the error term which is normally distributed with mean 0 and variance σ_2.

The model parameters are estimated by maximizing the Tobit likelihood function of the following form,

$$L = \prod_{y^* > 0} \frac{1}{\delta} f\left(\frac{yi - \beta Xi}{\delta}\right) \prod_{y^* \leq 0} F\left(-\frac{\beta iXi}{\delta}\right) \rightarrow 2$$

The significant variables do not all have the same impact on the adoption of wheat row planting. Hence, one has to compute the derivatives of the estimated Tobit model to predict the effects of changes in the explanatory variables. That is probability and intensity of the adoption of wheat row planting. As cited in Maddala, Johnston and Dinardo and Nkonya, McDonald and Moffit proposed the following techniques to decompose the effects of explanatory variables into adoption and intensity effects [19]. Thus; change in Xi (explanatory variables) has two effects. It affects the conditional mean of yi in the positive part of the distribution, and it affects the probability that the observation will fall in that part of the distribution. Similarly, in this study, the marginal effect of explanatory variables was estimated as follows.

The marginal effect of an explanatory variable on the expected value of the dependent variable is;

$$\frac{\partial E(Yi)}{\partial xi} = F(Z)\beta i$$

Where $\left(\frac{\beta ixi}{\partial}\right)$is denoted by Z,

The change in the probability of adopting a technology as independent variable Xi change is:

$$\left(\frac{\partial F(Z)}{\partial xi}\right) = f(Z)\frac{\beta i}{\partial}$$

The change in the intensity of adoption with respect to a change in an explanatory variable among adopters is:

$$\partial E\left(\frac{yi}{y_i i^* > 0}\right) / \partial Xi = \beta i \left[1 - \frac{Zf(Z)}{F(Z)} - \left[\frac{f(Z)}{F(Z)}\right]2\right] \text{Where,}$$

F(z) is the cumulative normal distribution of Z,

f(z) is the value of the derivative of the normal curve at a given point (i.e., unit normal density),

Z is the z-score for the area under normal curve,

β is a vector of Tobit maximum likelihood estimates and σ is the standard error of the error term.

Result and Discussion

Descriptive analysis

Descriptive statistics was run to observe the distribution of the independent variable. The personal, socio-economic, institutional, and situational characteristics of the respondents and factors affecting adopters and non-adopters about wheat row planting technology were analyzed. Of the total sample respondents 66 were adopters and 88 were non-adopters. These were 43% and 57% of the total sample, respectively.

Variables	Non-adopter		Adopter		χ^2-Value	P-value
	N	%	N	%		
Sex HH						
Male	80	90.9	64	97	2.281	0.131
Female	8	9.1	2	3		
Marital status						
Single	6	6.82	5	7.58	1.655	0.647
Married	74	84.1	58	87.88		
Widow	1	1.14	1	1.52		
Divorced	7	7.95	2	3.03		
Education HH						
Illiterate	37	42.1	11	16.7	12.901	0.005***
read and write	24	27.3	20	30.3		
Primary school	20	22.7	28	42.4		
Secondary and above	7	7.95	7	10.6		
Radio						
No	56	63.6	34	51.5	2.281	0.131
Yes	32	36.4	32	48.5		
Credit						
No	63	71.6	44	66.7	0.431	0.511
Yes	25	28.4	22	33.3		
Seed						
No	68	42.78	16	24.24	42.775	0.000***
Yes	20	22.73	50	75.76		
Training						
No	62	70.45	24	36.36	17.76	0.000***
Yes	26	29.55	42	63.64		
Source: computed from own survey, 2017						

Table 2: Descriptive statistics for dummy variables.

Based on the data revealed on Table 2, out of the total sample 93.5% respondents were male headed and the remaining 6.5% were female headed households. However, a chi-square (χ^2=2.281, p=0.131) comparison between categories of adopters and non-adopters in terms of their sex showed no evidence to conclude any systematic association between male headed and female headed households in terms of their wheat row planting technology adoption status. The Chi-square test (χ^2=12.901, p=0.005) indicated that there is existence of statistically significant difference at 1% level in the educational status among the adopter and non-adopters. Use of improved seed was assumed to increase farmers' status to adoption of wheat row planting. The result in the Chi-square test (χ^2=42.77, p=0.000) indicated that there was existence of statistically significant difference at 1% level in the use of improved wheat seed among the adopter and non-adopters. Respondents' participation in training was important for making people to be acquainted with the required knowledge and skill on wheat row planting technology. The chi-square test (χ^2=17.77, p=0.000) indicated that there was significant difference at 1% level in participating training between adopter and non-adopter.

Variables	Non Adopter		Adopter				
	Mean	Std. dv	Mean	Std. dv	Overall mean	t ratio	p-value
Age HH	47.32	15.39	42.2	14.3	45.12	-2.082	0.681
Fm size	5	2	5	3	5	0.461	0.058*
Fam Edu	2	1	3	2	2	3.973	0.019**
L Stock	4.86	2.89	6	4.3	5.37	2.04	0.008***
Farm size	1.03	0.56	0.96	0.63	0.99	-0.723	0.506
Extension	1.27	1.2	3.47	2.65	2.21	6.884	0.026**
Distance	25.23	24.85	14.49	12	20.62	-3.234	0.002***
Fertilizer	104.53	88.64	164.8	71.23	130.38	4.535	0.038**
Source: computed from own survey, 2017							

Table 3: Descriptive statistics for continuous variables.

Result showed in Table 3, the average family size and standard deviation of adopters were 5.32 and 3, respectively. Whereas the non-adopters average family size was found to be 5.14 with a standard deviation 2. The results indicated that there is significance mean difference among the adopters and non-adopters (t=0.461, p=0.058). According the result presented in Table 3, the average educated family members of adopter was found to be 3 with a standard deviation 2. Whereas the non-adopters average educated family members and standard deviation were 2 and 1, respectively. The result of t- test (t=3.973, p=0.019) showed that there was significant mean difference at 5% level among adopters and non-adopters. The results showed in Table 3 the mean TLU and standard deviation of adopters were 6 and 4.3, respectively. Whereas the non-adopters mean TLU and standard deviation were 4.86 and 2.89, respectively. Test of mean difference using t-test (t=2.042, p=0.008) showed that there was significant mean difference at 1% significance level among adopters and non-adopters. In Table 3 indicated the average frequency of extension contact for total sample respondents were found to be 2.2 with a standard deviation of 2.2. The average extension contact for non-adopter was 1.27 while for adopter the average extension contact was 3.47. The results of t-test with value of t=6.884 and P=0.026 indicated that there was statistically significant mean difference at 5% level among adopter and non-adopter. The results showed that in Table 3, the average walking distance for non-adopter was 25.2 minute with standard deviation 24.8 while for adopter the average walking distance and standard deviation were 14.5 and 12, respectively. The results of t-test with value of t=-3.234 and P=0.002 showed that there was statistically significant mean difference at 1% level among adopters and non-adopters. According the result in Table 3 indicated that, the average amount of fertilizer for non-adopter was 104.53 Kg while for adopter was 164.8 Kg. The results of t-test with value of t=4.535 and P=0.038 indicated that there was statistically significant mean difference at 5% level among adopters and non-adopters.

Cost and benefit analysis of row planting relative to broadcasting

Partial budget crystallizes ultimately into the statement of costs and returns based on input and output data. A partial budget is a technique for assessing the benefits and costs of a practice relative to not using the practice [21]. It is used to estimate the effect of changes in the farm operations. A partial budget usually prepared to ascertain the effect on the net benefit of the farm due to small change in the farm plan such as; changing to different technology. Example changing from hand weeding to herbicide use of weed control. Partial budgeting analysis was carried out according to CIMMYT methodology, for variables that varied (labor, fertilizer, herbicide, seed amount and the yield amount) for each method, i.e., Row planting and broadcasting.

Amount (birr/ha)			
Additional cost		**Additional revenue**	
DAP	458.13	Wheat yield	4058.8
Urea	274.58		
Land preparation	177		
Sowing	861		
Threshing	171		
Total added cost	1941.71	Total added return	4058.8
Reduced revenue		Reduced cost	
		Seed	253.2
		Manure	28.4
		Herbicide	4.44
		Weeding	399
		Harvesting	171
Total reduced revenue	0	Total reduced cost	742.04
A (Total added cost+reduced revenue)=1,941.71		B(Total added return+Total reduced cost)=4,800.04	
Net change=B-A=2,859.13			
Source: computed from own survey, 2017			

Table 4: Partial budget for row planting.

As shown in Table 4, the budget suggests that replacing broadcasting with row planting would increase profit by 2,859.13 birr per hectare with total additional cost and reduced revenue 1,941.71 birr per hectare. Therefore wheat row planting would be recommended in the study area.

Results of the econometric model

Tobit model was employed to identify determinant of the probability and intensity of wheat row planting adoption by farmers in the study areas and results are presented in Table 5. The variables included in the model were tested for the problems of multi-collinearity and heteroscedasticity. Problem of multi-collinearity was checked using VIF (Variance Inflation Factor) for continuous variable and using CC for dummy variable. The maximum value of VIF obtained for these variables was found to be 1.84 and maximum value of CC was 0.094. This shows that there was no problem of multi-collinearity. However, Breusch-Pagan test for heteroscedasticity indicated significance (P=0.0078) which is less than 10%, implying the existence of heteroscedasticity problem in model. To obtain the corrected robust variance estimates and correct the problem of heteroscedasticity, the robust option was applied in the model.

Variable	Estimated coefficient	Robust standard error	t ratio	p-value
Constant	-0.3862	0.3778	-1.02	0.308
Sex HH	0.1868	0.2461	0.76	0.449
Age HH	-0.0121	0.0045	-2.67	0.008***
Fm size	-0.0133	0.0324	-0.41	0.683
Education HH	0.0409	0.0621	0.66	0.511
Fam Edu	0.084	0.0362	2.32	0.022**
L Stock	0.0101	0.0121	0.83	0.406
Radio	0.0326	0.1024	0.32	0.751
Credit	0.0346	0.1007	0.34	0.732
Farm size	-0.0029	0.0899	-0.03	0.975
Seed	0.3452	0.1073	3.22	0.002***
Extension	0.0914	0.0306	2.98	0.003***
Distance	-0.0061	0.0027	-2.3	0.023**
Fertilizer	0.0009	0.0006	1.53	0.128
Training	0.1818	0.0935	1.94	0.054*
Log likelihood =-77.42		left censored observation=88		
F (14,140)=8.72		Uncensored observation=66		
Pr>F=0.0000		right censored observation=0		
pesudoR^2=0.39				
Note: ***, ** and * indicate the level of significance at 1, 5 and 10 percent, respectively.				
Source: Model result				

Table 5: Maximum likelihood estimates of Tobit model.

Age of household head: Age had a negative and significant relationship with adoption of wheat row planting at 1% probability level. This explanatory variable accounts 1.21% of the variation in adoption of wheat row planting. This might due to those younger farmers may have more schooling than older farmers and have been exposed to new ideas, easily understand technology and hence more risk takers.

Number of educated family members: The number of educated family members was positively and significantly affects adoption of wheat row planting at 5%levels of significance. This explanatory variable accounts 2.2% of the variation in adoption of wheat row planting.

Use of improved seed: Use of improved seed was positively and significantly affects adoption of wheat row planting at 1% levels of significance. This explanatory variable accounts 34.52% of the variation in adoption of wheat row planting.

Extension contact: Result of the study indicated that contact with extension agent was positively and significantly related to adoption of wheat row planting at 1% significance level. The variable accounted for 9.14% of the variation in the adoption of wheat row planting.

Distance from development center: Distance has a negative and significant relationship with adoption of wheat row planting at 5% level of significance. This explanatory variable accounts 0.61% of the variation in adoption of wheat row planting.

Training participation: Training was one of the extension events where by farmers get practical skill and technical information for new technology. Results of the study indicated that participation in training had positively and significantly related to adoption of wheat row planting at 10% significance level. The variable accounted for 18.18% of the variation in the adoption of wheat row planting.

Effects of changes in the significant explanatory variables on adoption of wheat row planting technology

All variables that were found to influence the adoption of probability and intensity of use of wheat row planting technologies might not have similar contribution in influencing the decision of farm household. Hence, using a decomposition procedure suggested by McDonald and Moffitt, the results of Tobit model was used to assess the effects of changes in the explanatory variables into probability and intensity of adoption and the result was presented in Table 6.

Variables	Change in probability of adoption	Change in intensity of adoption	Change among the whole
Age HH	-0.0103	-0.0034	-0.0121
Fam Edu	0.0713	0.0272	0.084
Seed	0.2883	0.1149	0.3452
Extension	0.0776	0.0296	0.0914
Distance	-0.0052	-0.0019	-0.0061

Training	0.154	0.0597	0.1818
Source: model result			

Table 6: Marginal effects of changes in significant explanatory variables on adoption of wheat row planting.

The result indicated that an increase in the age of household head by a year decreasing the probability of adoption of wheat row planting by 1.03% and decrease the proportion of land planted with row planting by 0.34% for adopters, this implies younger farmers more likely adopt wheat row planting than older farmers.

The result also indicated that an increase in the educated family members by one person leads to an increase in the probability that a farmer adopts by 7.13% and increase the proportion of land planted with row planting by 2.72% for user. These indicated that households with larger educated family members adopt wheat row planting.

The results showed that the estimated increase in the probability of adoption and the proportion of land planted with row planting resulting from use of improved seed was 28.83% and 11.49%, respectively, which were relatively large as compared to the changes resulting from other significant variables. This showed household use improved seed more likely adopt wheat row planting.

The result also revealed that an increase in the number of extension contact during cropping period by one day leads to an increase in the probability that a farmer adopts by 7.76% and increase the proportion of land planted with row planting by 2.96% for adopters. Implies that farmers with more extension contacts are more likely to be adopts of wheat row planting than those with less contact.

The marginal effect result indicated that an increase in the walking distance of development center by one minute decreases the probability of adopting by 0.52% and decrease the proportion of land planted with row planting by 0.19% for adopters. Hence farmers who are far away from development center he/she becomes less adopter.

The marginal effect result also showed that the estimated increase in the probability and proportion of land planted with row planting resulting from training participating was 15.4% and 5.97%, respectively. Farmers participate in training which farmers acquire new knowledge and skills than non-participant. This implies, participation in training would enhance the chance of adoption of the concerned technology.

Conclusion and Recommendations

Based on the findings of the study, the following recommendations were suggested:

Adoption of row planting increased the farmer net benefit. Hence, concerned bodies should make necessary effort to ensure that the benefit of row planting is spread to more farmers in the district.

Younger farmers adopted wheat row planting faster than older farmers. Therefore, the local government should arrange experience sharing and provision of short-term training programs in each Kebeles so as to share the rich knowledge of younger farmers to older.

Households with larger educated family members adopt wheat row planting. Hence, appropriate policies should be designed to provide adequate and effective basic educational opportunities to the rural farming households in general and to the study area in particular. In this regard, the regional and local government should strengthen the existing provision of formal and informal education through facilitating all necessary materials.

Improved seed user was adopting row planting than local seed. Therefore, the concerned bodies should be give due attention promoting the access and use of improved wheat seed through introducing new seed varieties suitable to the local condition, supply by fair price and timely to farmers. Farmers with more extension contacts are more likely to be adopts of wheat row planting than those with less contact. Therefore, extension agents should be strengthened frequency of contact by establishing additional development centers and increasing the number of extension workers. Farmers participate in training which farmers adopted new technology than non-participant. Hence, short term training and awareness creation programs through farmers training center should be arrange before the implementation of the newly introduced technologies to adopt by the vast majority households.

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