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Factors Affecting Adoption of Wheat Row Planting Technology in Girar Jarso Woreda, North Shewa Zone, Oromia Region, Ethiopia

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Abstract: Wheat is one of the most important cereal crops in Ethiopia. However, low production and productivity of wheat, which is mainly associated with poor adoption of technologies, is persistent in Ethiopia. In this regard, this study was conducted with the aim to find out the adoption level of wheat row planting technology and to identify factors that affect the adoption of wheat row planting in Girar Jarso woreda, North Shew zone, Oromia regional State, Ethiopia. In order to achieve these objectives, 118 rural households were selected by using three stage sampling procedure. Both primary and secondary data were used. The data were analyzed by using descriptive statistics and binary logistic regression model. The study result shows that about 45.76% and 54.24% of sample respondents were found to be adopter and non-adopter of wheat row planting technology respectively. A binary logistic regression model result shows that, age of the household head, education level of household, year of farming experience; total labor availability, total annual income and frequency of extension contact were found to be significant in affecting the adoption of wheat row planting. Therefore, the study recommends, the government, development workers, and policymakers should consider the provision of education and extension services. This study also suggests that, policymakers and development organizations should consider infrastructure development (particularly access to markets), and credit is important.

Keywords: Adoption, Wheat, Row Planting, Logit, Ethiopia.

Research Paper

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1. INTRODUCTION

Persistent agriculture, which employs about half of the population, dominates the economies of Sub-Saharan Africa (SSA). Nonetheless, it is shown that SSA has low levels of output and productivity in agriculture. Similarly, Ethiopia is heavily dependent on its agriculture sector [10-20]. Several factors contribute to low production of agriculture, such as population pressure that causes severe land degradation and tiny farm sizes, frequent droughts, and a lack of farm equipment [4].

The sector is dominated by smallholder farmers (96%), where about 56% of the smallholder farmers possess less than one hectare of land [20-18]. Despite its contribution to the GDP and export earnings, the sector's productivity is very low. In this regard, the research system, along with the other stakeholders, has to play a major role in improving technologies required to enhance agricultural productivity in the country [15].

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 [4].

Since 2000, Ethiopian agricultural production has been increased. For instance, In 2021/22 main crop season, cereals were cultivated on 10.5 million hectares of land producing 302.1 million quintal of food grains. This accounted for 81.19% and 88.36% of the nation's total food grain production area and yield, respectively [7]. Although these results are encouraging, Ethiopia has not yet reached its maximum agricultural potential due to

poor productivity and subsistence-oriented farming practices [7].

Wheat is one of a valuable commodity for food security and a significant cash crop in Ethiopia, particularly in the study areas, where it provides a significant portion of the household income for wheat-producing households. According to the [6], it occupies about 17% of the total cereal area in the country. However, its national average yield is about 2.97 t/ha [6]. This is low yield compared to global average of 4 t/ha [27].

Hence, increasing agricultural productivity, achieving food sufficiency and alleviating poverty among smallholder farmers through improved agricultural technology adoption is critical. 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 tenth year plan [9].

However, one of the main reasons for the low productivity in the country as a whole is the low degree of agricultural technology adoption [5-9]. Row planting technologies are also not widely used in wheat production, despite their potential benefits. Farmers continue to plant improved varieties using the traditional broadcasting approach, even after the release of several improved varieties [3]. Recent studies conducted in Ethiopia's show that yields are very responsive to row planting technology. For instance [22], reported average yield of 2.8t/ha (19.7%) in the highland areas using row planting which is above national average yield of 2.45t/ha in the country. Moreover, according to the [17], row planting on average increases production by 30%s and reduces the amount of seed consumption to one-fifth of existing seed use. Despite this, not all parts of Ethiopia, including the study's area, adopted the introduced technology as was anticipated. It appears that several variables influenced the farmers' decision to adopt row planting technology, which explains why the technology was not fully implemented by them despite being monitored.

In Ethiopia, studies on adoption of wheat row planting technology are limited and the degree of adoption has received less attention. For instance, [22-24], and [4], conducted study on factors influencing adoption of wheat row planting technology by in the country, but they did not provide more insights on the level of adoption of wheat row planting. Furthermore, despite its potential for increasing wheat production, to the best of the researcher's knowledge, the factors influencing the adoption of wheat row planting method and level adoption were not examined in the study areas. This study attempted to fill this knowledge gap by assessing the degree of wheat row planting adoption and factors affecting adoption of wheat row planting technology in Girar Jarso woreda, West Shewa zone, and Oromia regional state of Ethiopia.

2. MATERIAL AND METHODS

2.1. Description of the Study Area

The study conducted at Girar Jarso woreda of North Shewa Zone, Oromia National Regional State, Ethiopia. The woreda is found at a distance of 112 km from Addis Ababa along the road to Bahirdar. The total area of the woreda is about 42763 hectares, with the altitude ranging from 1300 to 3419 meters above sea level. The meteorological data shows that the average rainfall of the woreda is about 1200mm. Temperature of the woreda ranging from 11.5 to 35 degree Celsius [23]. Climate is one of the physical factors that influence human activity especially in agricultural society through its impacts on soils and vegetation cover of an area. The major soils of North Shewa zone are Vertisols, Cambisols, Nitosols, and Lithosols.

Mixed farming is the basis of the household in the woredas, intensively carried out by those who have land and livestock. The rain-fed agricultural sector is known for its low production, which is a result of conventional farming methods, low input utilization, poor soil fertility, water logging, and other associated issues. The main crops cultivated in the area include cereals (barley, wheat, maize, sorghum and teff), pulses (bean, pea, and lentil), fruits and vegetables (apple, cabbage, kale, onion). The livestock sub-sector is one of the components of the farming system. Wheat is one of the most important food crops in the woredas and mainly cultivated under traditional farming methods [23].

2.2. Data Collection Methods and Sampling Procedure

Both primary and secondary data were used in this study. Primary data were collected from sampled farm households. Secondary data were collected from the Girar Jarso agricultural office by asking office workers to gain knowledge about kebeles. In this study, three stage sampling techniques were employed. In the first stage, Girar Jarso woredas were selected purposively based its wheat potentials and better extension activities regarding wheat technologies. The Girar Jarso Woreda has 17 kebeles. In the second stage, three kebeles (namely Torban Ashe, Dire Doyu, and Koticho) were selected randomly. In the third and final stage sample households were selected randomly based on their proportional to kebeles size. Accordingly 118 wheat producer households were selected by using simplified formula as used by [25], at a 91% confidence level and a 9% level of precision.

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

Where: n: is the sample size, N: Total size of wheat households and e is the precision level.
N = 2786 e = 9% =118

2.3. Data Analysis

Data were analyzed using descriptive statistics, inferential statistics and Binomial logit model. Descriptive statistics, such as mean, frequency, and percentage were used to provide summary statistics related to the variables of interest.

2.3.1 Estimation of Adoption Index

The household planted wheat in rows during cropping season, was considered to be an adopter. The degree of row planting adoption for each sample household at the time of the survey was determined using the adoption index. By dividing the total cultivated area for wheat production by the i[th] farmer by the area set aside for wheat production employing row planting, the adoption index score was computed. To determine the degree of row planting adoption for wheat production in the study area, the adoption index was calculated using the ideas of [2, 1], and [19]. For every farmer who responded, the adoption index was determined as follows:

$$AI_i = \frac{Area\ under\ wheat\ row\ planting\ tecknology\ (AW_i)}{Total\ area\ allocated\ for\ wheat\ production\ (AT_i)}$$

Where, i stand for respondents (farmers), and AI_i represent the adoption index of the i[th] farmer. Following the computation of AI scores, respondents were categorized as low, medium, high, or non-adopters based on their AI value. The actual adoption index score ranges from 0 to 1. Adoption index score of zero point implies non-adoption of the row planting for wheat production and greater than zero (>0 and ≤ 1) implies adopters with three category; namely low adopters, medium adopters and high adopters.

2.3.2 Logistic Regression Model to identify Determinants of Wheat Row Planting Adoption

Binomial logit model [13, 12], was used in the study to identify determinants of wheat row planting adoption because of its computational and mathematical conveniences. A household was considered an adopter if it planted wheat in rows during the cropping season. The independent variables that were assumed to affect the adoption of wheat row planting were age and educational level of the household head, farming experience, total land ownership, household size, livestock holding size, total number of different types of crops cultivated in the 2017 cropping season, off-farm income, access to improved seed and credit services, access to chemical fertilizers and agricultural extension services, and household agro-ecological location. Data were analyzed using STATA version 14 computer software.

The justification for using logit is its simplicity of calculation and the fact that its probability lies between 0 and 1. Moreover, its probability approaches 0 at a slower rate as the value of the independent variable becomes increasingly smaller, and approaches 1 slower rate as the value of the independent variable becomes increasingly larger [13].

The function form of the logit model is specified as follows:

$$Pi = E\left(\frac{Y=1}{Xi}\right) = \frac{1}{1+e^{-(\beta 0+\beta iXi)}} \quad (1)$$

This will be writing as follows, z_i is equal to $\beta_0 + \beta_i X_i$

$$Pi = \frac{1}{1+e^{-zi}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$1\text{-}Pi = \frac{1}{1+e^{zi}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The probability that a given household is a row planter of wheat is expressed in equation 2, while the probability for a non-row planter of wheat is expressed in equation 3.

The ratio of the probability that a household is adopting wheat row planting to the probability that it is a non-row planting is:

$$\frac{Pi}{1-Pi} = \frac{\frac{1}{1+e^{-zi}}}{\frac{1}{1+e^{zi}}} = \frac{1+e^{zi}}{1+e^{-zi}} = e^{zi} \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$$Li = \ln\frac{Pi}{(1-Pi)} = zi = \beta_0+\beta_1X_1+\beta_2X_2+\ldots\beta nXn \ldots\ldots (5)$$

Where Li is the log of the odds ratio and it is called the logit.

The above equation with disturbance term can be written as:

$$Zi = \beta_0 + \sum_{i=1}^{n}(\beta ixi) + Ui$$

Where zi= function of explanatory variables (X), β_0 = an intercept, β_1, β_2,β_3…… βn are the slopes of the equation in the model, L_i is log of the odds ratio z_i, X_i is vector of a relevant characteristic or independent variables and Ui is disturbance term.

Dependent variable used in this study is adoption of wheat row planting technology which indicates takes value of 1 if the household is adopter and 0 otherwise. The independent variables that were assumed to affect adoption of wheat row planting were considered by reviewing the studies done so far [24-16]. Accordingly, wheat row planting was adoption is expected to correlate positively with age and educational level of household head, farming experience, total land owned, household size, livestock holding size, farm income, access to credit services, availability of labor and agricultural extension services whereas distance from nearest market is hypothesized to affect wheat row planting negatively.

3. RESULTS AND DISCUSSIONS

3.1. Descriptive Analysis

Descriptive statistics were used to observe the distribution of the independent variables. The personal, socio economic, institutional and situational characteristics of the respondents and factors affecting

adopters and non-adopters of wheat row planting technology were analyzed.

3.1.1. Statistical Analysis of Continuous Independent Variable

The descriptive statistics of the continuous variables are presented in the table below. The table shows that the mean age of both adopters and non-adopters was 51.2 and 49.6, respectively. The survey results indicate that 46% were adopters and 54% were non-adopters of wheat row planting technology. On average, the adopters of wheat row planting technology earned a larger total farm income (ETB 6750.60) than the non-adopters (ETB 4835.20) of this technology in Girar Jarso Woreda.

Table 1: Statistical analysis of continuous variable

variables	Non adopter =64		Adopter =54		t-test	p-value
	Mean	Std. error	mean	Std. error		
Age	49.65625	1.920573	51.24074	1.584491	-0.5722	-0.5722
Edu	2.6875	0.4802	3.6851	0.5246	-1.4032	0.1632
Farm Expr	26.0312	1.6726	27.8518	1.8029	-0.7379	0.4610
Dist_Market	1.4669	0.066094	1.1026	0.8599	-3.4142	0.0009***
Ex_Contact	3.1230	0.114374	4.4230	0.149896	2.4376	0.0165**
Family Size	6.10637	0.30055	7.0740	0.02989	-2.2548	0.0258**
Land Size	2.2664	0.1356	2.5566	0.1329	-1.5116	0.1334
Farm_Inco	4835.2003	468.0635	6750.556	657.515	-2.4243	0.0169**
Labor	6.2812	0.4753	8.9081	0.7644	-3.0116	0.0032***
TLU	4.201	0.201	5.103	0.3412	-1.022	0.0022

***Source**: own computation from survey data, 2023.*

Farmers with more experience in wheat production appear to have more information and better knowledge and are supposed to evaluate the advantages of the technology. Concerning the respondents' farming experience, the most experienced farmers in the sample had a mean experience of 27.85 years, whereas the least experienced farmers had 26.03 years of experience in wheat farming (Table 1). On average, respondents had 26.94 years of experience in wheat production (Table 1).

In particular distance from the nearest market and input suppliers influences farmers' adoption of new technologies. Markets are communication centers for producers, consumers, and traders, and it is hypothesized that the distance between the respondent's residence and the nearest marketplace (in hours) is negatively correlated with the decision to adopt the newly introduced wheat row-planting technology. In this study, the sample farmers, on average, travel about 1.28 hours to sell their wheat production. When comparing the average travel distance of non-adopters and adopters, they traveled an average distance approximately 1.47 and 1.10 hours, respectively (Table 1).

In visiting farmers, mere contact with an extension agent cannot result in an attitudinal change in households because adoption is a gradual process, and there is a difference in the speed of adoption among farmers. Therefore, the frequency of visits to an extension agent should be considered. The average frequency of contact for non-adopters was 3.1230, and adopters received 4.4230 contacts annually. The frequency of contact has a significant impact on adoption; this means that when contact with extension agents increases, the adoption of technology also increases because farmers are more aware of the technology and its importance (Table 1).

Family size in the study considered the number of individuals who resided in the respondent's household. Large family size is assumed to be an indicator of labor availability in the family. Based on this fact, this variable was hypothesized to have a positive and significant relationship with the adoption of wheat production technologies because the availability of labor is likely to influence the gross margin of innovation. The mean family size of adopters was 6.10, whereas that of non-adopters was 7.07. The average family size of respondents was 6.59 members (Table 1).

The average age of the house hold head were smallholder for non-adopters (about 50 years) than adopters (about 51 years). Adopters have completed on average 4 grades of formal education while non-adopters have completed only 3 grades. Adopters have relatively higher cultivated land (2.6 ha) than non-adopters (2.3 ha). Adopters have relatively higher TLU (5.1 ha) than non-adopters (4.2 ha). The average active labor in adult equivalent for adopter was 8.9 while it was 6.2 for non-adopters see above (Table 1).

3.1.2Statistical Analysis of Dummy Variable

As depicted in Table 2, credit has also been found to be an important variable in explaining the variation in wheat row planting technology among farmers. This implies that credit availability shifts the cash constraint outwards and thus enables farmers to make timely purchases of inputs that they cannot otherwise from provide their resources. As we have been told by farmers, they do not like to use credit because credit may cause losses when the technology is not

successful and credit requires a legal format. Consequently, farmers do not want to use credit. As the above table shows, out of 118 households, 73 did not use credit for the stated reason. Among 73 non-adopter households, 44 were non-adopters and 29 were adopters. In addition, the above table shows that among the 45 credit users, 20 were non-adopters and 25 were adopters. The above result shows that adopters of technology and users of credit are large in number, but in mass, people do not like to use credit, and adoption levels are generally low.

Table 2: Statistical analysis of dummy variables

Credit utilization	Non adopter	adopter	Total	Chi	P-value
No	44	29	73	2.8105	0.094*
	68.75	53.7	61.86		
Yes	20	25	45		
	31.25	46.3	38.14		
Female	10	1	11	6.5727	0.010**
	15. 63	1.855	9.32		
Male	54	53	107		
	98.15	84.38	90.68		

***Source**: own computation from survey data, 2023.*

Sex of house hold is an important determinant of adoption of wheat row planting technology. The statistical analysis shows that from 11 female household only one female house hold head is adopter and the rest are an adopter. The p-value of the analysis shows that being female household headed reduces the level of adoption significantly at 5%. The result of statistical analysis shows that being male household headed increases the level of adoption because males are nearest to the information than females. Among 107 male house hold head 54 of them are adopter and 53 of them are non-adopter. According the result obtained from the above table among 11 female household head 15. 63% are non-adopters' and 1.855. Again from the above table among 107 male house hold head 84.38 are adopter and non-adopter 98.15.

3.1.3. Adoption Index among Households

Among 118 sample households about 54% of respondents were adopter of wheat row planting technologies whereas 46% respondents were non-adopter. The mean adoption index scores of non-adopters, low, medium and high adopters groups were 0.00, 0.21, 0.49 and 0.87, respectively.

Table 3: Distribution of adoption index among households

Adopter category	No.	Percentage (%)	Adoption index (AI)	Mean of AI	Min	Max
Non adopter	64	54.24	0.00	0.00	0.00	0.00
Low	16	13.56	0.01-0.33	0.21	0.01	0.32
Medium	24	20.34	0.34-0.66	0.49	0.34	0.65
High	14	11.86	0.67-1.00	0.87	0.67	1.00
Total	118	100	0.00-1.00	0.38	0.00	1.00

***Source**: own computation from survey data, 2023.*

3.2. Main Factors Affecting Adoption of Wheat Row Planting Crops

Age of the Household:

Age is expected to have a significant positive effect on the adoption of wheat row planting, with the assumption that older people have more farming experience. This enables farmers to compare the advantage of extension packages and easily adopt new technologies. Age is also related to the risk management nature of individual farmers. As a result, the age of the household has a significant positive effect (at the 1% level of significance) on the adoption of wheat row planting technology in Girar Jarso Woreda. The age of the household head had a positive effect on the adoption of wheat row planting technology, implying that older household heads are more experienced with various timing-related aspects and management of the crop until they reach a certain age level. A single-year increase in the age of the household results in a 68% increase in the probability of adopting wheat row planting technology while other variables remain constant. Similar to this [14], reported positive relationship between age and adoption which enables easy adoption of new technologies.

Year of Farming Experience (YFE):

Farmers with more experience in wheat production appear to have relatively information and better knowledge, and are supposed to evaluate the advantages of the new technology. Hence, we hypothesized that farming experience positively affects the adoption of wheat row panting technology. As a result, the experience of farming households has a significant effect (at 1%) on the adoption of wheat row planting technology. A single-year increase in the household farming experience increases the probability

of wheat row planting technology adoption by 93%, while the other variables remain constant. These findings were similar with [24].

Table 4: The result from econometric model

Logistic regression Number of obs = 118			
LR chi2(8) = 31.22			
Prob > chi2 = 0.000			
Log likelihood = -57.72 Pseudo R2 = 0.151			
variables	**Coef.**	**Std. Err.**	**dy/dx**
Age	0.57	1.375523***	0.68
Sex	2.054406	3.012781	2.05
Education	0.1262024	0.241866***	0.13
Farm Experience	0.9324302	0.0796375***	0.93
Credit	1.603565	1.795234	1.60
TLU	0.6334385	0.4099292	0.63
Farm Size	-0.5326	0.4396084	- 0.53
Labor in man-days	0.5238199	0.2420838**	0.52
Land size	0.9436769	0.942414	0.94
Farm Income	0.00036	0.0002079*	-0.0003
Extension frequency	0.63015	0.8266205**	0.63
Market Distance	-2.476551	1.543604	- 2.48

***Source**: own survey data, 2023.* *, **, and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Education level of the Household:

Education plays an important role in the productivity level and adoption of new technology. It is hypothesized that, smallholder farms with a higher level education are more likely to adopt wheat row-planting technology because education enables people to know more about the importance of new technologies. As expected education had a positive and significant relationship with the adoption of wheat-row planting technology at 1% significant level, in the study area. This implies, farmers with higher level education have better probability to adopt improved wheat production technology. This is due to the fact that, education improves access to information, and helps farmers easily to understand and analyze the farming situation and importance of the wheat production package. The study also shows that, each additional year in the level of formal education increases the likelihood of adoption of wheat row planting technology by 13 percent. This study is consistent with [11], who stated adoption is expected to correlate positively with education.

Total Labor Availability:

The availability of labor has a positive significant effect on the adoption of wheat row planting technology at a 5% level of significance. This shows that households with a larger labor force are more likely to adopt wheat-row planting technology. During the FGD the researcher also observed that, most of the farm households in the study area used family labor. An increase in the number of laborers by one unit increases the household's likelihood of adopting wheat row planting by 52%. This similar with [16], who argued labor availability has positive effect of on adoption.

Total Farm Income:

Total farm income has a significant positive impact on the adoption of wheat row-planting technology at the 10% level. This is because of income is important for the purchase of agricultural inputs and payment of rent for agricultural land. The study result indicated that, an increase in the total income of farmers by one ETB increases the likelihood of wheat row planting adoption by 0.03% at the study areas [24]. Also found that households with relatively higher farm income have better chance to adopt technology.

Frequency of Extension Contact:

At 5% significance level, the frequency of household visits by development agents has a positive and significant effect on the likelihood of adopting wheat row planting technology in the study areas. This is due to, increases because farmers are more aware of the importance of the technology. The study shows, as the frequency of extension agent increases by one unit, the probability of the adoption of wheat row planting technology increases by 63 percent. This is in line with [14], who found that, extension contact has an influence on farm households' adoption of new technology.

Distance from the Nearest Market:

As expected distance from the nearest market has a negative significant relationship with the adoption of wheat row planting technology. This implies that as the distance increases adoption of wheat row planting technology decreases. This is because of the closer they are to the nearest market, the more likely that the farmers will receive valuable information. According to the result, as distance increases by one hour the probability of adoption decreases by 247%. This is consistent with

[14], who showed as market distance increases adoption and intensity of adoption is expected to decrease.

4. CONCLUSION AND RECOMMENDATION

Wheat is one of the most important cereal crops in Ethiopia. However, low production and productivity of wheat, which is mainly associated with poor adoption of technologies, is persistent in Ethiopia. In this regard, this study was conducted with the aim to find out the adoption level of wheat row planting technology and to identify factors that affect the adoption of wheat row planting in Girar Jarso woreda, North Shew zone, Oromia regional State, Ethiopia. In order to achieve these objectives, 118 rural households were selected by using three stage sampling procedure. Both primary and secondary data were used. The data were analyzed by using descriptive statistics and binary logistic regression model.

The study result shows that about 45.76% and 54.24% of sample respondents were found to be adopter and non-adopter of wheat row planting technology respectively. A binary logistic regression model result shows that, age of the household head, education level of household, year of farming experience; total labor availability, total annual income and frequency of extension contact were found to be significant in affecting the adoption of wheat row planting. Therefore, the study recommends, the government, development workers, and policymakers should consider the provision of education and extension services. This study also suggests that, policymakers and development organizations should consider infrastructure development (particularly access to markets), and credit is important.

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