



Determinants of Adoption of Improved Bread Wheat Varieties among Smallholder Farmers in Awbare District, Somali Regional State, Ethiopia

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops grown in the Awbare district, primarily to enhance household income and ensure food security. This study aimed to assess the adoption status and identify the factors influencing the adoption of improved bread wheat varieties in the Awbare district, located in the Somali Regional State. To conduct this study, 160 randomly

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selected households were interviewed face-to-face. Additionally, key informant interviews and focus group discussions were utilized to supplement the data gathered from individual households. Quantitative data analysis methods, including descriptive statistics and binary logistic regression models, were employed alongside qualitative data analysis. Of the total respondents, 71 (44.3%) were adopters of improved wheat varieties, while 89 (55.6%) were non-adopters. The binary logistic regression results indicated that factors such as farm size, access to extension services, and farmers' perceptions of wheat yield positively and significantly influenced the adoption of at least one of the three recommended varieties. Conversely, variables such as sex, age, distance from the market, and distance from the development agent's office had a negative and significant impact on the adoption of improved bread wheat varieties. This study reveals that the agricultural extension service is a significant barrier to improving bread wheat production. An effective extension program connecting stakeholders is essential for encouraging the adoption of better wheat varieties. The findings show that larger farms are more likely to adopt these varieties, highlighting the need for research and extension agencies to support smaller farmers with appropriate technologies. Sustaining the adoption of wheat varieties demands ongoing focus on the factors affecting adoption.

Keywords: Adopter; aware; binary logit; bread wheat; farmers; non-adopters; varieties.

1. INTRODUCTION

1.1 Background of the Study

Wheat is a crucial cereal crop, with global production in 2022 estimated at a record 784 million tons, marking a 0.6% increase from the previous year, before slightly declining to 777 million tons in 2023 (FAO, 2023a). World wheat utilization for the 2024/25 season is forecasted to rise to 797 million tons, while global wheat stocks are projected to increase by 0.6%, reaching 318 million tons by the end of the same period (FAO, 2024). Wheat remains vital for global nutrition, supplying approximately 19% of the world's caloric needs and providing 21% of food calories and 20% of protein for over 4.5 billion people in 94 developing countries (FAO, 2012; von Braun et al., 2010).

Wheat is cultivated on 10 million hectares in Africa and serves as a major staple crop and an imported commodity across the continent. Over the past two decades, wheat consumption in Africa has steadily increased, driven by population growth, urbanization, and changing dietary preferences. This surge in demand has led to a significant rise in wheat import bills, averaging an annual increase of 9%. In 2021, Africa spent approximately \$85 billion on food imports, with wheat accounting for 15% of this expenditure (FAO, 2021). Despite efforts to boost domestic production, the gap between wheat consumption and production in Africa continues to widen. Analyses indicate that large yield gaps exist across most wheat-producing regions, suggesting substantial potential to increase production through improved genetics and

agronomic practices. For instance, adopting drought-tolerant varieties and expanding irrigated wheat areas could significantly enhance yields (Alemu, 2024).

Ethiopia ranks second to South Africa in total wheat area and production. Wheat is the fourth most cultivated crop in Ethiopia, following Teff, Maize, and Sorghum, and is primarily grown in the highlands at altitudes of 1500 to 2800 meters, with temperatures between 6°C and 11°C (CSA, 2012). In the 2012/13 season, approximately 4.8 million farmers cultivated wheat on over 1.6 million hectares, comprising 13.5 percent of the national grain area. Production for that year was 3.4 million metric tons, contributing to 15 percent of total grain output (CSA, 2013). The main wheat varieties are durum wheat (60 percent of production) and bread wheat (*T. aestivum*) (Mideksa and Tadele, 2014).

Wheat in Ethiopia is primarily utilized for domestic consumption, seed, and industrial purposes, with households allocating 9% of their food budget to it. National consumption rose from 2 million metric tons in 1995/96 to 4.2 million metric tons in 2012/13, making it the second most important staple after maize (Berhane et al., 2011). Urban consumption is increasing due to population growth, lifestyle shifts, and rising teff prices (Abu, 2013). Despite a significant rise in production over the past 15 years, domestic supply still falls short, resulting in Ethiopia being a net wheat importer. Wheat represents the most crucial imported staple, comprising about 22% of domestic consumption and 33% of the market,

with self-sufficiency at roughly 78% (CSA, 2013; USDA, 2013). The Ethiopian Grain Trade Enterprise controls commercial wheat imports, providing subsidized prices to mills and consumer associations. While this subsidy aims to keep prices low for urban consumers, it inadvertently leads to lower prices for farmers, which may disincentivize domestic production (Bergh et al., 2012; Abu, 2013).

Wheat production in agro-pastoral households of Somali Region had started before 1970; however, the introduction and dissemination of improved bread wheat at farmer level were started the Regional Agricultural Bureau with the collaboration of Somali Regional Pastoral and Agro pastoral Research Institute (SoRPARI) and Ethiopian Seed Enterprise (ESE) in 1999 (SoRPARI, 2010). Wheat is a vital cereal crop in Awbare district, serving as a staple for local agro-pastoral households and providing income and raw materials for flour factories. While some farmers also grow maize, sorghum, and barley, these crops offer fewer benefits compared to bread wheat (ADAO, 2015). Farmers in the area mainly adopt Kubsa, Pavon 76, and Hawi varieties based on specific criteria (SoRPARI, 2010). Even though there is a tremendous and continuous effort made by the Somali region's livestock, crop, and rural development bureau in collaboration with the Somali region pastoral and agro-pastoral research institute on the introduction and dissemination of improved bread wheat varieties, the adoption status is still not yet known. Therefore, factors affecting the adoption of improved bread wheat by involving and participating farmers in the study area can help to get useful and reliable information and also as an input in promotion of improved bread wheat varieties within the study area as well as other areas having similar socio-economic and geographical conditions and widely adopted disease resistant and drought tolerant varieties are very important to achieve these objectives.

2. METHODOLOGY

2.1 Description of the Study Area

2.1.1 Geographical location

The study was conducted in Awbare district, located in the northeastern Ethiopian Somali Region, bordering Northern Somalia. The district spans latitudes 9°18' to 10°12' N and longitudes 42°37' to 43°26' E, with Awbare town as the administrative center, 74 km northeast of Jigjiga and 5 km from the international border. It is

bordered by Siti Zone to the northwest, Jigjiga district to the south, and Kabribeyah district to the southeast, comprising 59 kebeles (51 agro-pastoral and 8 pastoral). Geographically, the district features three land types: northwest valleys, central high-altitude plains, and southeast lowlands, with altitudes ranging from 1000 to 2117 m.a.s.l. and a highest peak at Hero-geel. Temperatures average between 16°C and 29°C (ADAO, 2015).

2.1.2 Population and land size

The total area of the district is 3,862km² and its total population was 339,056 people of which 45% of the total population is female, and 55% of the total population is male. While the rural and urban population is 88.29% and 11.71% respectively. The average household size is 6 and the percentage of population under 15, 15 - 64 and above 64 years old is 45%, 52% and 3% respectively. The population in Awbare district is mainly from Somali tribes' which are Muslim in religion (CSA, 2007).

2.1.3 The farming system

The farming system in Awbare district is primarily agro-pastoral, featuring a climate suitable for various crops and livestock. Farmers use oxen ploughs or tractors and practice mixed agriculture, growing sorghum, maize, barley, wheat, and beans. Livestock includes cattle, camels, donkeys, and poultry, with male ruminants sold for cash and milk from females used at home. Agriculture relies on two rainy seasons: Deyr from mid-March to May and Gu from October to December, with a dry season (Jilal) from December to March that forces farmers to relocate for pasture and water. Insufficient rainfall can lead to drought and food shortages. Land sizes vary by kebele.

2.1.4 Infrastructure

Adequate physical infrastructure, including roads, water supply, education, electricity, health services, and telecommunications, is crucial for rapid economic and social development. In Awbare, many rely on ponds and wells for drinking water, but accessibility and quality are issues, leading to health risks. There is only one asphalt road connecting Jigjiga and Togwajale, while other roads are seasonal, hindering transport during the rainy season. Improving education and health can enhance productivity, increase household income, reduce poverty, and promote food security.

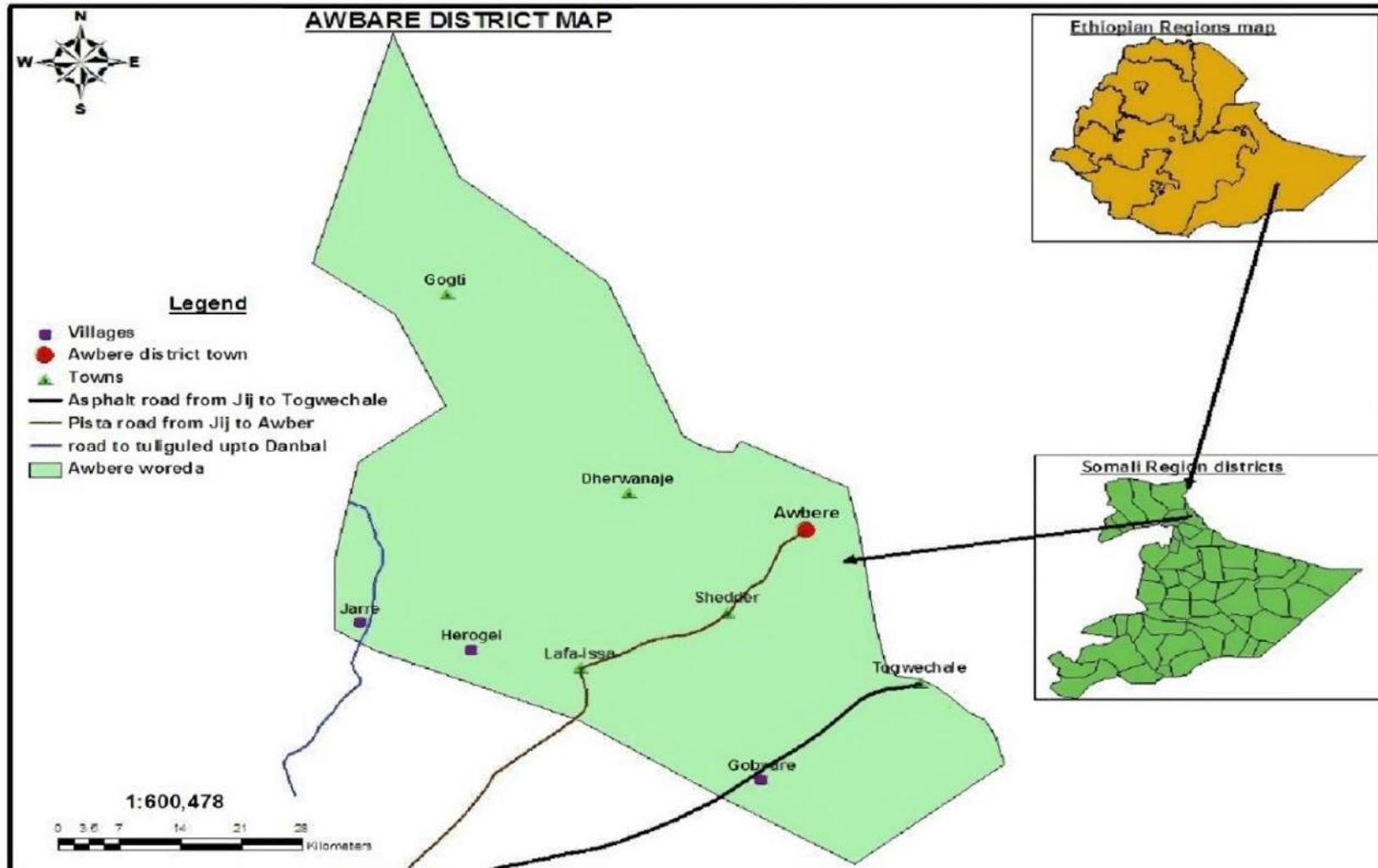


Fig. 1. Map of the Awbarre District

2.2 Sources and Methods of Data Collection

This study used both primary and secondary data sources. Primary data were collected from 160 household heads across five randomly selected kebeles, with qualitative data gathered through key informant interviews and five focus group discussions. Secondary data were sourced from regional bureaus, NGOs, and local reports. A survey instrument was designed, pre-tested, and revised for validity, with pretesting conducted on 12 agro-pastoralists in a nearby kebele. Ten trained enumerators, familiar with the area and fluent in the local language, collected the data under researcher supervision.

2.3 Sampling Techniques and Sample Size

In principle, accurate information about a given population could be obtained only from a census study. However, due to financial and time constraints, in many cases, a complete coverage of the population was not possible. A multistage sampling technique was used for the study. In the first stage, 25 wheat-producing *kebeles* were purposively selected based on their wheat production potential. In the second stage, five *kebeles* were selected randomly using a lottery method from the wheat-producing *kebeles*. A total of 4,518 wheat grower households in the selected *kebeles* were used as the sampling frame, and in the third stage, a total of 160

respondents were selected randomly using a lottery method.

The total sample size was determined by using Yemane's (1967) formula:

$$n = \frac{N}{1 + N(e)^2} = \frac{4518}{1 + 4518 * (0.08)^2} = 151 + 6\% = 151 + 9 = 160$$

Where, N=total number of households (4518), n=sample size, and e=error of tolerance at 8%. Accordingly, the calculated sample size was 151, and taking a 6% non-return rate from respondents, a total of 160 respondents were used. A list of farmers was obtained from the district agriculture office, and the number of samples was taken using the probability proportional to size (PPS) sampling technique against the total number of wheat growers in the kebeles as indicated in Table 1 below.

Table 1. Distribution of sample households in the kebeles

No	Kebele	Number of households	Sample size
1.	Sheik dawale	846	30
2.	Gobobley	907	32
3.	Jare	992	35
4.	Libahful	881	31
5.	Rurujis	892	32
Total		4518	160

Source: Awbare District Administration Office (ADAO), 2015

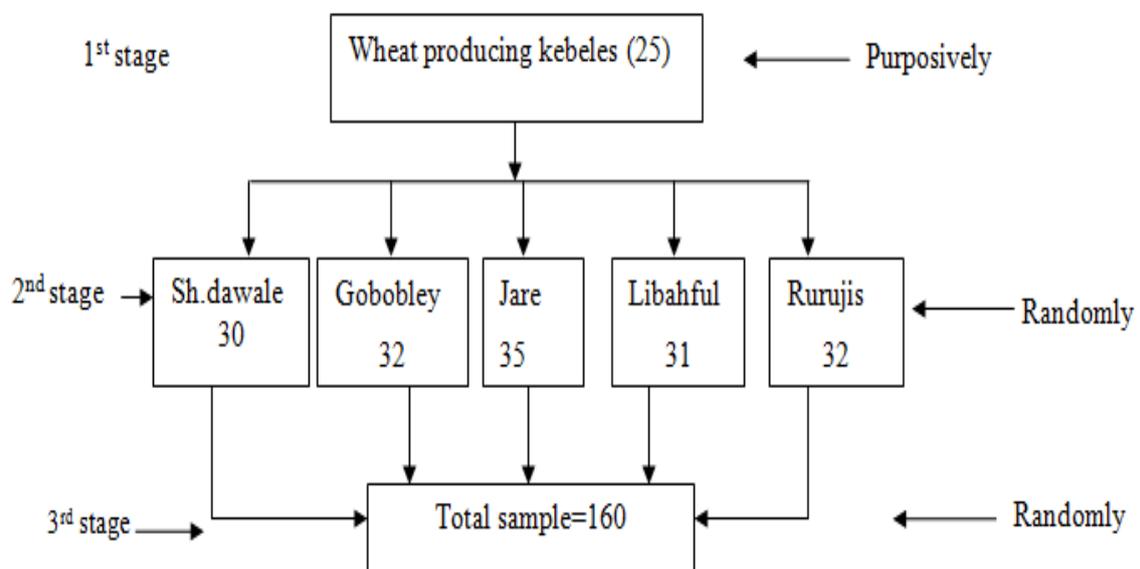


Fig. 2. Sampling procedure

2.4 Methods of Data Analysis

Descriptive statistics, including frequency and percentages, were employed to outline the adoption status using SPSS Version 24. The binary logit model was utilized to determine the factors influencing the adoption of improved wheat varieties by smallholder farmers in the study area. Additionally, qualitative data were analyzed by narrating and describing the perspectives and opinions of respondents and key informants, which supported the quantitative findings of this research.

2.5 Model Specification

Various models, including binary logit and probit, have been utilized to analyze farmers' adoption behavior (Mubarak, 2009). While the cumulative probability functions of these models are similar, binary logit allows for easier calculation of predicted probabilities. These models assess factors influencing technology adoption and offer probabilities based on variables such as education, controlling for other factors. A binary logit model was specifically employed to analyze factors affecting wheat technology adoption, highlighting the relative influence of explanatory variables on the adoption probability.

As to Gujarati (1995), the binary logistic distribution function for the decision on use can be stated as:

$$n = \frac{1}{1 + e^{-z(i)}} \quad (1)$$

Where: $p(i)$: is a probability of a household being non-adopter of improved bread wheat varieties for i^{th} household.

e : represents the base of natural logarithms (2.718) and

$Z(i)$: is a function of explanatory variables (X_i) and is expressed as:-

$$Z(i) = \beta_0 + \beta_1 \chi_1 + \beta_2 \chi_2 + \dots + \beta_m \chi_m \quad (2)$$

Where β_0 is the intercept and β_i is the slope parameter in the model, which is estimated using maximum likelihood method. The slope tells how the log-odds in favor of not adopted technology change as independent variables change by a unit.

The odds are defined as the ratio of the probability that a household is non-adapted to the improved bread wheat varieties p_i to the probability that the household adopted technology $(1-p_i)$.

$$(1 - p_i) = \frac{1}{1 + e^{z(i)}} \quad (3)$$

Therefore;

$$\frac{(p_i)}{1 - p_i} = \frac{1 + e^{z(i)}}{1 + e^{-z(i)}} = e^{z(i)} \quad (4)$$

$$\frac{P(i)}{1 - P(i)} = \frac{1 + e^{Z(i)}}{1 + e^{-Z(i)}} = e^{\beta_0 + \sum_{i=1}^m \beta_i \chi_i} \quad (5)$$

Taking the natural logarithms of the odds ratio of equation (5) results in what is known as the binary logit model, as indicated below.

$$\left(\frac{P(i)}{1 - P(i)} \right) = \ln \left[e^{\beta_0 + \sum_{i=1}^m \beta_i \chi_i} \right] = Z_{(i)} \quad (6)$$

If the disturbance term U_i is taken in to account the binary logit model becomes:

$$Z_{(i)} = \beta_0 + \sum \beta_i \chi_i + U_i \quad (7)$$

So, the above econometric model was used in this study so as to identify variables that affect the adoption of improved bread wheat varieties.

2.6 Multicollinearity Test

To run the model, data entry and analysis were conducted using SPSS. Prior to applying the binary logit model, potential multicollinearity among continuous and dummy variables was assessed. Multicollinearity complicates the identification of individual effects of independent variables on the dependent variable due to strong interrelationships. This issue creates prediction problems in the logit model. Variance inflation factors and contingency coefficients were utilized to test for multicollinearity (Gujarati, 2004).

Variance Inflation Factor (VIF) is used to check multicollinearity of continuous variables. As

R_i^2 increase towards 1, which is as the collinearity of regressor (explanatory variable) X_i with other regressor increases, its VIF also increases, and in the limit, it can be infinite. The larger the value of VIF_i , the more troublesome or collinear is the variable X_i . As a rule of thumb, if the VIF of a variable exceeds 10 (this will happen if R_i^2 exceeds 0.90), that variable is said to be highly collinear (Gujarati, 2004). Multicollinearity of continuous variables also can be tested through Tolerance. The tolerance is 1 if X_i is not correlated with the other regressors; whereas it is zero if it is perfectly related to other regressors. A popular measure of multicollinearity associated with VIF (X_i) is defined as:

$$VIF(X_i) = \frac{1}{1-R_i^2}$$

Where, R_i^2 is the coefficient of multiple determinations when the variable X_i is regressed on other explanatory variables, a rise in the volume of R_i^2 that is an increase in the degree of multicollinearity.

The contingency coefficient was used to check the multicollinearity of discrete variables. It measures the relation between the row and column variables of a cross-tabulation. The value ranges between zero and one, with zero indicating no association between the row and column variables and a value close to one indicating a high degree of association between the variables. The decision criterion is that if the value of the contingency coefficient is greater than 0.75, the variable is said to be collinear and would be avoided from further consideration in the multivariate analysis (Healy, 1984 as cited in Ataklti, 2008). The contingency coefficient was computed as follows:

$$c = \sqrt{\frac{x^2}{n + x^2}}$$

Where, c =coefficient of contingency, x^2 = a chi-square random variable and n =total sample size.

2.7 Summary of Independent Variables and their Hypothesis

Table 4 summarizes the key independent variables used in the study, including their descriptions, nature (categorical, continuous, or dummy), and the expected direction of influence on the dependent variable. The variables include demographic, economic, and institutional factors expected to affect household decisions or outcomes.

3. RESULTS AND DISCUSSION

3.1 Current Adoption Status of Respondents

New bread wheat varieties are typically recommended as a package for farmers. However, many farmers adopt only certain components of the package. Adoption rates vary, influenced by several factors. Out of 160 sampled households, 71 (44.33%) were involved in improved bread wheat production, while 89 (55.67%) were not during the two cropping seasons. The current adoption status is detailed in Table 5.

3.2 Factors Affecting the Adoption of Improved Bread Wheat Varieties

Using the binary logit model for hypothesized variables, it is necessary to test the problem of multicollinearity or association among the potential independent variables. Two measures are often suggested to test the existence of multicollinearity. These are: Variance Inflation Factor (VIF) for association among the continuous explanatory variables and contingency coefficients for dummy variables. VIF shows how the variance of an estimator is inflated by the presence of multicollinearity (Gujarati, 2004). According to Gujarati (2004), VIF can be defined as: $VIF(X_i) = 1/1-R_i^2$ where R_i^2 is the squared multiple correlation coefficient between X_i and the other explanatory variables.

A statistical package called SPSS was used to compute the VIF values. Higher VIF values indicate problematic collinearity, with a threshold of 10 suggesting multicollinearity is present. To address this, it is crucial to exclude any variable with a VIF of 10 or more from the logit analysis (Gujarati, 1995). Thus, the variance inflation factor (VIF) was utilized to assess multicollinearity among continuous variables.

The values of VIF for continuous variables, as shown in Table 2, were below the critical value of 10, indicating no serious multicollinearity issues. Therefore, all continuous explanatory variables were included in the binary logistic model. To assess the association among discrete variables, the contingency coefficient was calculated based on Chi-square values. A coefficient close to 1 indicates a strong association, while values near 0 show little to no association. Results in Table 3 confirmed no significant association among the discrete explanatory variables. After screening for the best variables and checking for

multicollinearity, as indicated in Table 2 and 3, it was concluded that there were no multicollinearity issues. Model analysis was then carried out.

Table 2. Multicollinearity test for continuous variables using VIF (n=160)

Variables	Tolerance	VIF
Age	.886	1.129
Family size	.889	1.125
Number of livestock	.908	1.101
Years of experience	.909	1.100
Distance from the market	.676	1.480
Distance from the DAs office	.832	1.203
Farm Size owned by farmers	.632	1.581

Source: Computed from own survey data, 2016

Table 3. Multicollinearity test for continuous variables using VIF (n=160)

Variables	Sex	Education level	Participation in off farm activities	Extension service for respondent	farmers Perception on wheat yield	farmers Perception on cost of inputs
Sex	1					
Education level	-.067	1				
Participation in off-farm activities	.104	-.096	1			
Extension service for the respondent	.117	-.018	-.060	1		
Perception about yield	-.146	.072	-.084	-.055	1	
Perception about cost	-.039	-.085	.059	-.078	.003	1

Source: Computed from own survey data, 2016

Table 4. Summary of independent variables

No	Independent Variable	Description of the variable	Nature of the Variable	Expected Effect
1.	Education level	Education level of household head	Categorical	Positive
2.	Age	Age of household head	Continuous	Negative
3.	Sex	Sex of household head	Dummy	+ (males)
4.	Family size	Family size of household head	Continuous	Positive
5.	Participation Off- farm activities	Participation of household head in off-farm activities	Dummy	Positive
6.	Livestock ownership	Total livestock unit the household head owns.	Continuous	Positive
7.	Extension-services	Availability of extension-services for household farmer	Dummy	Positive
8.	Farmers experience in extension activities	Experience of farmers in extension activities	Continuous	Positive
9.	Distance from market	Distance from the home of the farmer to the nearest market	Continuous	Negative
10.	Farm size	Total farm owned by farmer	Continuous	Positive
11.	Farmers perception on yield	Farmers perception of improved bread wheat yield	Dummy	Positive
12.	Distance from development agent office	Distance from the home of the farmer to the development agent office	Continuous	Negative
13.	Farmers' perception on cost of wheat variety	Farmers' perception about improved wheat varieties	Dummy	Negative

Table 5. Distribution of respondents by status of adoption (n=160)

Adoption category	Frequency	Percent
Adopters	71	44.33
Nonadopters	89	55.67

Source: Computed from own survey data, 2016

3.3 Interpretation of Significant Explanatory Variables

Out of the thirteen independent variables that were hypothesized, seven were found to significantly affect the dependent variable. These variables include sex, age, access to extension services, distance from the nearest market, distance from the nearest Development Agents (DAs) office, farm size, and farmers' perceptions about the yield of the improved wheat variety (see Table 6). Each of these variables is explained in further detail below.

Sex: The binary logit model results indicate that sex negatively affects the adoption of improved bread wheat varieties at a 10% significance level. Specifically, when men are taken as a reference group, the probability of women adopting improved bread wheat varieties decreases by 0.533 times, assuming all other variables are held constant. This finding aligns with the study conducted by Yemane (2014), who found that female-headed households were less likely to adopt new technologies compared to their male counterparts. The implication is that women face unequal opportunities compared to men when it comes to adopting new technologies. Factors contributing to this disparity include cultural norms, religious beliefs, the delivery of extension services, and the gender of the Development Agents (DAs) in the study area.

Age: The results of the binary logit model show that the age of the household head negatively affects the adoption of improved bread wheat varieties, and this effect is significant at the 1% level. The marginal effect from the model indicates that for each additional year of age, the probability of adopting improved bread wheat varieties decreases by a factor of 0.036, assuming all other variables remain constant. Farmers who are traditionally bound may be hesitant to adopt new ideas, techniques, and technologies due to their fear of potential risks associated with changing their established agricultural practices. This resistance can hinder the acceptance of innovations in wheat production. A study

conducted by Million and Belay (2004) reported similar findings.

Extension service: The results of the binary logit model indicated that extension services positively and significantly influence the adoption of improved bread wheat varieties at a 5% probability level. The positive coefficient for extension services suggests that when respondents have access to these services, their likelihood of adopting improved bread wheat varieties increases. Specifically, the marginal effect shows that, with other variables held constant, if a farmer participates in extension services, their probability of adoption increases by a factor of 0.281. Similarly, a study conducted by Yemane (2014) found results that align with those of this study.

Farm Size of Household: The binary logit model reveals that farm size significantly influences the adoption of improved bread wheat varieties at a less than 10% significance level. Farmers with larger land can access more information and have stronger purchasing power due to higher harvests and income. An odds ratio of 0.159 indicates that as farm size increases by one hectare, the odds of adopting improved wheat varieties increase by a factor of 0.159. This finding is supported by research from Onumadu and Osahon (2014), Oyewole et al. (2014), and Ogutu and Obare (2015).

Distance from nearest market: The results of the binary logit model indicate that the distance to the nearest market negatively affects the adoption of improved bread wheat varieties at a 1% significance level. The marginal effect shown in the model output reveals that for each unit increase in distance from the market, the probability of adopting improved bread wheat varieties decreases by a factor of 0.451, assuming all other variables remain constant. This decline in likelihood may be attributed to the limited opportunity for farmers to access markets, which in turn reduces their access to new information, technology, and the necessary inputs for implementing these technologies. This finding aligns with the research conducted by Minyahel (2008), Daniel (2008), and Mubarak (2009).

Table 6. Binary logit model output (n=160)

Independent Variables	Coef.	Std. Err.	P> z	Marginal Effect
Sex	-2.685*	1.569	0.087	-0.533
Age	-0.290***	0.103	0.005	-0.036
Educllevel	0.226	0.757	0.765	0.028
Famsiz	0.312	0.320	0.330	0.039
Particoff	1.366	1.150	0.235	0.176
Livestock	-0.017	0.087	0.840	-0.002
Extserv	4.669**	2.083	0.025	0.281
Farexpect	0.177	0.112	0.115	0.022
Distmark	-3.615***	0.935	0.000	-0.451
Disaof	-1.079**	0.521	0.038	-0.135
Farmsize	1.275*	0.661	0.054	0.159
Wyield	4.491***	1.653	0.007	0.422
Percecost	1.019	1.218	0.403	0.106
_cons	12.104	6.755	0.073	

Source: Computed from own survey data, 2016

*, ** and *** significant at 10%, 5% and 1%

Distance from DA office: The binary logit model results show that distance from the DA office negatively impacts the adoption of improved bread wheat varieties at a 5% significance level. Specifically, an increase in distance decreases the probability of adoption by 0.135 times, likely due to limited visits and communication with DAs, resulting in less access to updated information. This finding aligns with Mubarak (2009).

Perception of wheat yield: The binary logit model results showed that a positive perception of improved bread wheat yield significantly affects the adoption of improved varieties at the 1% level. When farmers have a better perception of wheat yield, their likelihood of adopting improved varieties increases. Specifically, the marginal effect indicates that, holding other variables constant, a positive perception increases the likelihood of adoption by a factor of 0.422, aligning with findings by Wen-chi et al. (2015) on the yield perception difference between adopters and non-adopters.

4. CONCLUSIONS

This study explored the adoption status and key factors influencing smallholder farmers' adoption of improved bread wheat varieties in the Awbare district of the Somali Regional State. Based on data collected from 160 households and utilizing a binary logistic regression model, the analysis revealed that the adoption rate of improved wheat varieties is relatively low, with only 44.33% of respondents identified as adopters. The results indicate that several socio-economic,

institutional, and perception-related variables significantly affect adoption decisions. Specifically, farm size, access to extension services, and positive perceptions of wheat yield were found to significantly enhance the likelihood of adoption. Conversely, factors such as age, sex, and distance from markets and development agents' offices had a negative and significant impact on adoption. These findings highlight the need for targeted policies and programs to address the specific barriers faced by non-adopters. Strengthening agricultural extension services, especially in remote and underserved areas, is crucial to enhancing farmers' knowledge and motivation to adopt improved wheat varieties. Additionally, improving rural infrastructure, including road networks and market access, can facilitate better information flow, supply of inputs, and marketing of outputs. Furthermore, it is essential to pay special attention to gender disparities in technology adoption. This involves promoting gender-sensitive extension services and providing support to female-headed households through tailored capacity-building programs. Smallholder farmers with limited land resources should also receive assistance through input subsidies, access to credit, and group-based extension models to ensure equitable access to improved technologies. Ultimately, the sustained adoption of improved wheat varieties in the region requires a multi-faceted strategy that considers the varied constraints faced by farmers. Enhancing farmer education, facilitating closer proximity to agricultural support services, and fostering positive perceptions of the benefits of new technologies are vital steps toward improving

wheat productivity and achieving food security in Awbare and similar agro-pastoral communities.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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