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Research and Reviews: Journal of Agricultural Science and Technology

Vol-15, Issue- 02, Year- 2026

ISSN No- 2278-2206

Research Article

Received Date- February 12, 2026

Accepted Date- February 26, 2026

Published Date-

Adoption of Major Improved Crop Varieties in Selected Districts of the Southwest Ethiopia Region.

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Abstract

Agriculture forms the backbone of the Ethiopian economy and significantly contributes to the livelihoods of the majority of the population. It remains a central pillar of food security, employment, and rural development across the country.The present study aims to examine the adoption of improved major crop varieties and to identify the key factors influencing their uptake in the southwest Ethiopia region. The research was carried out in the districts of Bita, Chena, Andiracha, and Sheyi Bench, located in southwestern Ethiopia. Data for this study were collected through household individual survey interviews, key informant interviews, and focus group discussions from primary sources and published and unpublished secondary sources. Descriptive statistics and binary logistic regression of econometric model was employed to indicate the finding this study. The adoption of major improved crop varieties were lower, only 34.90% of the sample households were used improved crop varieties in 2022/2023 production year Improved maize,

wheat, common bean, and faba bean varieties were distributed in 2022/2023 production year in the area. Improved maize adopters were 25.3%; wheat adopters were 11.49%; common bean was 2.68% and 0.76% were faba bean adopters. Binary logistic regression results indicate that educational status, total annual income, and frequency of extension agent contact positively and significantly affect adoption of major improved crop varieties. The main challenges to adoption were supply problems, inflated improved seed price, lower productivity difference with local landraces and disease attack, and land shortage. Regional, zonal, and district governments should work on accessing quality improved seed of farmers' interest on time and needed amount, and special attention should be given to districts with the least adoption rate by creating awareness, training, demonstration, and accessing agricultural inputs to achieve better technology adoption levels.

Key words: *Adoption, Improved varieties, Binary logistic, Maize, Wheat, Southwest*

1. Introduction

Agriculture is the mainstay of the Ethiopian economy and more than 85% of the rural populations are engaged in agriculture and plays a substantial role in the life and livelihood of most Ethiopian. However, the agricultural production system in Ethiopia was traditional and less supported by technologies like irrigation, improved varieties and improved practices [1]. The majority of smallholder farmers depend on conventional methods of production which has impaired production and productivity [2]. To intensify the agriculture sector of the county by technology, governmental and non-governmental bodies have made many efforts in the past two decade [3]. A central aim of this process has been to boost agricultural production and productivity.

The adoption of enhanced agricultural technologies is a technique for boosting productivity in the agricultural sector, alleviating poverty, and ensuring food security [4]. In agricultural sector technological improvement includes utilization of irrigation, mechanization, improved cultivars, soil fertility improvement and pest control mechanisms enhance the productivity per unit area of land and bring about a rapid increase in production [1]. Technological adoption in agricultural sector can increase products from agricultural sector, improvement on households' income and livelihoods, spillover effect on other sector like industry and manufacturing and whole countries economy. In country like Ethiopia with majorities of its population are under poverty and have

large agricultural resources like arable land, water and human resources, agriculture is strong option for economic development and to overcome poverty [2]. To improve agricultural technology adoption of farmers, non-governmental and governmental bodies have supported in different ways to improve agricultural productivity and livelihoods of farmers, but still below expected [1]; almost half of crop land covered without fertilizer, utilization of pesticide was below 20%, irrigated land nearly 1% and only 10% of cropped land covered by improved varieties.

Many improved agricultural technologies that boost farmers' production and productivities were introduced and disseminated by agricultural offices, research center and universities in the study area [5]. However, the majority of farmers in the study area are still using their traditional way of farming practices like utilization local seed, oxen based land preparation, rain-fed agriculture, lower soil fertility improvement measure, lower pest, disease and weed control that slower progress in smallholders' agriculture [6]. The lower application recommended technology that improve the whole agricultural sector and livelihood of producers does not achieved its objective and still subsistence production are practiced in the area. Farmers cannot easily adopt improved agricultural technology due to various socio-economic, demographic, and institutional factors [7,8, 9], which include gender, land size, family size, age, income, credit access, extension service access and access to market. However, some studies have reported multiple barriers to adoption of improved crop varieties, including lower technology awareness, risk aversion of farmers about technology, institutional restriction that supply and disseminating technologies, farmers limitation in human and financial capital to access technologies and infrastructure problem to access and supply products to demand [4].

During our earlier studies in the area, farmers need assessment study and agricultural production problem assessment study, we recognized only a few farmers are using the recommended improved technologies , which results to lower productivity of crops as compared to the potential of the area and crops. In addition, during the period of improved seed demand assessment, we recognize that utilization of improved seed was lower as compared to other areas of the region. So, why the farmers in these zones reluctant to use the improved seed for improvement of their production and productivity?

Objective of the study

- To identify and analyze factors influencing adoption of major improved crop seeds among farmers in the study area.

2. Research Methodology

2.1. Description of the study Area

Kaffa, Sheka and Bench-Sheko zone was three zones from southwest Ethiopia region selected for this study. Four sample districts were taken: two districts, Bita and Chena, from the Kaffa zone, Sheyi-Bench district from the Bench-Sheko zone, and Andiracha district from the Sheka zone. Bita is one of the districts in the Kaffa zone, located 523 km southwest of Addis Ababa, the Capital of Ethiopia. It is geographically located between 7° 12′33″ and 7°35′00″ North latitudes and 30°29′15″–35°51′00″ East longitudes. Bita district covers an area of 109,247ha of Kaffa zone. The district share a boarder to the East by Chena district of kaffa zone, to the west Yeki district of Sheka zone, to the north Gesha district of Kaffa zone and to the northeast by Gawata district of Kaffa zone. The elevation ranges from 950 to 2570 m.a.s.l. It receives a mean annual rainfall of 1571 to 1862 mm and reaches a maximum between June and September. The average monthly temperature was 22.6°C, with a maximum of 32.9°C and a minimum of 13.5°C. Agriculture remains the major means of livelihood in the district, and the major crops grown in the district are permanent crops, cereals, pulses, vegetables, and root crops.

Chena is another district selected for this study from Kaffa zone, it is located at 07º18'48"N Latitude and 36º16'25"E Longitude and at an altitude of 2020 masl. The district was boardered with Decha to the east, Bench-Sheko zone to the south, Gimbo to the northeast, Bita to the west and Gawata to the north. It has an agro ecology of highland covers 15%, midland 80% and lowland 5%. The district has a mean annual temperature of 19°C, with a minimum of 16°C and a maximum of 28°C, and a mean annual rainfall of 1800 mm. Chena district have 901.92km^2 total area coverage with crop-livestock mixed farming system. Enset, coffee, maize, barley, potato, sorghum, teff, bean and wheat are the major crop grown in the district.

The district selected from Bench-Sheko zone was Sheyi-Bench district having 46,315.04ha of total area coverage. The agro-ecology of the district was 70% mid-land and 30% low land. Menit-Goldiya bordered the district from east and south, Debub bench from west, Semen bench from northwest and Kaffa zone from north. Sheyi-Bench district receive an average annual rain fall of 803.35mm and average temperature ranging 15°C to 25°C. Crop-livestock mixed farming system

practed in the district with major crop growing include maize, wheat, taro, enset, teff, common bean, faba bean and sorghum.

Andiracha district is one of the selected district for this study from Sheka zone with having 2 low land kebeles, 10 midland and 5 highland kebeles. It is geographically lied between 7^0 25' to 7^0 45'N and 35^0 05' to 35^0 35'E. It is bordered to the northwest to Oromia region, to the south by Yeki, to the southwest by the Gambella region, to the north by Masha, and to the east by the Kaffa Zone. The district receive an annual rainfall ranging from 1800mm to 2200mm, and the annual temperature ranges from 17 °C to 29°C . The district has a total area coverage of 200,869.5ha with 36.94% covered by forest. Mixed farming system is practiced in the district with an agroforestry system and main crops produced in the district include Enset, coffee, maize, and potato.

2.2. Sampling technique and sample size determination

To select sample households multistage sampling procedure was employed. Two districts from the Kaffa zone and one district from Sheka and one district from Bench-Sheko zone were selected randomly from the FSRP districts. To take proportion to the size of each zone, we take two districts from the Kaffa zone and one from the other zones. Secondly, two sample kebeles were selected from each district randomly. Then sample households was selected randomly from list of households in the selected kebele.

Table 1: Sample households taken from each kebeles

District	Kebele	Sample households
Bita	Sheda	37
	Dacha-Difa	35
Chena	Boba-gota	30
	Boba-bela	34
Andiracha	Shebena	27
	Chegecha	32
Sheyi Bench	Mazi	34
	Shapa-guyidi	32

The size of sample households for this study was determined using the formula that was developed by Yamane [10]:

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

Where n is the sample households selected and interviewed, N is the total population of sample area, and e is error level. A total of 261 sample households was interviewed with structured questionnaire on adoption of major improved crop varieties as shown in table 1.

2.3. Data Type, Source, and Collection Technique

Data for this study were collected from primary and secondary sources by including quantitative and qualitative data. Data collection method employed for this study include key informant interview, focus group discussion and individual household survey interview by structured questionnaire. Key informant interviews were conducted at the Woreda and kebele levels, which have better information about the type of improved crop seed distributed in the area. Focus group discussions were conducted in all kebeles of four districts by including different community members, which gives better information on trends and adoption of agricultural inputs. A household survey was conducted in all eight Kebeles with a total of 261 sample households of different sizes, proportional to households in each kebele.

Primary data were about the socio-economic characteristics of households, type and amount of improved crop varieties cultivated in 2022/2023, and challenges to improved crop seed utilization. Secondary data collected from published and unpublished sources including website reports, annual and quarterly report of respected government office and other sources.

2.4. Method of data analysis

The analytical method used to indicate the finding of this study include both descriptive statistics and Econometric model.

2.4.1. Descriptive statistics

Descriptive statistics like mean, frequency, percentage and standard deviation used indicate the sample household's utilization of improved seed, respondents' demographic, socio-economic conditions, type and amount of improved crop varieties used by using SPSS and Stata package. T-test and $\chi 2$ test employed to the mean difference and frequency variation between adopter and non-adopter.

2.4.2. Econometric analysis

To estimate factors determining the adoption of major improved crop seeds by farming households were analyzed by binary logistic model. Binary logistic regression better estimates the adoption of

major improved varieties of households with factors of magnitude; however probit model estimates only the probability of adoption. While the binary logistic model estimates the magnitude of factors' effect with their direction by the Odds ratio. The output of binary logistic regression indicate by how much factor can the change in the independent variable increase or decrease dependent variable. However, many binary models only indicate the probability of occurrence. In this study the dependent variable is about utilization of major improved crop varieties in 2022/2023 production year or not. The dependent variable is binary with 1 when the household is an adopter and 0 when not an adopter.

The model is specified mathematically by:

$Pi = E(Y = 1/xi) = 1/1+e\text{-}z = e^{z}/1+e^{z}$ ---------- (2)

Where Pi represents the probability of adoption of major improved crop seed, Yi = 1, and exp (Zi) is the odds ratio "e to the power Zi". In the case of explanation, equation (2) is written as: of Z.

$Pi = 1/1+e\text{-}Z$---------- (3)

Where, $Zi = \beta 0 + \beta iXi$.

The probability of a respondent choosing to adopt improved crop seed successfully is given by equation (3), and the probability of a respondent not adopting improved crop seed is given by equation (4).

$Pi = 1\text{-}pi/xi = 1/1+e^{Zi}$---------- (4)

If Pi is the probability of an adopter, then the non-adopter is (1 − Pi). So, 1 − Pi =1/1+eZi and

$P_i/1\text{-}p_i = \frac{1+e^{Zi}}{1+e^{-Zi}} = e^{Zi} = \boldsymbol{e}^{(\boldsymbol{\beta 0+\beta 1X1i+\cdots+\beta kXki+Ui})}$. ---------- (5)

Pi/1-Pi is an odds ratio that favors adopters as a result. That is the probability that a particular farmer participates in the adoption of improved seed and does not participate in the adoption.

Then, taking the log to both sides.

$Y = \ln (Pi/1\text{-}Pi) = Zi = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3... + \beta iXi + Ui$---------- (6)

Equation 6 was the binary logistic model which a regression was conducted.

2.5. Factors affecting the adoption of improved crop varieties

Many studies indicated different factors affect household decisions whether to use improved crop varieties or not. The most common determinant factors indicated by many authors include sex of household head, educational status, family size, age of household head, land size, livestock size, credit access, extension agent contact, and total annual income [4,7,8,9,11,12,13,14,15,16].

Sex of household head has an effect on adoption of improved crop varieties, and male-headed households are more likely to adopt improved crop varieties than female-headed households [7,11]. The age of the household head has both increasing and decreasing effects on the adoption of improved varieties due to purchasing capacity and awareness level of household head. Finding in southern Ethiopia indicated age have positive effect on adoption of improved crop varieties [12]; and has negative effect in central Ethiopia and Kaduna State, Nigeria, said that as age of household head increase utilization of improved crop varieties decrease [4,9]. Family size of household head has a positive effect on adoption of improved crop varieties due to additional family members adding labor and capital for better management and purchasing of seeds [9,13]. The land holding size of the household is also an important factor for farmer, whether to use or not improved crop varieties. Size of farmers land holding has positive effect on likelihood of adoption of major improved crop varieties [4,11]. Educational status of farmers has an effect on the decision of improved crop varieties, as the more literate farmers better know the advantage of improved varieties, have information, are better aware of it, and easily decide whether to adopt or not [7,8].

Institutional factor like access to market, measured by distance from market, is an important factor for farmers, whether to adopt or not, as many farmers are producing for selling. Many studies found that as the distance from the market increases, households' likelihood of adoption of improved crop varieties decreases due to difficulty of providing their product to market and profitability issue [7,14]. The income of households affects the purchasing power of inputs like improved crop varieties, as there is only a cash payment system of input delivery. There is a positive relationship between the income of households and the likelihood of adoption of improved crop varieties [7,12]. Livestock size of farmers has both positive and negative effects on the likelihood of adoption of improved varieties. The volatile nature of livestock easy to sell and convert to cash, can positively affect the adoption of improved crop varieties [7,11]. However, many other authors found that negative relationship between livestock size and improved crop variety adoption due to resource competition between livestock production and crop production

[4]. Credit access has a positive effect on the adoption of improved crop varieties that can improve the purchasing capacity of farmers who face cash shortages [9,12]. The finding of many studies indicated that adoption of improved crop positively varieties related with frequency of extension agent contact. Extension agent contact improves farmers' adoption of improved crop varieties by getting advice, training, better awareness about variety, management, disease control, and inputs [7,9,11]. Hypothesized explanatory variables that are expected to affect the adoption of major improved crop seed were indicated with their expected effect in Table 2.

Table 2: Definition of variables, their measurement, and expected effects

Variable	Type and measurement	Expected effect	Supporting studies
Dependent variable			
Adoption IMV	Dummy (1=adopter, 0=non=adopter)		
Independent variable			
Sex	Dummy (1=male, 0=female)	+	7,8,11
Age	Continuous (age in year)	+/-	12/4,9
FMLSIZ	Continuous (number of family member)	+	9,13
LNDSIZ	Continuous (size of land holding in hectare)	+	4,9,11
EDUSTAT	Continuous (year of schooling)	+	7,8,9,11
DSTMRKT	Continuous (desistance in kilometer)	-	7,14
LOGTTINC	Continuous (logarithm of annual income in percent)	+	4,7,12
TLU	Continuous (livestock owning size in TLU)	+/-	7,11/ 4
CRDACSS	Dummy (1=yes, 0=no)	+	9,11,12
FRQEXTCNT	Continuous (times of extension contact per year)	+	7,9,11

3. Results and Discussion

3.1. Demographic and socioeconomic characteristics of the sample households

The majorities (87.74%) of the sample households were male-headed and only 12.26% were female-headed. There is a significant variation between male-headed and female-headed households at 1% with Chi-square value of 10.436. It indicate that female headed households are less adopter of improved crop varieties than male-headed households. It might be due to females are mainly engaged in caring family and working within the home, lower information access to females, and lower cash income access and resource control of females lowered their adoption

rate compared to male headed. It agrees with findings in the Arsi highland and Bale zone Oromia region of Ethiopia where that male-headed households were more probable to adopt improved varieties than their female counterparts [8,11]. The majority, 97.70% of the sample households, were married, 0.4% were single, 1.5% were divorced, and 0.4% were widowed, but there is no significant relation of major improved crop varieties adoption with marital status (Table 3).

Table 3: Discrete socio-economic and institutional characteristics of sample households

Variable		Total sample (N=261)	Adopter (N=91)	Non-Adopter (N=170)	Chi-Square (χ^2)
Sex	Male	229	88	141	10.436***
	Female	32	3	29	
Marital status	Single	1	1	0	4.56
	Married	255	90	165	
	Divorced	4	0	4	
	Widowed	1	0	1	
Credit access	Yes	111	62	49	37.47***
	No	150	29	121	
Access Training	Yes	95	73	22	115.892***
	No	166	18	148	
Extension agent contact	yes	141	85	56	87.246***
	No	120	6	114	
Access to information	yes	95	68	27	88.652***
	No	166	23	143	
Agricultural cooperative membership	Yes	27	17	10	10.469***
	No	234	74	160	

*Significant levels are indicated by ***, **, and *, which are P<0.01, P<0.05, and P<0.1, respectively*

About 42.53% of the sample household heads have credit access from formal and informal sources, including farmers' cooperatives, Omo micro-finance, relatives and friends, while 57.47% have no credit access. The Pearson chi-square test indicates that there is a significant variation in credit access to adopters and non-adopters of major improved crop varieties, with a chi-square value of 37.47. Households that have credit access are more likely to adopt improved crop varieties than those without credit access, and this agrees with findings at Wolaita, Ethiopia, and Kaduna state, Nigeria [9,12], which highlighted access to credit can strengthen farmers' input purchasing capacity when farmers have income shortages.

In the 2022/2023 cropping season of summer and winter, about 36.40% of the sample households received training on crop production, and 63.6% did not receive any training on crop production. The relationship between training access and adoption of major improved crop varieties was statistically significant with chi-square value of 115.892. Household heads with access to training are more likely to adopt improved crop seeds than households with no training access. Farmers' capacity building through training is crucial for the adoption of improved varieties, and training promotes their adoption rate of improved technologies [12,13]. Farmers in the study area contact extension agents for input need, advice on crop management and disease control, credit access and other supports. Out of the sample households, 54.02% are contacted extension agents in the 2022/2023 cropping season. There is a significant relationship between adoption of major improved crop varieties and contacting extension agent with chi-square value of 87.246. Majorities of farmers who contacted extension agents are adopters of major improved crop seeds than with no contact with extension agents. It was consistent with findings of the South Omo zone of Ethiopia and Kaduna state of Nigeria, which said that household extension contact promotes adoption of improved crop varieties [7,9].

Information on improved crop varieties are very important tool for farmers to adopt it; about 36.40% of the sample households have information access on improved crop varieties distributed in the area from the agricultural office, extension agent, neighbor farmer, radio and television. The finding indicates that there is there is a significant effect of information on improved crop varieties on household's adoption at 1% significance level. Majorities of farmers who have information access are adopters of improved crop varieties than those with no information access, and agree with findings at Bale zone, Ethiopia [11].

Agricultural cooperative membership of farmer are one of and important factor to adopt improved crop seeds. About 10.34% of the sample households were members of an agricultural cooperative like coffee suppliers union and Participatory Forest Management (PFM) members. The results indicate that agricultural cooperative membership has an effect on adoption of improved crop varieties at 1% significance level with a chi-square value of 10.469. The finding indicates those agricultural cooperative members are more adopters of major improved crop seeds than non-members, and it is consistent with findings at Bale zone, Ethiopia [11]. The memberships in agricultural cooperatives support farmers by accessing credit, seed or seedling, improved livestock breed, training and awareness creation on agricultural technology and livelihood improvement.

The mean age of sample households was 43.38 years having 22 years minimum and maximum of 75years. The mean age of non-adopter was 48.10 years and adopter was 34.57 years, the mean age difference was statistically significant at 1%. It indicate that elder household head are less adopter than younger household heads. The finding is in line with findings in Kaduna state of Nigeria, which said that it is indicative of the predilection for younger farmers to embrace improved practices than older farmers [9], and disagrees with findings at Wolaita, Ethiopia [12]. The mean educational status of the sample household was 4.84 years of schooling. Adopters of major improved seed had a mean of 5.74 years of schooling, and non-adopters had 2.47 years of schooling. The findings indicate that more educated household heads are more adopters of major improved seed than less educated household heads, and it was consistent with findings in the Arsi highland of Ethiopia and Kaduna state, Nigeria [8,9]

Table 4: Continuous socio-economic and demographic characteristics of sample households

Variable	Total sample (N=261)		Adopter (N=91)		Non-adopter (N=170)		Sig.
	Mean	Sta.dev	Mean	Sta.dev	Mean	Sta. dev	
Age of HH head	43.38	10.58	34.57	6.47	48.10	9.71	0.000***
Educational status	4.84	3.75	5.74	3.8	2.47	2.34	0.000***
Family size	6.49	2.07	6.47	2.29	6.51	1.95	0.902
Land size	2.04	1.54	2.12	1.54	1.99	1.55	0.526
Distance from market	5	1.99	4.60	2.32	5.21	1.76	0.020**
Distance from FTC	1.55	0.68	0.82	0.23	1.95	0.488	0.000***
Livestock owning	2.55	1.11	2.42	0.97	2.63	1.17	0.142
Total income	83,881.22	55,869.89	119,538.46	52,985.17	64,794.11	47,497	0.000***

*Significant levels are indicated by ***, **, and *, which are P<0.01, P<0.05, and P<0.1, respectively*

The mean distance of the sample households from the market to home was 5km, while adopters of major improved crop varieties were located 4.60 km away from the market, and non-adopters have a mean distance of 5.21km from market, the mean difference was significant at 5% (Table 4). The finding indicates that households close to the market are more adopters of improved varieties than households far from the market, and agrees with findings at the north Wollo zone, Ethiopia [14]. It was due to road infrastructure problems that resulted in higher transportation costs, hindering households' adoption of improved varieties. Market access is one of the determinants for the

adoption of improved varieties, as the majority of adopters were producing for the market or selling [17]. The sample households were 1.55km away from the farmers' training center, while adopters of major improved crop seeds were 0.82km and non-adopters were 1.92km away from the Farmer Training Center (FTC), and the mean difference was significant at 1%. The finding shows that the farmer training center is a center of agricultural technology; farmers close to the FTC are more likely to adopt improved crop varieties than those far from the FTC.

The sample households generate a mean annual income of 83,881.22 Ethiopian Birr (ETB), while adopters of major improved crop seeds generated a mean total annual income of 119,538.46 ETB, and non-adopters got 64,794.11 ETB from different sources, and the mean difference was statistically significant at 1% significance level. The result indicates that households that generate higher income are adopters of major improved crop seed than households that generate lower income. As the income of households increases have a tendency to adopt technology, which means adoption of technology is affected by total income and purchasing power of households (7,12).

3.2. Adoption of major improved crop varieties

The major improved crop seeds distributed to farmers in the 2022/2023 production year were maize, wheat, common bean, and faba bean. About 34.90% of the sample households were adopters of major improved crop varieties in the 2022/2023 cropping season in the area. The adoption level in the area was more than East Shewa zone of Oromia region and the North Shewa zone of Amhara region, Ethiopia, where only 29% were adopters of improved varieties [4]. However, the adoption level in the study area was less than the adoption level in South Ari Woreda (51.41%), Damote Gale Woreda (55%), and Arsi highland (42.66%) of Ethiopia [7,12,8]. This current lower adoption level in the study area might be due to lower technology demonstration and dissemination level, lower awareness and knowledge about the variety distributed, inflated price of seed supplied, lower supply of varieties of farmers interested in time, needed quantity, and quality. About 72.40% of the sample households have experience of using improved varieties before; when we compare with current adopters, the trend of adoption of improved varieties was decreasing. The main reason that respondents raised for decreasing adoption level was delivery problem, lower productivity differences with local varieties, and inflated prices.

There is a difference on adoption major improved crop varieties between the sample district and the difference was significant at 1% significance level. The adoption level major improved seed of Sheyi-bench district was 57.58%, Bita district was 31.94%, Chena district was 34.37%, and

Andiracha district was 13.55% in 2022/2023 production year. Households in the Sheyibench district were better adopters than households in other districts, while households in the Andiracha district were the least adopters of improved crop seeds compared to others. This variation might be the availability of some productive, disease-resistant, and locally adapted varieties in the area.

3.2.1. Types of improved crop varieties adopted

About 25.3% of the total sample households were adopters of improved maize varieties in the 2022/2023 production year. Which is more than the finding in central Ethiopia, only 12% were adopter of improved maize, and the rest rely on their local landrace [4]. However, the adoption level of maize in the study area was less than that found in Damote Gale Woreda of Wolayta zone, Ethiopia, where about 55% were adopters of improved maize variety [12]. The type of improved maize varieties distributed in the area includes Shone, BH-661, and DK-777. There is a variation in the adoption of improved maize varieties between districts, and the Pearson chi-square test was significant at 1%. Out of the sample households from each district, 29.68% of the Chena district, 13.89% of the Bita district, 13.55% of the Andiracha district, and 43.94% of the Sheyi Bench district were adopters of improved maize varieties. Households in the Sheyi-Bench district were better adopters, and households in the Bita and Andiracha district were less adopters of improved maize varieties (Table 5).

Table 5: Adoption of major improved varieties

Types of improved crop	Total sample		Bita		Chena		Adndiracha		Sheyi Bench		Chi-Square (χ^2)
	Yes	no	Yes	No	Yes	no	Yes	no	Yes	No	
Maize	66	195	10	62	19	45	8	51	29	37	22.06***
Wheat	30	231	6	66	5	59	4	55	15	51	11.04*
Common bean	7	254	3	69	2	62	0	59	2	64	2.313
Faba bean	2	259	0	72	0	64	1	58	1	65	2.206

Source own survey 2023/2024

Improved wheat variety adopters were 11.49% of the total sample households, which is less than the findings at Arsi highland Ethiopia, where 55% were adopters of improved bread wheat [8]. Shorima, kingbird, and Ogolcha were the types of improved wheat varieties distributed in the 2022/2023 production year in the area. There is a significant variation in improved wheat adoption between districts at a 10% significance level by chi-square test which indicate that there is very

low variation in adoption of improved wheat between sample districts. Out of the sample households from each district, 8.33% of the Bita district, 7.8% of the Chena district, 6.77% of the Andiracha district, and 22.72% of the Sheyi Bench district were adopters of improved wheat varieties. The finding indicates that the very low adoption level of improved wheat varieties in the area than in central Ethiopia and the southern highlands of Ethiopia, 42% and 55% of the sample households utilize improved wheat varieties [4,8]. Comparatively, households in the Sheyi Bench district were better adopters than households in other districts.

About 2.68% of the sample households' utilized improved common bean in the 2022/2023 production year, and there is no significant variation in the adoption of improved common bean between districts. The adoption level of common bean in the area was very low and less than finding in Kucha district southern Ethiopia, reported that 45.73% of the sample households was adopter of Nasir variety. Nasir is an improved common bean variety distributed in the area. The lower adoption of improved common bean in the area may be due to lower supply, lower awareness about variety and agro-ecological factors.

Out of the sample households only 2 households or 0.76% was used improved faba bean in the 2022/2023 production year. The adoption level farmers in the area was by less than central highland of Ethiopia, they reported that 23.2% of the sample households was adopter of improved fava bean varieties [18]. Only Gabelicho variety was distributed in the area in 2022/2023 production year, however in centera highland of Ethiopia five varieties of fava bean were distributed including Walki, Dosha, Gebelicho, Dagim, and Lalo [19]. According to respondents, there is high demand of improved faba bean seed in the area due to availability of suitable agro-ecology in the area but the lower adoption was due to a shortage of fava bean seed in the area.

3.3. Determinants of the adoption of major improved crop varieties

To estimate factors determining adoption of major improved crop varieties in southwest Ethiopia binary logistic regression model was employed. The dependent variable is adoption of major improved varieties (if household was adopter=1, otherwise=0). The independent variables include Age, sex, educational status of household head, family size, land size, livestock owning by TLU, logarithm of total annual income, credit access, distance of home from market, and frequency of extension agent contact. The results of analysis indicated in Table 6, indicates that the model are jointly significant at 1% chi-square test level and the data fits the model well. An explanatory variable explained 65.56% of the variation of the dependent variable with pseudo R^2 value of

0.6556. Out of ten explanatory variables age of the household head, the educational status of the household head, the logarithm of the total annual income of the household, and the frequency of extension agent contact significantly affected household decisions on adoption of major improved crop varieties [20]. However sex of the household head, family size, land size, distance from market, livestock size, and credit access were not statistically significant. The main reason for the insignificant effect of those variables in econometric model was that, the mean difference between adopters and non-adopters were small, frequency variation was small, and the effect of those variables are lower in the area.

Household heads age (AGE)

The results of analysis indicate that age of household head negatively affect the likelihood of adoption of major improved crop varieties at 1% significance level (Table 6). An increase of household head age by one year decreases the likelihood of adoption of major crop varieties by a factor of 0.827 keeping other variable constant and odds-ratio disfavor. It indicate elder household head are less likely adopter than younger household heads. It is due to It might be elder household heads choose their local seed, have lower education level, knowledge, lower information access and lower awareness. The finding was in line with studies at North Wollo, Ethiopia, and Kaduna state of Nigeria, where there is a negative relationship of age of household head with probability of adopting improved Teff and maize varieties, which is consistent with the postulate that older farmers are restore their old ways and averse to innovating [9,14].

Household heads educational status (EDUSTAT)

There is a positive and significant relationship between education level of the household head and likelihood of adoption of major improved crop varieties at 1% significance level. An additional year schooling of household head increase the likelihood of adoption of major improved crop varieties by a factor of 3,707 keeping other factor constant [21, 22]. The finding indicates that less educated household head are not likely to adopt improved crop varieties than educated household heads. This might be due to better educated farmers are more rational in considering new technologies, becoming aware, and this awareness enhances the adoption of technologies [14]. The findings were similar to studies at Abuna Gindeberat, Ethiopia, and Kaduna state of Nigeria, suggesting that education endows respondents with greater intellectual capacity and know-how to

dissect and assimilate the strengths and drawbacks of new technologies and in deciding to adopt or not [9,13].

Table 6: *Results of binary logistic regression of major improved crop varieties adoption*

Sample (N) =261, LR chi2 (10) = 231.13, Pseudo R2 = 0.6556, Probability > chi2= 0.000; Log likelihood = -60.719

Independent variables	Odds Ratio	Coef.	St.Err.	P>|z|
SEX	0.337	-1.086	1.420	0.445
AGE	0.827***	-0.190	0.073	0.009
EDUSTAT	3.707***	1.310	0.315	0.000
FMLSIZ	0.799	-0.223	0.211	0.291
LNDSIZ	1.078	0.075	0.380	0.843
DSTMRKT	0.738	-0.303	0.235	0.197
LOGTTINC	19.65**	2.978	1.310	0.023
TLU	0.745	-0.295	0.392	0.452
FRQEXTCNT	1.799**	0.588	0.237	0.013
CRDACSS	0.398	-0.921	0.924	0.319
Constant	$1.58e^{-5}$	-11.055	7.280	0.129

*Significant levels are indicated by ***, **, and *, which are P<0.01, P<0.05, and P<0.1, respectively*

Household's annual income (LOGTTINC)

There is a positive significant relationship between households' annual income and likelihood of adoption of major improved crop cultivar at 5% significance level. The finding indicate that farmers generating lower income are less adopter of improved crop varieties than that generating higher income. Other things being equal, an increase in the logarithm of total annual income by 1% increases the adoption of major improved crop varieties by a factor of 19.65 odds-ratio favors. Farmers' annual income improves their purchasing capacity, and the cash payment system of agricultural input delivery favors households with higher income to utilize improved crop varieties. The findings were in line with studies in the central and south Omo zone of Ethiopia, households with higher income have a higher likelihood of adopting improved crop varieties than those with lower incomes [4,7].

Frequency of extension agent contact (FRQEXTCNT)

The likelihood of adoption of major improved crop varieties positively influenced by frequency of extension agent contact at 5% significance level. Keeping other variable constant, one more time contact with extension agent increase the likelihood of adoption of improved crop varieties by a factor of 1.799. Contacting extension agent are one of the tool to improve farmers technology adoption level in rural area; farmers that frequently contacting extension agent are more adopter of improved varieties than those not frequently contacting extension agent [4,8,13]. Extension service delivery and advisory services of extension agents, improved technology supply, management practices and recommended input and management services that advised by extension agents are very important to farmers.

3.4. Challenges of the Adoption of major improved crop varieties

The main challenges for the adoption of major improved varieties are ranked by comparing their effect each other on sample households. The main challenges identified for the adoption of major improved crop varieties were ranked by index ranking method includes supply problem, inflated seed price, lower productivity difference with local landrace and disease attack, and land shortage in their order of rank (Table 7).

Table 7: Ranking of challenges to the adoption of major improved crop varieties

Factors	Ranks			Sum	Index	Rank
	1	2	3			
Supply problem	107	68	51	508	0.324	1
Inflated seed price	72	63	55	397	0.254	2
Lower productivity difference and disease resistance	45	59	88	341	0.218	3
Land shortage	37	71	67	320	0.204	4

A. Supply problem

The supply problem is related to affording quality seed of farmer interest at the right time and needed amount. According to respondents, seed supplying bodies does not supply the type of seed of farmers' interest at the right time. Seeds are supplied by the district agricultural office through development agent at the peasant association level, but they are supplied at a late season and sometimes after farmer have sown their local land race. Also, district agricultural offices were not supplying the type of seed farmers were interested in. Farmers are mainly interested in for specific varieties by it productivity, disease and pest resistance, adaptability on the area and early maturity.

The qualities of the seed were another issue, especially with maize and wheat, and sometimes seeds of poor quality were supplied. Also, in the supply procedure, farmers may not get the amount of seed they want due to a seed shortage. The seed supply issue is the primary challenge adoption of improved varieties; accessing quality seed of farmer interest at the right time promotes the adoption of improved seed [4,9,15,19].

B. Unaffordable price of seed

According to the respondent, the price of seed was one of the challenging issues for farmers. The farmers perceive that those improved varieties are too expensive compared to the local landrace, and also, they are beyond the purchasing capacity of some farmers. The farmers who have purchasing capacity look for its productivity and profitability of purchasing and using those seeds. Expensiveness of the expense of improved crop seed was one of the challenges for the adoption of improved varieties [4,19].

C. Lower productivity difference with the local landrace and disease attack

The main issue farmers interested on improved crop varieties was their higher productivity advantage over the local landrace. However, now farmers in the study area raised that, they are experiencing a lower productivity difference with local ones and which may not afford them much profit. Non difference of certified seed with local one was one of the reason for farmers in East Shewa zone of Oromiya region and Noth shewa zone of Amhara region, Ethiopia [4].The other main problem was disease attack on improved crop varieties, especially wheat, and the control mechanisms were difficult.

D. Land shortage

Currently, due to population growth, land fragmentation is common in Ethiopia, particularly in the study area [18]. Even though the land holding of households in the area was higher as compared to other areas, it is mainly covered by perennial crop coffee and Enset. Households those especially youth those interested for adoption of improved varieties have lower land holding and also using improved varieties on land they were cultivating by share in were too costly for them.

Conclusion

Households' socio-economic, demographic, and institutional factors have a relationship with household adoption of improved crop seeds. The adoption of major improved crop varieties was

lower in the area. There is a better adoption rate at the Sheyi Bench district, and households in the Andiracha district were the least adopters. About quarter of the sample households used improved maize varieties, while11.49% adopted improved wheat varieties and 2.68% and 0.76% were adopted common bean and faba bean varieties respectively. Shone, BH-661, and DK-777 of improved maize varieties; shorima, kingbird, and Ogolcha of improved wheat varieties, Nasir of common bean variety and Gabalicho faba bean variety distributed in 2022/2023 production year in the area. Adoption of major improved crop varieties in the area was positively influenced by income level, frequency of extension contact and educational level. Supply-related problems, inflated seed prices, lower productivity differences with local land races and disease attack, and land shortage were the challenges to farmers in adopting improved varieties.

Recommendation

To improve the adoption of improved crop technologies government should work on improving awareness and knowledge to become more rational in decision-making by improving their educational status. Government and NGOs work on improving farmers' income and accessing market opportunities that empower their input purchasing capacity by promoting market-oriented production. Frequent contact of farmers with extension agents for their advice, input supply, and support is influential for technology adoption, so extension agents should be accessible to farmers for their support. Frequent training and access to agricultural input information for farmers are other tools to promote the adoption of major improved crop varieties.

Regional, zonal, and district governments should work on accessing quality improved crop seed of farmers' interest on time and needed amount by participating and private sectors. There is a variation of agricultural technology adoption between districts, so the regional and zonal governments should give special attention to districts with the lowest adoption rate by creating awareness, training, demonstration, and accessing agricultural inputs of farmers' interest to achieve a better technology adoption level.

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