Received: 22 February 2024 | Accepted: 10 June 2024

DOI: 10.1002/fes3.560

Food and Energy Security Open Access WILEY

ORIGINAL ARTICLE

Determinants of malt barley varietal adoption decisions of farmers: Evidence from the central highlands of Ethiopia

Mekonen Haile[1,2] | Fetien Abay[2] | Zewdie Bishaw[3] | Berhane Lakew[1] | Yemane Tsehaye[2]

[1]Ethiopian Institute of Agricultural Research (EIAR), Addis Ababa, Ethiopia

[2]Mekelle University, Mekelle, Ethiopia

[3]International Centers for Agricultural Research in the Dry Areas (ICARDA), Rabat, Morocco

Correspondence
Mekonen Haile, Ethiopian Institute of Agricultural Research (EIAR), P. O. Box: 2003, Addis Ababa, Ethiopia.
Email: mekonenhl@gmail.com

Abstract

Barley is one of Ethiopia's most important cereal crops, ranking fifth in total cereal production, after maize, wheat, teff, and sorghum. Based on its intended use, it is divided into two types: food barley and malt barley. This study investigated the factors that affect farmers' decisions to adopt malt barley technology. The research was conducted in eight major malt barley-growing districts in the central highlands of Ethiopia. Data were collected from both primary and secondary sources. A structured questionnaire was used to obtain quantitative data from 400 sample farmers. Key informant interviews and focus group discussions were conducted to triangulate and substantiate the quantitative data. Secondary data were also used to supplement the primary data. The data were analyzed using descriptive statistics and econometric models. A logistic regression model was employed to analyze quantitative data. The findings revealed that educational level of the household head, family size of the household, access to input, experience, and access to demanded variety all have a positive and significant impact on malt barley technology adoption. However, the age of the household head, income from off-farm activities, and distance to the market have a negative and significant impact on farmers' decisions to use malt barley technology. Up to 2021, about 30 malt barley varieties were released or registered by the Ministry of Agriculture for production nationwide, while only six to seven varieties were adopted by the sampled farmer households. As a result, we concluded that strong government support and clear policy direction are required to encourage farmers and other stakeholders to invest more to enhance adoption of improved varieties across malt barley growing areas.

KEYWORDS

adoption decision, determinates, farmers, malt barley, variety

1 | INTRODUCTION

Barley (*Hordeum vulgare* L.) is the world's fourth most important cereal crop, after maize, wheat, and rice, with estimated area coverage, production, and productivity of 48.94 million hectares, 145.62 million tons, and 2.98 tons/ha respectively (FAOSTAT, 2023). European Union, the Russian Federation, Australia, Ukraine, and Canada were the world's top five barley producers in 2021/22 with average area coverage, production, and yield of 10.27, 7.8, 5.5, 2.5, and 3 million hectares, 52.1, 18, 14.6, 9.4, and 6.8 million tons, and 5.07, 2.3, 2.67, 3.82, and 2.28 tons/ha, respectively. During the same period, Morocco, Ethiopia, Algeria, Tunisia, and South Africa were the five largest barley producers in the African continent, with estimated area coverage, production, and grain yield of 1.5, 0.96, 0.53, 0.51, and 0.1 million hectare, 2.8, 2.4, 0.56, 0.43, and 0.33 million tons and 1.87, 2.45, 1.06, 0.84, and 3.5 tons/ha, respectively (FAOSTAT, 2023).

In the 2020/21 main cropping season, barley was grown by more than 3.7 million smallholder household heads in most highland areas of Ethiopian for multiple purposes (food, feed, beverage, and roof thatching). During the same cropping season, Oromia and Amhara regions contributed about 81.2% and 83.8% of the overall barley production and area coverage of the country (Central Statistical Agency [CSA], 2021). According to the FAO (2023) estimate, from 2019 to 2021 the average per capita food use of barley in Ethiopia was 16.8 kg/year which was the second in the world next to Morocco (19.6 kg/year). In Ethiopia, barley is mostly classified into food and malt types based on its uses. The country's Central Statistics Agency reports area coverage and production of food and malt barley together. As a result, the exact area allocation and quantity produced for food and malt barley are unknown. However, Alemu et al. (2014) and Lakew et al. (2016) estimated 85%–90% of annual barley production area in Ethiopia used for food barley, with the remaining 10%–15% (about 100,000–150,000 ha) being used for malt barley cultivation.

Malt barley breeding in Ethiopia began in the early 1960s with the introduction of malt barley germplasm from other countries (Fekadu et al., 1996). From 1964 to 1992, more than 900 malt barley genotypes were evaluated for adaptation, disease resistance, and other important agronomic traits. Of the total introduction, about 10% were from the USA through FAO, 17% from Kenya, and the remaining 73% from European countries (Fekadu et al., 1996). Research on malt barley has been continued, with the main goal of improving domestic malt barley production by developing and deploying appropriate malt barley technologies to save foreign exchange from malt imports. From the beginning of the barley improvement program in the 1960s until 2021, about 30 malt barley varieties were released/registered for production in Ethiopia (Ministry of Agriculture, 2021). Most of these varieties including Holker (the oldest variety) are being produced at different scales across Ethiopia's potential malt barley-growing areas. While a lot of malt barley varieties were released and the amount of grain produce increased from time to time, there was a mismatch of malt barley grain and malt demand and supply. According to New Business Ethiopia (2017), in 2017, Ethiopian breweries used about 118,000 tons of malt per year, whereas local malt production was 52,000 tons, accounting for approximately 45% of the domestic demand. As a result, the country was forced to spend hard currency on malt imports to meet breweries' demand. This scenario has changed as the country becomes self-sufficient in malt barley production and malt supply.

Generation of new technology and deployment of new technologies and innovations are necessary for agricultural development, particularly in an agrarian economy such as Ethiopia. Despite the release of several malt barley varieties in Ethiopia over the last four decades, farmers' access to improved barley varieties and certified seeds has been limited (Alemu & Bishaw, 2019; CSA, 2021). Among other problems, the inability to obtain the required improved variety and quality seeds at the right place and at the right time, along with a weak promotion system, account for the limited usage of improved barley technologies and innovations, which contributes to low agricultural production. The average adoption rate of improved barley varieties accounted for 41.4% in Oromia, Amhara, and Southern Ethiopia Regional States. This adoption rate can be taken as the national average, since the three regions account for more than 90% of barley production in the country. The Oromia region had the highest proportion of adopters (71%), followed by Southern Ethiopia (27.4%) and Amhara (17.1%) regions (Yigezu, 2015). As indicated in the CSA (2021) report, however, only 6% of the barley producing areas was covered by certified seeds of improved varieties during the 2020/21 main cropping season.

Since malt barley has become a commercial crop in Ethiopia, various value chain actors (farmers, farmers' cooperatives, grain traders, maltsters, and breweries) are involved from production to utilization of the crop. Therefore, the variety development and registration of the crop must consider the quality and other requirements of these actors. Accordingly, farmers adopt malt barley technology that meets their family's food, feed, and cash demand. Among the various factors that determine malt barley varietal adoption the social, economic, and institutional factors can be taken as the main variables. Similarly, recent studies have investigated the determinant factors of malt barley and other crops adoption in Ethiopia and other countries. Several authors pointed out the major factors that affect farmers' decision to adopt barley and other crops technology: barley (Abate & Abebe, 2022; Alemu & Bishaw, 2019; Kebede & Tadesse, 2015; Milkias & Muleta, 2021; Shate et al., 2021; Tigabie et al., 2013; Tufa & Tefera, 2016; Yigezu et al., 2015); wheat (Abera, 2008; Alemu, 2014; Siyum et al., 2022; Tekeste et al., 2023); rice (Hagos & Zemedu, 2015; Rahman et al., 2022); pearl millet (Okeke-Agulu & Onogwu, 2014); maize (Danso-Abbeam et al., 2017; Milkias & Abdulahi, 2018); and sorghum (Muhammed & Ibrahim, 2020). This research was proposed to fill a knowledge gap in the study target areas by focusing on the determinants of farmers' malt barley variety adoption decisions.

2 | MATERIALS AND METHODS

2.1 | Description of the study area

The adoption study was conducted in eight major barley-growing districts of the central highlands of Ethiopia during the year 2021. The survey districts were Dagem and Basona Worana from North Shewa zone, Ejere and Dendi from West Shewa zone, Digulunatijo and Limunabilbilo from Arsi zone, and Kofele and Shashemene from West Arsi zone. In total, eight districts were surveyed, one from Amhara and seven from Oromia Regional States (Table 1 and Figure 1).

2.2 | Sampling techniques and sample size

For this study, a representative sample of farm households from eight districts was chosen using a multistage sampling technique as depicted in Table 2. First, using official data of the Central Statistical Agency, five zones with the highest barley production were selected from the Oromia and Amhara regional states in central Ethiopia. The five selected zonal administrations provided 35.6% and 40.6% of the nation's total barley area coverage and production in the main cropping season of 2020/21, respectively (CSA, 2021). Second, eight districts were chosen from West Shewa, Arsi, West Arsi, and North Shewa zones (two districts from each). Third, two *kebeles* (lowest administrative units in Ethiopia) were selected from each district by agricultural experts, and finally, participant household heads were chosen at random from the *kebele* list. The total sample size was calculated using Yamane's (1967) formula.

$$n = \frac{N}{\left[1 + N\left(e^2\right)\right]} \tag{1}$$

where n is the sample size, N is the population size, and e is error tolerance (5% for this study). The overall sample size (400) was determined using the above formula from the total number of barley-growing farmer household heads in the study areas.

2.3 | Method of data collection

Primary data on malt barley variety adoption at the household level were collected using a pre-tested structured questionnaire using tablet-based technology called Computer Assisted Personal Interview (CAPI) device equipped with CSPro 7.5 (Census and Survey Processing System) software. The data were verified through key informant interviews (KII) and focus group discussions (FGD) with agricultural experts, cooperative representatives, and development agents at the *kebele* level. The questionnaire included demographic information, land

TABLE 1 Geographical location and weather data of the districts.

	Location				
Districts	Altitude (masl)	Latitude (N)	Longitude (E)	Annual rainfall (mm)	Temp. (°C)
Degem (NS)	1500–3541	9°50′	38°37′	900–1400	15–22
Ejere (WS)	2055–3935	9°2′45″	38°24′4″	1050	20
Dendi (WS)	2135–3284	8°55′	38°10′	800–2500	16–26
Basoworana (NS)	500–3200	9°49′60″	39°19′60″	950–1200	10–22
Digelunatijo (AR)	2400–2800	7°46′	39°15′	1200	10–15
Limunabilbilo (AR)	2500–4245	7°43′18″	39°17′51″	1000–1200	13
Kofele (WAR)	2685	7°4′51″	38°47′15″	1300–1500	5–20
Shashemene (WAR)	1950	7°12′4″	38°35′43″	1485	14.5

Abbreviations: AR, Arsi; NS, North Shewa; WAR, West Arsi; WS, West Shewa.

Source: Agricultural Office of each district (2021).

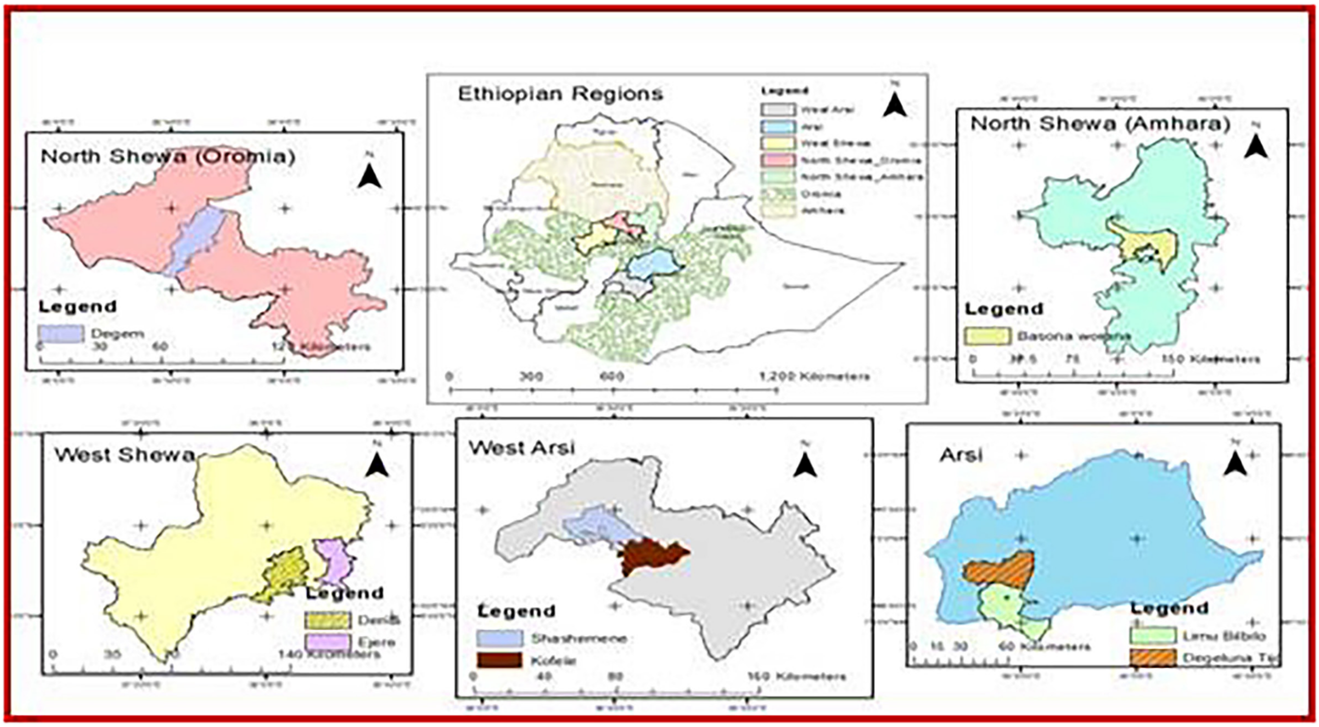

FIGURE 1 Map of the study areas for malt barley in Ethiopia.

TABLE 2 Distribution of sample farmers in malt barley study districts.

	Number of farmer household heads			
Districts	Male	Female	Total	Sample size
Degem	21,249 (88.8%)	2680 (11.2%)	23,929	53
Ejere	12,689 (87%)	1891 (13%)	14,580	33
Dendi	16,261 (84.5%)	2972 (15.5%)	19,233	43
Basoworana	20,168 (71.3%)	8133 (28.7%)	28,301	63
Digelunatijo	15,320 (84%)	2911 (16%)	18,231	41
Limunabilbilo	19,154 (85.3%)	3290 (14.7%)	22,444	50
Kofele	17,015 (80%)	4248 (20%)	21,263	48
Shashemene	21,600 (70%)	9200 (30%)	30,800	69
Total			178,781	400

Note: Numbers in parentheses indicate percentage share of gender.

Source: District Office of Agriculture (2021) and own survey data (2021).

use, crop production, knowledge of improved varieties, livestock ownership, income sources, access to inputs, and distance to markets. Secondary data were also collected from many sources (internet, publications, reports from district and zonal agricultural offices, Ministry of Agriculture, Ministry of Trade and Regional Integration, Ministry of Industry, maltsters, breweries, agricultural research centers, and seed enterprises).

This study was conducted using a cross-sectional research design. The information was collected from both primary and secondary sources. To properly collect consistent data using questionnaires, enumerators who are experienced with CAPI-based data collection and familiar with the culture and practice of the society were recruited; thereafter, orientation and briefings were given to them. Qualitative data from KIIs and FGDs were used to triangulate and substantiate the quantitative data by using a checklist.

2.4 | Data analysis

Quantitative and qualitative data collected via questionnaires were coded, cleaned, and statistically analyzed using STATA version 14 software. For data analysis, descriptive statistics and econometric models were used. Descriptive statistics such as frequency, percentage, mean, and standard deviation were utilized; additionally, for discrete and continuous variables, the chi-square and *t*-test were used. The logit model was applied to analyze the determinant factors of malt barley varietal adoption in farmer households. The model significantly contributed to estimating the association of independent and dependent variables. The binary logit model is recommended by Gujarati et al. (2004), because it provides reliable findings for discrete choice estimation as well as analyzing the factors influencing the adoption of improved technology and predicting the possibility of adoption between adopters and non-adopters.

$$\text{Logit}\left(P_i\right) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots\ldots + \beta_n X_{ni} + e_i \quad (2)$$

where P_i is a binary dependent variable (1 for technology adopters, 0 for non-adopters), X_i is the *i*th value of the independent variable, β_i is the number of parameters to be estimated, e_i is the "error" variability of the dependent variable that is not explained by the independent variable term, and n is the number of independent variables.

3 | RESULTS AND DISCUSSION

Both descriptive and econometric methods were used to analyze the data. Descriptive statistics were used to describe the demographic and socioeconomic characteristics of the sample malt barley producers and malt barley varietal adoption. Econometric analysis was also used to investigate the determinants influencing malt barley technology adoption in the central highlands of Ethiopia. Before assessing the model results, the multi-collinearity issue was investigated. There was no multi-collinearity among the explanatory variables because the mean of variance inflation factor (VIF) = 1.33 (Table 3). According to Yamane (1967), if a variable's VIF is larger than 10, it is said to be extremely collinear and multi-collinearity is a concern; if the values are close to one, we can infer that multi-collinearity is not a problem. The VIF was calculated based on the formula developed by Tobin (1955):

$$\text{VIF}\left(X_j\right) = \frac{1}{\left[1 - R_{j^2}\right]} \quad (3)$$

where X_j is the *j*th quantitative explanatory variable regressed on the other quantitative explanatory variables. R_{j^2}

TABLE 3 Variables, values, and expected signs.

Variable	Description	Value	Expected sign
Dependent			
Adoption of MB variety	MB variety used by HHH	1 = Adopter	0 = None
Independent			
Sex	Sex of the household head	0 = F, 1 = M	−/+ve
Age	Age of the household head	Years	−/+ve
Education	Educational level	1 = Lit 0 = Illit	+ve
Family size	Family members of the house	Number	+ve
Livestock owned	Number of livestock in TLU	Number	+ve
Farm income	Income (*Birr*) from farm products	Number	+ve
Off-farm income	Income (*Birr*) from off-farm	Number	−ve
Farm size	Farm size in hectare	Number	+ve
Input access	Accessibility of agricultural inputs	1 = Yes 0 = No	+ve
Experience	Experience of HHH in MB prod.	Years	+ve
Oxen ownership	Availability of oxen for plowing	1 = Yes 0 = No	+ve
Demanded variety	Access to the demanded MB variety	1 = Yes 0 = No	+ve
Market distance	Walking distance to the market	Minutes	−ve

Abbreviations: F, female; HHH, household head; Illit, illiterate; Lit, literate; M, male; MB, malt barley.

is the coefficient of determination when the variable X_j regressed on the remaining explanatory variables.

3.1 | Results of the descriptive statistics

The variables in this section are denoted by descriptive statistics such as frequency, percentage, mean, and standard deviation. Furthermore, chi-square and *t*-tests were used to evaluate the relationship between categorical and continuous variables for malt barley varietal adoption.

3.1.1 | Demographic and socioeconomic characteristics of the respondents

The summary of the descriptive statistics of continuous and categorical variables employed in this study, respectively, presented in Tables 5 and 6. The average age of a farmer household head was 40.38 years, whereas the mean age of adopters and non-adopters was 39.96 and 43 years, respectively. This finding implies that malt barley technology adopters are younger than non-adopters in Ethiopia's central highlands. One of the key continuous variables that describe farmer households is family size. The average household size in this study was 6.47, with adopters having a mean value of 6.55 and non-adopters having a mean value of 5.98, indicating that malt barley technology adopters had larger family sizes.

Farm animals provide money, food, draught power, farmyard manure, and transportation in the study areas, as they do elsewhere in the country. The number of farm animals owned by household heads was calculated using a tropical livestock unit (TLU). The average number of farm animals owned by household heads in the sample was 7.22 TLU, with mean values of 7.34 and 6.43 TLU for adopters and non-adopters, respectively (Table 5). Households with higher TLU are more likely to adopt malt barley technology.

Adopters generated 45,721 ETB (Ethiopian Birr; 1 ETB was equivalent to 0.0239 USD at the time of the survey) on average from their farm in the study year, which was much more than non-adopters (27,814 ETB); however, income generated from off-farm activities by non-adopters (41,689 ETB) was about four times greater than that of adopters (10,122 ETB). In terms of farm size, there was no statistically significant difference between adopters and non-adopters. Non-adopters travel for an average of 200 min to find a nearby market, whereas adopters walk for only 88 min (Table 4).

Table 5 presented that the level of education of the sampled household heads varied. Of the respondents, 80.5% were literate. Literacy level for adopters was higher (74%) than that for non-adopters (6.5%), indicating that educated household heads are more interested in adopting malt barley technology than non-adopters. Similarly, adopters (67.5%) had more access to agricultural inputs than non-adopters (3.75%). Respondents varied in their malt barley production experience (low <5 years; medium 5 to 10 years; high >10 years). About 71% of adopters had medium to high levels of experience with malt barley production, whereas only 6.25% of non-adopters had medium to high-level experience. Farmers with extensive experience were interested in adopting malt barley technology. From the total number of farmer household heads who participated in the study, 77.75% owned oxen for their malt barley farming activities. Among them, only 8.25% were non-adopters, whereas 69.5% were adopters. Farmers were also asked whether they had access to improved malt barley varieties based on their demand. Sixty-six percent of the participants said yes, while 34% said no. Adopters

TABLE 4 Socioeconomic characteristics of respondents for continuous variables.

	Adopters		Non-adopters		Total		
Variables	Mean	Std	Mean	Std	Mean	Std	*t*-Value
Age (year)	39.96	11.85	43	9.95	40.38	11.64	1.82**
Family size	6.55	3.38	5.98	2.05	6.47	3.23	−1.23**
TLU	7.34	3.73	6.43	1.95	7.22	3.55	−1.79NS
Farm income (ETB)	45,721	57,806	27,814	19,261	43,214	54,428	−2.3NS
Off-farm income (ETB)	10,122	24,648	41,689	59,970	14,541	73,738	6.86**
Farm size (ha)	1.56	0.94	1.52	0.59	1.55	0.9	−0.27NS
Distance (min)	87.8	120.3	199.8	102.1	103.5	124.1	6.59**

Abbreviations: NS, non-significant; Std, standard deviation.

**Significant at 5% level.

Source: Own survey data (2021).

TABLE 5 Distribution of households based on categorical variables.

		Adopters		Non-adopters		Total		
Variables	**Category**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**χ^2-value**
Sex	Male	289	72.25	48	12	337	84.25	0.11NS
	Female	55	13.75	8	2	63	15.75	
Education	Literate	296	74	26	6.5	322	80.5	48.16***
	Illiterate	48	12	30	7.5	78	19.5	
Access to input	Yes	270	67.5	15	3.75	285	71.25	62.85**
	No	74	18.5	41	10.25	115	28.75	
Experience	Low	59	14.5	31	7.75	90	22.5	48.31***
	Medium	144	36	22	5.5	166	41.5	
	High	141	35.25	3	0.75	144	36	
Access to oxen	Yes	278	69.5	33	8.25	311	77.75	13.33**
	No	66	16.5	23	5.75	89	22.25	
Access to demanded variety	Yes	252	63	12	3	264	66	57.65*
	No	92	23	44	11	136	34	

Abbreviation: NS, non-significant.

*Significant at 10%, **significant at 5%, ***significant at 1%.

Source: Own survey data (2021).

TABLE 6 Number and gender disparities in malt barley variety adoption.

	Adopters		Non-adopters		Total	
Sex	**No.**	**%**	**No.**	**%**	**No.**	**%**
Male	289	72.25	48	12	337	84.25
Female	55	13.75	8	2	63	15.75
Total	344	86	56	14	400	100

Source: Own survey data (2021).

had greater access to the demanded malt barley varieties (63%) than non-adopters (3%).

3.1.2 | Number of respondents adopted malt barley varieties

From the total sampled household heads, 86% (344) used malt barley technology while 14% (56) did not adopt it, indicating that the majority of farmers adopted the technology during the study year (Table 6). Moreover, among adopters male household heads accounted for 72.25% of the total adoption whereas only 13.75% of the overall adopters were female household heads, indicating a low level of malt barley technology adoption by female household heads.

Participant household heads obtained malt barley varieties from both formal and informal sources. Farmers' cooperatives, seed enterprises, agricultural offices of each district, agricultural research centers, and maltsters were mentioned as formal variety suppliers. Malt barley varieties were also sourced informally from other farmers, relatives, and local markets. Traveler (57.27%), IBON-174/03 (24.13%), Holker (12.21%), HB-1963 (2.62%), Fatima (1.74%), and others (2.03%) were malt barley varieties grown by farmers who adopted the technology. The frequency of varietal distribution varied across districts and households; for instance, Traveler was grown by sample farmers in all study districts except Basonaworana. Figure 2 illustrates the frequency and percentage share of malt barley varieties.

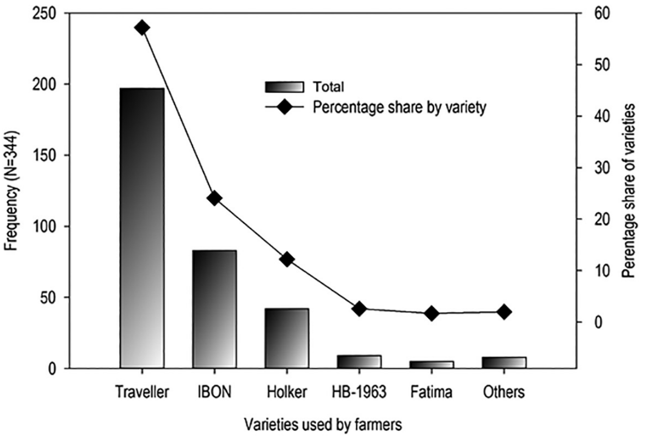

FIGURE 2 Malt barley varieties used by sample farmers.

3.2 | Econometric model analysis

This section presents the findings of an empirical investigation into the factors influencing farmers' decisions to adopt malt barley technology in Ethiopia's central highlands. Using the hypothesized explanatory variables listed in Table 7, the logit model was used to predict the probability of malt barley technology adoption. Five of the 13 explanatory variables included in the econometric model had a positive and significant influence on the adoption of malt barley technology. The results of the logit model analysis of the 400 observation are presented in Table 7. The quality of fit of the model shows acceptable pseudo-R2 of 0.5164 and significant at 1% (P=0.000) level indicating that the model fit the data well, suggesting that 51.64% of the variability of adoption of malt barley varieties can be explained by sets of variables selected from the binary logit regression model. Education, family size, input availability, experience of malt barley production, and access to demanded malt barley varieties are among these variables. On the other hand, the age of the household head, off-farm income, and market distance all had a negative and significant impact on the adoption of malt barley technology.

In this study, the age of the household head was shown to be the opposite of experience, which influenced the adoption of malt barley technology negatively. The result of the marginal effect (Table 7) showed that a 1-year increase in the age of the household head reduced the probability of farmers' decision to adopt malt barley technology by 0.13%. According to the study, younger farmer household heads adopted malt barley technology than non-adopters because they can easily search for and find current crop market prices using various information technology devices; and able to compare with other crops. Similar results were found that age has a negative impact on farmers' adoption of barley (Tufa & Tefera, 2016) and highland maize (Milkias & Abdulahi, 2018) technologies.

The educational level of household heads influences the adoption of malt barley technology in a positive and significant way. Table 6 presented the educational level of the sampled household heads varied, and 80.5% of the total respondents were literate. Literate household heads were more interested than illiterate ones in adopting malt barley technology. One more year of schooling for the household head increased the probability of adopting malt barley technology by 5.27% on average (Table 7). Based on the findings of the study, education improved farmer household heads' awareness of the benefits of adopting malt barley technology. Tigabie et al. (2013) and Kebede and Tadesse (2015) found similar results in studies of malt barley technology adoption.

The study found that household size influenced the adoption of malt barley technology at a 5% significant level.

TABLE 7 Farmers' malt barley varietal adoption logit results.

Explanatory variable	Coefficient	SE	Marginal effect (dy/dx)
Sex	−0.0674275	0.6019097	−0.0017435
Age	−0.0490725*	0.0261934	−0.0012967
Education	1.304294**	0.4720762	0.0526974
Family size	0.3011803**	0.1173849	0.0079586
TLU	−0.1272012	0.0979165	−0.0033612
Farm income	5.93e-06	6.65e-06	1.57e-07
Off-farm income	−0.0000241***	6.86e-06	−6.36e-07
Farm size	−0.0819715	0.3370735	−0.0021661
Access to input	1.510796***	0.4412833	0.0579596
Experience	1.300674***	0.3342407	0.0343698
Access to oxen	0.8056001	0.5061886	0.0268339
Access to demanded varieties	1.773033***	0.5003783	0.0675009
Distance	−0.0034465**	0.0015552	−0.0000911
Constant	−1.536633	1.232271	
No. of observations	400		
Pseudo R^2	0.5167		
LR χ^2 (13)	167.4***		
Log likelihood	−78.284596		

*Significant at 10%, **significant at 5%, ***significant at 1%.

Source: Own survey data (2021).

The marginal effect results showed that a one-person increase in household size enhanced the likelihood of adopting malt barley technology by 0.80% (Table 7). According to the findings of this research, having a larger family size is associated with receiving a larger labor grant, allowing a household to produce labor-intensive malt barley grain/seed and raising the family's standard of living. Hagos and Zemedu (2015) presented similar results for rice technology adoption.

According to the marginal effect result (Table 7), the probability of malt barley technology adoption is lowered by 636% for every unit of income obtained from sources other than the farm. The findings of this research showed that off-farm income-generating activities such as small-scale trading and off-farm employment might take most of the household's time than cultivating the crop which affected the adoption of malt barley technology. Contrary to this result, Milkias and Muleta (2021) reported that farmers who participated in off-farm activities adopted barley technology positively and significantly.

In this study, access to agricultural inputs by the surveyed household heads positively and significantly affected the adoption of malt barley technology. According to the responses of farmers who participated in this survey, certified seed, chemical fertilizers, herbicides, and other pesticides are among the agricultural inputs frequently required to increase malt barley production and productivity. Based on the marginal effect result (Table 7), a one-unit increase in agricultural input accessibility improved malt barley technology adoption by 5.80%. As a result, farmers' adoption of malt barley technology can be accompanied by an affordable and timely supply of agricultural inputs.

One of the explanatory variables that positively and significantly affect the adoption of malt barley technology is the household head's experience in the production of malt barley. According to the findings of this study, 1 year of experience in malt barley cultivation increased the adoption of improved malt barley varieties by 3.44%. Experienced farmers are more likely to adopt improved malt barley varieties because they can compare differences in yield and quality obtained using improved varieties and others. Milkias and Muleta (2021) found a positive and significant effect of experience on barley technology adoption. Similarly, Shate et al. (2021) and Abate and Abebe (2022) indicated a positive contribution of experience to the technical efficiency improvement of malt barley production which leads to a positive impact on adoption of malt barley technology.

Farmers who participated in the survey were also asked if they had access to improved malt barley varieties based on their demand; this was one of the independent variables that positively and significantly affected the adoption of improved malt barley varieties at a 1% significant level in this study. The results revealed that the adoption of malt barley technology increased by 6.75% for every unit supply of demanded malt barley variety. This result suggests that farmers who received varieties of malt barley in response to their demand were more likely to adopt the technology. The findings of Kebede and Tadesse (2015) also showed that the probability of adoption and use of malt barley technology tends to increase with an increase in access to improved varieties of the crop.

The distance traveled to the nearby market to sell commodities and buy agricultural inputs impacts the adoption of malt barley technology. In this study, the household head's travel distance to the market area has a negative and significant impact on the adoption of malt barley variety. The result of the marginal effect showed that varietal adoption declined by 0.009% for every additional minute of walking time to the local market. Based on the results of this study, farmers who are located far from a local market are less likely to adopt malt barley technology. Similarly, negative impact of market distance for the adoption of crop technologies reported by Tufa and Tefera (2016), Hagos and Zemedu (2015), Okeke-Agulu and Onogwu (2014).

4 | CONCLUSION AND RECOMMENDATION

Malt barley is evolving as a commercial crop in Ethiopia, and the farming community's acceptance of the crop is growing over time. The crop is cultivated by farmers in the highlands of Ethiopia not only as a cash crop (malt) but also as a source of food (grain) and livestock feed, and material for roof thatching (straw). As a result, farmers in the study area grow the crop for several reasons. In addition, several actors are involved in the production, processing, and marketing of malt barley grain, malt, and beer. The business is also attracting huge investments from within and outside the country. Currently, malt barley production is almost sufficient for domestic markets, and there is an opportunity to increase malt barley in terms of area and production and potential export. Therefore, strong government support and clear policy direction are necessary to encourage farmers and other stakeholders to invest more along the malt barley value chain to boost the export market.

This study investigated the factors that influence farmers' decisions to adopt malt barley technology in Ethiopia's central highlands. The educational status of the household head, family size of the household, access to inputs, mbarley production experience, and access to the demanded variety of a crop had a significant and positive influence on the adoption of malt barley technology. However, the age of the household head, income generated from off-farm activities, and distance traveled to the nearest market had a significant and negative impact on the adoption of malt barley technology. The authors have highlighted the following remarkable issues for improving malt barley demand and supply chain in general and malt barley varietal adoption in particular. These are as follows: (1) institutional support, such as providing farmers with training on improved malt barley varieties production, quality management, and marketing; supplying the necessary agricultural inputs, including desired malt barley varieties, on time and at reasonable prices; and organizing farmers for cluster farming to supply the required quantity of malt barley grain for the companies. (2) Policy assistance for malt barley producers, certified/legal dealers, and maltsters by minimizing the detrimental influence of brokers on the malt barley value chain. This study was limited due to budget restrictions and security concerns at the time of data collection. Thus, to have a clear view on the overall malt barley varietal adoption in the country, the authors recommend further investigations in major growing areas.

ACKNOWLEDGMENTS

The authors would like to thank the farmers who volunteered and gave their time for the survey, as well as agricultural experts and development agents from all districts for their coordination and professional assistance; the Holeta Agricultural Research Center staff who assisted with data collection; and the Ethiopian Institute of Agricultural Research for overall support.

FUNDING INFORMATION

No funding was received to support this research work or manuscript.

CONFLICT OF INTEREST STATEMENT

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Mekonen Haile https://orcid.org/0000-0003-3236-1962

REFERENCES

Abate, G. A., & Abebe, E. A. (2022). Technical efficiency of malt barley production in Estie Woreda, Amhara region of Ethiopia. *Bahir Dar Journal of Business and Economics*, *2*, 44–69.

Abera, H. B. (2008). *Adoption of improved* tef *and wheat production technologies in crop-livestock mixed systems in northern and western Shewa zones of Ethiopia*. University of Pretoria. https://repository.up.ac.za

Alemu, D., & Bishaw, Z. (2019). *Varietal adoption and seed commercial behavior: Barley seed system landscape in the highlands of Ethiopia*. Working paper 2019-2. Beirut, Lebanon: International Center for Agricultural Research in the Dry Areas (ICARDA). ISBN: 978-92-9127-532-8.

Alemu, D., Kelemu, K., Lakew, B., & Kelemework, F. (2014). *Value chain analysis of malt barley in Arsi and west Arsi zones of Oromia region*. Self Help Africa.

Alemu, T. (2014). *Adoption and impact of improved agricultural practices and wheat production efficiency of smallholders in the Arsi zone of Ethiopia*. Haramaya University.

Central Statistical Agency (CSA). (2021). *Agricultural Sample Survey 2020/21*. Report on the Area and Production of Major Crops (Private Peasant Holdings, Meher Season). Volume I. Addis Ababa, Ethiopia. Statistical Bulletin 590.

Danso-Abbeam, G., Bosiako, J., Ehiakpor, D., & Mabe, F. (2017). Adoption of improved maize variety among farm households in the northern region of Ghana. *Cogent Economics & Finance*, *5*(1), 1416896.

FAOSTAT. (2023). *FAO Statistical Databases (Food and Agriculture Organization of the United Nations)*. http://www.fao.org/faostat/en/#data/QC.

Fekadu, A., Berhanu, B., Fekadu, F., Adise, N., & Tesfaye, G. (1996). Malt barley breeding. In H. Gebre & J. Van Luer (Eds.), *Barley research in Ethiopia: Past work and future prospects* (pp. 24–33). In: Proceedings of the First Barley Research Review Workshop, 16–19 Oct. 1993, Addis Ababa, IAR/ICARDA. Addis Ababa, Ethiopia.

Food and Agriculture Organization of the United Nations (FAO). (2023). *Food Outlook – Biannual report on global food markets*. Rome. https://doi.org/10.4060/cc3020en

Gujarati, D. N., Bernier, B., & Bernier, B. (2004). *Econometrica* (p. 17-5). De Boeck.

Hagos, A., & Zemedu, L. (2015). Determinants of improved rice varieties adoption in Fogera district of Ethiopia. *Science, Technology and Arts Research Journal*, *4*(1), 221–228.

Kebede, W., & Tadesse, D. (2015). Determinants affecting adoption of malt barley technology: Evidence from North Gondar, Ethiopia. *Journal of Food Security*, *3*, 75–81. https://doi.org/10.12691/jfs-3-3-2

Lakew, B., Yirga, C., & Fikadu, W. (2016). Malt barley research and development in Ethiopia: Opportunities and challenges. *Agricultural research for Ethiopian renaissance*. In: A. Dawit, D. Eshetu, A. Getnet, & K. Abebe (Eds.), Proceedings of the National Conference on agricultural research for Ethiopian renaissance held on January 26–27, 2016, in UNECA. Addis Ababa to mark the 50th Anniversary of the establishment of the Ethiopian Institute of Agricultural Research (EIAR).

Milkias, D., & Abdulahi, A. (2018). Factors influencing intensity of adoption of improved highland maize varieties: The case of Toke Kutaye District, West Shewa Zone, Oromia regional state, Ethiopia. *Journal of Economics and Sustainable Development*, *9*(15), 1–9.

Milkias, D., & Muleta, G. (2021). Economic analysis of factors influencing adoption of barley HB1307 variety in western Shewa highlands: The case of Elfeta District. *International Journal of Agriculture and Biosciences*, *10*(2), 94–100.

Ministry of Agriculture (MoA). (2021). *Plant variety release, protection and seed Qual1ty control directorate*. Crop Variety Register Issue No. 24, Ministry of Agriculture, Addis Ababa.

Muhammed, N. K., & Ibrahim, T. S. (2020). *Determinants of adoption of improved sorghum varieties* (Sorghum bicolor) *among households in Niger State, Nigeria*. http://repository.futminna.edu.ng:8080/jspui/handle/123456789/2772. ISSN: 0300-368X

New Business Ethiopia (NBE). (2017). *Ethiopia to end malt import boosting local production*. https://newbusinessethiopia.com/manufacturing/Ethiopia-to-end-malt-import-boosting-local-production/

Okeke-Agulu, K., & Onogwu, G. (2014). Determinants of farmers' adoption decisions for improved pearl millet variety in Sahel savanna zone of northern Nigeria. *Journal of Development and Agricultural Economics*, *6*(10), 437–442.

Rahman, M. S., Sujan, M. H., Acharjee, D., Rasha, R., & Rahman, M. (2022). Intensity of adoption and welfare impacts of drought-tolerant rice varieties cultivation in Bangladesh. *Heliyon*, *8*(5), e09490. https://doi.org/10.1016/j.helion.2022e09490

Shate, A. E., Tefera, T., & Gidey, G. (2021). Technical efficiency of malt barley production in Malga District of Southern Ethiopia. *Innovative Systems Design and Engineering*, *12*(1), 16–21.

Siyum, N., Gizaw, A., & Abebe, A. (2022). Factors influencing adoption of improved bread wheat technologies in Ethiopia: Empirical evidence from Meket District. *Heliyon*, *8*(2), e08876. https://doi.org/10.1016/j.heliyon.2022.e08876

Tekeste, K., Degefa, T., Admasu, S., & Dawit, A. (2023). Determinants of adoption of improved varieties of wheat (*Triticum aestivum*), Teff (*Eragrostis teff*), and maize (*Zea mays* L.) in Central Ethiopia. *Journal of Agricultural Extension*, *27*(2), 1–14.

Tigabie, A., Yirga, C., & Haji, J. (2013). *Determinants of malt barley technology adoption in the case of Oromia, Ethiopia* [MSc thesis]. Haramaya University.

Tobin, J. (1955). *Estimation of relationships for limited dependent variables*. Cowles Foundation Discussion Papers. 220. https://elischolar.library.yale.edu/cowles-discussion-paper-series/220

Tufa, A., & Tefera, T. (2016). Determinants of improved barley adoption intensity in Malga District of Sidama Zone, Ethiopia. *International Journal of Agricultural Economics*, *1*(3), 78–83.

Yamane, T. (1967). *Statistics: An introductory analysis* (2nd ed.). Harper and Row. In: Otabor Joseph Osahon, Obahiagbon Kingsley. Statistical approach to the link between internal service quality and employee job satisfaction: A case study. *American Journal of Applied Mathematics and Statistics*. Vol. 4, No. 6, 2016, pp 178–184.

Yigezu, Y., Yirga, C., Testaye, A., & Aw-Hassan, A. A. (2015). *Adoption study of improved barley varieties in Ethiopia*. Ethiopian Institute of Agricultural Research (EIAR), International Center for Agricultural Research in the Dry Areas (ICARDA). https://mel.cgiar.org/reporting/download/hash/LaZP2aPb

How to cite this article: Haile, M., Abay, F., Bishaw, Z., Lakew, B., & Tsehaye, Y. (2024). Determinants of malt barley varietal adoption decisions of farmers: Evidence from the central highlands of Ethiopia. *Food and Energy Security*, *13*, e560. https://doi.org/10.1002/fes3.560