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Determinants of Participation and Extent of Participation in Contract Farming Among Smallholder Malt Barley Farmers in Oromia Region, Ethiopia: A Double Hurdle Approach

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Abstract

The study examined contract farming participation intensity determinants among small-scale malt barley farmers in the Arsi Highlands, Oromia Region, Ethiopia. Data was gathered from 384 sample respondents using a multistage sampling procedure. Age, livestock ownership, crop output, price, advice service, cooperative membership, and credit were found to be major determinants of probability of contract farming participation. However, total land size and farming experience negatively determined the likelihood of participation in contract farming. The contract participation intensity was defined by educational level, landholding size, production selling price, amount of fertilizer applied, and off-farm income. It is discovered that smallholder producers of malt barley are increasingly drawn to contract farming. It is anticipated that the trend will continue, bringing about more awareness of the advantages of contract farming as well as better access to and utilization of agricultural input supplies.

Keywords: Contract farming, participation, intensity, Oromia, Ethiopia

Introduction

Poverty alleviation and economic growth drive transformation of subsistence agriculture in Ethiopia (Admassie *et al.*, 2016; Atakilte, 2018). Agriculture development flagship programs that include agricultural commercialization clusters; irrigated wheat production; ten in ten; ye lemat tirufat; the green legacy; and integrated soil fertility management practices put in place to achieve food system transformation.

Initiatives for the commercial transformation of subsistence agriculture attract the involvement of private companies in diverse sectors, including multinational beer companies, including Heineken, Diageo, Bavaria, and Soufflet in Ethiopia (Holtland, 2017; Tefera and Bijman, 2021). These multinational breweries renovated and upgraded old breweries, which led to soaring malt demand in the country. To bridge the gaps in malt demand, actors in the upstream (malt barley farmers) and midstream (malt factories and breweries) and downstream (retailers)

began collaborating more closely through contractual agreements to create a local malt barley supply chain in Ethiopia. The malt barley supply focuses on organizing farmers in such a way as to provide technology like seeds of improved varieties for malt barley production, training, and other support so that farmers, in return, are expected to supply quality products deemed necessary for malting on a contractual basis.

The barley subsector in Ethiopia employs 3,630,719 barley farm holders who manage 799,127.84 hectares of land as one of their primary sources of income (CSA, 2022). Nevertheless, the barley sub-sector has been characterized by a number of intricate production, marketing, and financial limitations, such as high transaction costs associated with gaining access to markets, new technology, information, and inputs (Shiferaw et al., 2022; Dagnew et al., 2024). On account of these, the barley sub-sector is defined by strong demand and limited supply of the malt raw material and the grain as a whole. The upgrading of breweries and malt mills, along with a shift in consumer behavior toward higher beer consumption, is driving up demand for malted barley. Breweries and malt makers must consequently expand the scope of their malt procurement programs to fulfill the increased demand for malted barley. Despite widespread promotion of malt barley contract farming in major barley producing regions, farmers' engagement as net sellers in the output market remains relatively low (Gebru et al., 2019; Dagnew et al., 2024). In light of this, the study set out to look into the variables that affect farmers' involvement in contract farming in the research areas, as well as the extent of participation towards the national plan of import substitution and saving foreign currency expenditures.

Research Methodology

Descriptions of the Study Area

The study was carried out in the Oromia Region of Ethiopia in the Tiyyo and Limu Bilbilo districts of the Arsi zone and the Kofele and Shashemene districts of the west Arsi zone. From an astronomical perspective, the zones are located between 7°08'58" N and 8°49'00" N latitude and 38°41'55" E and 40°43'56" E longitude. The research areas experience an annual mean rainfall ranging from 1020 mm to 1300 mm. The research region offers ideal edaphic and climatic conditions for agricultural output. Wheat, barley (food and malt), beans, peas, maize, teff, sorghum, oats, chickpeas, noug, linseed millet, potatoes, and other vegetables are among the principal annual crops farmed in the two zones (Oromia Finance and Economic Development Bureau (OFEDB), 2019).

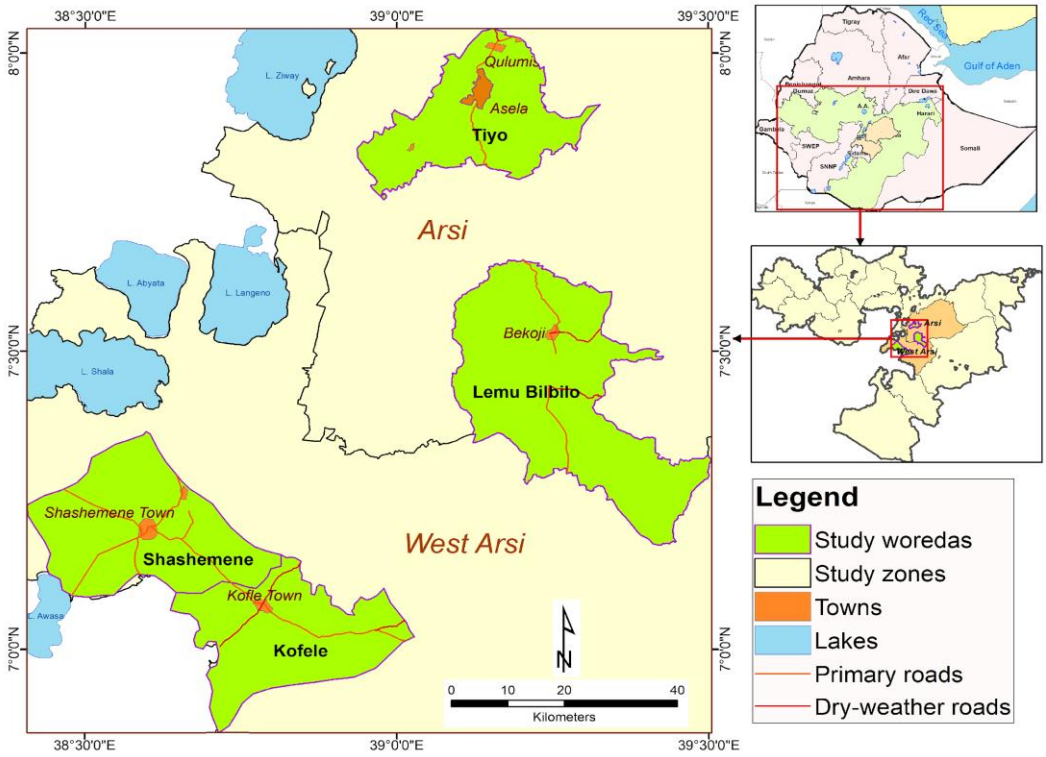

Figure 1. Map of the study area (Arsi and West Arsi zones)

Sampling Methods and Sample Size

The potential for malt barley production, the existence of contract farming practices, and the scheme's potential for scaling up were the factors taken into account while selecting the sample. Thus, the Arsi and West Arsi zones were purposively selected owing to their current potential for producing malt barley and presence of contract farming. Additionally, from each zone two districts, Lemu-Bilbilo and Tiyyo as well as Kofele and Shashemene were selected at random, respectively. The number of kebeles producing malt barley and their marketing profiles were used for randomly selecting two kebeles from each district. Then lists of malt barley producer households obtained from the respective kebeles and a simple random sampling technique was employed to determine the appropriate number of respondents in each kebele.

Accordingly, a representative sample size for the study was determined using the population size of malt barley producers obtained from district agricultural offices. A representative sample size was determined employing the formula provided by Kothari (2004):

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

$$n = \frac{(1.96)^2\ (0.5)\ (0.5)\ (92{,}286)}{(0.05)^2\ (92{,}286)\ +\ (1.96)^2\ (0.5)\ (0.5)} \approx 384$$

Where n is the required sample size, e is the desired level of precision, Z is the inverse of the standard cumulative distribution that corresponds to the confidence level, p is the estimated proportion of an attribute that is present in the population, and q = 1-p. The statistical Table, which includes the area under the normal curve at a 95% confidence level and p = 0.5, given by Kothari (2004), is where the value of Z can be determined. On the basis of this, 384 homes in total were chosen for the study from four districts; q = 1-p; N is the size of the whole population from which the sample was obtained; and a 95% confidence level and ± 5% precision were assumed. Finally, a sample of 384 (190 contract and 194 non-contract) household heads was drawn from eight Kebeles using simple random sampling with probability proportionate to size (see Table 1).

Table 1. Selected study districts, [1]Kebele and household sizes

District	Sampled *Kebele*	Household size	Sample households	Contract farming	
				CF	NCF
Limu Bilbilo	Chiba Michael	1323	90	23	23
	Limu Dima	1261		21	21
Tiyyo	Haro Bilalo	1,233	84	19	19
	Dosha	1,358		23	23
Kofele	Gurmicho	1,203	92	22	22
	Alkaso	1,249		24	24
Shashemene	Hursa Simbo	1037	118	31	32
	Gonde Karso	946		28	29
Total		9,610	384	190	194

CF = contract farming participants, while NCF is the farmers' producer for open market
Source: Agriculture Office

Sources and Methods of Data Collection

Both primary and secondary data were utilized for this study. A total of 384 malt barley farmers were contacted as the primary data source through face-to-face personal interviews. The respondents to the household survey were 190 contract participants. For comparison purposes, 194 non-contract malt barley farmers were

[1] Kebele is the smallest administrative division in Ethiopia.

randomly selected from the study area based on households' lists available at the respective study *Kebeles*. The interview schedule consisted of both open and closed-ended types of questions so as to collect information pertinent to the purposes of the study. Detailed household and plot-level data were gathered accordingly to allow statistical analysis of the quantitative data, given the available time and resources.

Methods of Data Analysis

In this study, descriptive and inferential statistical methods were utilized where deemed appropriate for the data attribute. Analytical methods that address each study objective are presented below.

Descriptive Analysis

Statistical inference and descriptive analysis were used in this research data analysis. Inferential statistical techniques, including the $\chi 2$-test and t-test were employed to compare household and farm characteristics between contract farming participants and non-participants. The household and farm profiles of the research areas are characterized using descriptive statistical methods such as averages, ratios, percentages, and frequencies.

Model specification for determinants of contract farming participation

In empirical studies on the determinants of farmers' participation in contract farming, diverse econometric models have been employed. The Probit, Tobit, Heckman, and double hurdle models have all been alternatively used to test determinants of involvement in contract farming (Komarek, 2010; Wang *et al.*, 2011; Abebe *et al.*, 2013; Ochieng *et al.*, 2016). The econometric approach to be used depends on the nature of the response variable. Participation in contract farming is a dependent variable that was analyzed in this study. Where contract farming participation status was denoted by 1 if the household head participated in contract farming in previous cropping period and 0 otherwise.

But the biggest issue with utilizing survey data to evaluate participation decisions is the sizable fraction of households reporting no adoption or participation. Traditionally, zero observations have been handled using the Tobit model, which was first developed by Tobin in 1958. However, it has limitations because the same variables and parameters that influence the probability of participation also control the levels of involvement. This assumption implies that the direction (sign) of a particular determinant's marginal effect is the same for smallholder farmers' involvement as well as the intensity of their engagement when they make the decision to participate (Burke, 2009). When modeling smallholder farmers' involvement in contract farming, this isn't a reasonable assumption to make.

Therefore, more adaptable models are needed to enable distinct procedures for identifying the variables that influence farmers' decisions on involvement as well as the degree of involvement. A binary variable is used to denote contract farming participation. Participants could not, however, get all of their barley sales through the program. The double-hurdle (DH) model (Cragg, 1971) that we employed suggests that the choice of whether to sell through the contract and the choice of how much to sell are independent choices. These choices are selected one after the other and may go through two distinct decision-making processes (Bellamare and Barrett, 2006). Therefore, the double hurdle model combines a zero-truncated continuous distribution to forecast non-zero values with a binary model to predict zero values. The amount of barley sold through contract farming is used for the second obstacle. According to Green (2003), a generalization of the Tobit model, the double-hurdle model features two independent stochastic processes that decide whether to participate and how intensely. For example, Hailemariam et al. (2006) found that a variety of factors affect the choice and rate of adoption of poultry technology. Further studies employing the model include the fertilizer adoption in Ethiopia study by Gebregziabher and Holden (2011), Kehinde and Adeyemo (2017), and Shiferaw (2008), which determined the reasons behind farmers' reluctance to adopt suggested technologies in the production systems of cocoa and pigeon pea in Nigeria and Tanzania, respectively.

While there are some similarities between the Heckman procedure and the double-hurdle model's parameterization in that both methods yield two distinct sets of parameters, the double-hurdle model is thought to be less constrictive. This is so because non-participants in the Heckman model will never, ever participate. On the other hand, non-participants in the double-hurdle model are viewed as a cornerstone solution in a utility-maximizing model (Yami et al., 2013). The double-hurdle model for contract participation assumes that smallholder farmers who voluntarily choose not to engage in contract farming are the source of the zero values reported in the first hurdle, while smallholder farmers who voluntarily choose to sell malt barley through contractual arrangements are the source of the values reported in the second hurdle.

The double-hurdle model, which assumes that the decision to engage in contract farming and the level of participation were controlled by two distinct stochastic processes, calls for the combined use of the Probit and the truncated regression models. A normal Probit model is used to estimate the formal model of the first hurdle, which is the participation choice given below:

$$D_i^* = \alpha' Z_i + \mu_i \qquad (2)$$

$$D_i = 1, if\ D_i^* > 0\ and\ 0\ if\ D_i^* \leq 0$$

D_i^* is a latent variable that takes the value 1 if the farmer sells malt barley via contractual arrangements and zero otherwise; and α is a vector of parameters. Z is a vector of explanatory variables that include demographic, socio-economic, and governance-related factors, while μ is a vector of error terms. The formal model of the second hurdle or intensity of participation equation is presented as:

$$Y_i^* = \beta' X_i + \mu_i \quad (3)$$

$$Y_i = Y_i^*, if\ Y_i^* > 0\ and\ if\ D_i^* > 0,$$

$$Y_i = 0, otherwise$$

$Y_i^*\ and\ Y_i$ are the observable and hidden involvement levels in contractual agreements, respectively. The percentage of malted barley sold to each contracting partner was used to evaluate the level of involvement in the agreements. β is a vector of parameters to be estimated and X_i is a vector of variables impacting the household intensity of participation in contractual arrangements, including governance-related, socioeconomic, and demographic aspects, while μ is a vector of error terms.

Table 2. Summary of explanatory variables

Dependent variables			**Measure**	
First hurdle: Contract farming participation status			Dummy: Yes = 1, otherwise =0	
Second hurdle: Extent of contract farming participation			Continuous variable denoted by quantity of malt barley sold in quintals	
Explanatory variables			Hypothetical sign of influence on dependent variables	
Code	Descriptions	Measurement (unit)	Participation decision making in CF	Extent of contract farming participation
GENDER	Sex of the respondent	1 for male respondents married, and 0 for female respondent	Positive or negative	Positive or negative
RESPAGE	Respondent's age	Year	+/ -	+/ -
EDUCS	Educational level of the household head	Number of school years completed	+/ -	+/ -
MASTS	Marital status	1 married, 0 otherwise	+	+
HHSIZ	Number of family members	Number	+	+/ -
FASIZ	Cultivated farm size	Hectare	+	+
LIVES	Livestock ownership	TLU	+	+
COPMEM	Cooperative membership	Yes = 1, otherwise =0	+	+
CRACS	Credit access	Yes = 1, otherwise =0	-	+/ -
ADVIS	Access to advisory service	Yes = 1, otherwise =0	+	+
OFINC	Off/non-farm income	Birr/year	+/ -	+
MBFEX	Barley farming experience	Year	+	+
YIELD	Yield	Q/ha	+	+
DMKT	Distance to market	Number of minutes	+	-
PRICE	Price for 1 quintal barley	Birr/Qt	+	+
ACSIV	Access to imp. varieties	Yes = 1, otherwise =0	+	+
ACSTR	Access to training	Yes = 1, otherwise =0	+	+
NUMCC	Number of crops cultivated	Number	-	+
CFP	Contract participation	Yes = 1, otherwise =0	+	+
LEVCOM	Level of commercialization	Number	+	+/ -

Source: Literature review

Results and Discussion

Descriptive Statistics

The study comprises a sample of 384 farm household heads. From the sample, about half, i.e., 49.50%, were contract farmers, while 50.50% were non-contract malt barley farmers. The average age of the total sample household heads is 45 years old, which indicates that farm household heads were at their productive

ages. The average schooling level of the total sample household heads is 6th grade. Only 20.05% of the respondents have completed secondary education. Generally, the level of education among malt barley farmers is basically considered to be low. The average family size of the total sample household heads is 7 persons, which is higher than the national average family size of 4.6 members. A larger family size guarantees that family labor is available when needed for agricultural tasks and lowers the expense of hiring labor, which could be one cause.

Analysis of socio-economic status of the households' indicated that the average landholding size for sampled household heads was 1.84 hectares. The livestock holding size in Tropical Livestock Unit was 7.26 for sample households. Distance travel to get various inputs and services determine information access and adoption decisions, accordingly the average travel time taken to reach the main road for the total sampled of household heads is 26.74 minutes. Mekonnen and Alamirew (2017) found that farmers near all-weather roads had a 19% commercialization index, while their remotely located counterparts recorded a 16% commercialization index. On average the farm size allocated for malt barley production by the total sample household heads was 0.74 hectares. Also, the average farm size allocated for malt barley production by contract and non-contract farmers was 0.83 ha and 0.66 ha, respectively. The t-test mean comparison indicated a significant difference: farmers with larger malt barley farm sizes are more involved in contract farming. Research indicates that the size of a land holding affects both the amount and the participation in contract farming, as demonstrated by studies conducted on rice and maize contract farming in Ghana and Benin, respectively, by Olounlade et al. (2020) and Ragasa et al. (2018).

Of the total sample household heads, 94.79% were male, while 93.68% and 6.32% were male and female-headed farm households that participated in malt barley contract farming, respectively. Descriptive statistics show that a household headed by male is in a better position to participate in contract farming than a household headed by female. The majority, or 83.59%, participated in improved crop production and protection technique trainings at least once in the previous cropping period. Participation in agro-industrial supply chains such as breweries or malt factories heavily requires production of quality, volume, and timely supply of products, which can be realized through getting training to be knowledgeable to that end. Access to and use of quality inputs such as improved varieties have been one of the most blamed constraints to realizing the maximum crop production potential in general and barley production in particular. About 86% of contract farmers utilized high-yielding improved malt barley seeds as compared with 79.38% of non-contract farmers. Literature documents the positive role of cooperative membership for farmers in information access, input and output markets, technology, etc. Out of the sampled households, only 53% were cooperative

members. Access to credit and other extension services are expected to attract and link farmers with coordinated market chains and ease liquidity and input supply. Only 25% of the sample households had a chance of using financial services. Comparing malt barley farmers in terms of their access to and use of financial services, significant differences were observed: farmers selling their malt barley production through formal agreements were in a better position in terms of access to and use of financial services. It was found that farmers selling their malt barley production through formal agreements were 37 percent, while their counterparts were only 12 percent.

Table 3. Summary of demographic and socioeconomic variables

Item		Non-contract farmers		Contract farmers		T-Test
		Average	SD	Average	SD	
Respondent age		43.40	11.10	46.00	11.10	-2.02**
Family members		6.88	3.00	7.77	3.02	-2.90***
Educational level of the household head (grade completed)		6.07	3.37	6.13	3.59	-0.18
Landholding (ha)		1.70	1.66	1.98	1.46	-1.77*
Malt barley farm size (ha)		0.66	0.60	0.83	0.52	-2.88***
Household income (Birr/year)		48045	51292	86203	58317	-6.80***
Distance to main road (Min.)		30.03	18.17	23.53	18.76	3.44***
Livestock size (TLU)		6.84	4.28	7.69	4.31	-1.94*
Amount of credit used (Birr)		179.28	472.79	707.96	946.92	-6.90***
Variable	Item	NCF	Percent	CF	Percent	$\chi^2 - test$
Gender	Female	8	4.12	12	6.32	
	Male	186	95.88	178	93.68	0.93
	Total	194	100	190	100	
Marital status	Unmarried	9	4.64	12	6.32	
	Married	185	95.36	178	93.68	0.52
	Total	194	100	190	100	
Participation of training	Yes	140	72.16	181	95.26	
	No	54	27.84	9	4.74	37.34***
	Total	194	100	190	100	
Association in cooperative	Yes	57	29.38	146	76.84	
	No	137	70.62	44	23.16	86.77***
	Total	194	100	190	100	
Getting to credit	Yes	24	12.37	70	36.84	
	No	170	87.63	120	63.16	31.09***
	Total	194	100	190	100	
Having improved seeds	Yes	154	79.38	164	86.32	
	No	40	20.62	26	13.68	3.24*
	Total	194	100	190	100	

Note: NCF: Non-contract farming; CF: Contract farming; ***, **, and * represent significant t-test results at 1%, 5%, and 10% levels, respectively.
Source: Estimated from survey data

Table 4. Demographic and social networks

Item	List	Number of respondents		Non-contract farmers		Contract farmers		$\chi^2 - test$
		No.	Percent	No.	Percent	No.	Percent	
Gender	Female	20	5.21	8	4.12	12	6.32	
	Male	360	94.79	186	95.88	178	93.68	0.93
	Total	384	100	194	100	190	100	
Marital status	Unmarried	21	5.47	9	4.64	12	6.32	
	Married	363	94.53	185	95.36	178	93.68	0.52
	Total	384	100	194	100	190	100	
Participation of training	Yes	321	83.59	140	72.16	181	95.26	
	No	63	16.41	54	27.84	9	4.74	37.34***
	Total	384	100	194	100	190	100	
Association in cooperative	Yes	203	53	57	29.38	146	76.84	
	No	181	47	137	70.62	44	23.16	86.77***
	Total	384	100	194	100	190	100	
Getting to credit	Yes	94	24.48	24	12.37	70	36.84	
	No	290	75.52	170	87.63	120	63.16	31.09***
	Total	384	100	194	100	190	100	
Having improved seeds	Yes	318	82.81	154	79.38	164	86.32	
	No	66	17.19	40	20.62	26	13.68	3.24*
	Total	384	100	194	100	190	100	

Note: *** and ** represent significant t-test results at 1%, 5%, and 10% levels respectively.
Source: Estimated from survey data

Results of Econometric Analysis

Determinants of contract farming participation and its intensity

Factors that affect smallholder farmers' participation decision and intensity of participation in malt barley contract farming were examined using a double hurdle model. The first hurdle (Probit model) results on the determinants of malt barley contract participation decision, the Likelihood ratio (LR) of 107.94 is significant at p<1%. This suggests the combined importance of the explanatory factors contained in the model. Similarly, outcomes of the reduced regression models that were computed and displayed in Table 5 below shows that LR of 356.14 of the fitting models for information produced by malt barley contract farming was significant at p<1%. This indicates the joint significance of the explanatory variables in influencing the intensity of participation in contract farming. Yet, the results expose that there is some variation in the outcomes of the Probit and truncated regression models, and the factors that determined the variables that affected the farmers' choice to engage in contract barley farming were not quite the same as those that affected their level of involvement. This explains why the double-hurdle model is appropriate for analyzing farmers' involvement in malt barley contract farming. Below are brief discussions of the significant focal points.

Table 5. Determinants of contract farming participation and its intensity

Variables	Probit Regression (1st Hurdle)			Truncated Regression (2nd Hurdle)			
	Coef.	RStd. Err	dy/dx	Variables	Coef.	RStd.Err	dy/dx
Sex	0.145	0.399	0.056	Sex	-2.878	1.958	1.96
Age	0.020*	0.010	0.008	Age	0.046	0.063	0.06
Educational	0.011	0.030	0.004	Educational	0.322**	0.161	0.16
Household size	0.008	0.033	0.003	Household size	-0.485**	0.200	0.20
Land holding size	-0.173**	0.076	-0.067	Land holding size	24.810***	2.407	2.41
Livestock ownership (TLU)	0.061**	0.026	0.024	Livestock ownership (TLU)	-0.444*	0.245	0.25
Malt barley farming experience	-0.044**	0.019	-0.017	Malt barley price	0.012***	0.003	0.00
Distance to market	0.012**	0.005	0.005	Access to advisory service	-2.545*	1.556	1.56
Access to advisory service	0.981***	0.282	0.329	Access to chemical fertilizers	0.135***	0.034	0.03
Access to chemical fertilizers	0.005	0.004	0.002	Cooperative membership	3.327**	1.103	1.10
Cooperative membership	1.097***	0.175	0.408	Access to credit	-3.532***	1.283	1.28
Access to credit	0.889***	0.208	0.343	Off/non-farm income	0.000**	0.000	0.00
Off/non-farm income	0.000	0.000	0.000	_cons	-14.184	4.326	
Constant	-3.116	0.738		/sigma	9.674	0.731	
Number of obs = 303				Number of obs = = 303			
Log pseudo-likelihood = -147.02137				Log pseudolikelihood = -1117.5661			
Wald $chi^2(15)$ = 83.75				Wald chi2(12) = 363.20			
Prob > chi^2 = 0.000				Prob > chi2 = 0.0000			
Pseudo R^2 = 0.2932							

Significance: *** p<0.01, ** p<0.05, * p<0.1
Source: Analysis of survey data

Age of the household head: Age was statistically significant and positively influenced farmer's contract farming participation decision but was insignificant in influencing intensity of contract farming participation. The implication is that as the age of a farmer increases, he/she is more likely to participate in contract farming. This result is found to be inconsistent with the study of Alene *et al.* (2008), which revealed that as one grows older, risk-taking decreases, which could also decrease chances of contract farming participation. This could be because older farmers would have developed greater experience, networks, and trust that would allow them to participate in contract farming.

Educational level of the household head: Education had a significant and positive coefficient at p<5% in influencing farmer's malt barley contract farming participation intensity but was insignificant in determining participation decision. The implication is that farmers with higher levels of education were more likely to raise the volume of malt barley sales in contract farming. This result is in line with findings of Awotide *et al.* (2016) and Nhan (2019), who found that education positively determines the rice market's participation intensity in Nigeria and Vietnam, respectively.

Landholding size: The estimated coefficient of total land size significantly determined both contract farming participation and its intensity negatively and

positively at p<1%, respectively. This shows an inverse relationship between farm size and the likelihood of a decision to participate in contract farming. But once a farmer made the choice to engage in contract farming, the intensity of sales volume relied on farm size. This contradicts the theory and the findings of a prior study conducted by Khan et al. (2019), which indicated that farmers allocated their land for crops that responded to market signals in proportion to their land ownership. However, Rao *et al.* (2017) could not find a significant difference in farm size between contracted and decision-contracted farmers in India.

Livestock holding size (TLU): The livestock holding size (TLU) of a household has shown a significant influence on contract farming participation decisions positively, but the extent of participation negatively, at p<5% and p<10%, respectively. The size of the livestock holding had a positive and significant coefficient, at less than five percent, influencing the farmer's contract farming participation decision. A large herd of animals demonstrates status and serves a variety of social and economic purposes. Farmers may find it easier to finance the investment necessary to enter contract farming if they have enough cattle. Studies show the mixed influence of livestock holdings on contract farming participation. For instance, Khan *et al.* (2019) did not find any significant relationship between livestock holding and farmers' maize and potato contract farming participation decisions in Pakistan. In contrast, Muroiwa et al. (2018) found a favorable correlation between farmers' decisions to engage in contract farming in Zimbabwe and their ownership of cattle.

Malt barley farming experience: Malt barley farming experience was statistically significant but negatively determined both contract farming participation decision at <5%. That is a 1 year increase after 6 years of average malt barley farming experience; the probability of participation decision decreases, keeping other covariates unchanged. But studies present mixed results; for instance, Maertens and Velde (2017) observe that farmers with previous experience in cotton farming are more likely to participate in contracts; Ruml *et al.* (2022) find no significant influence of experience on participation and its intensity between rice contract and non-contract farmers. Azumah *et al.* (2016) revealed that rice farming experience negatively affects farmers' contract farming participation and intensity.

Access to advisory service: The variable access to agricultural advice was statistically significant and exerted a positive influence on contract farming participation decisions at <5% and but with significant negative influence on intensity of participation at <10%. The implication is that with improved access to advisory services, so does contract farming participation inclination but not the intensity. In line with this study, Abebe *et al.* (2013) attested that farmers

participate in contract farming as they seek various supports that enhance farmers' knowledge about improved production systems.

Access to chemical fertilizers: The variable quantity of fertilizer applied showed strong insignificant influence on intensity of contract farming participation at <1%. This implies that quantity of fertilizer applied is directly associated with quantity of malt barley sales, as marketable surplus production is a function of input use, including improved varieties and chemical fertilizers. Consistent with the finding, Shiferaw *et al.* (2014) underline the importance of adoption of improved varieties, fertilizers, and pesticides to increase quantity and quality of product sales.

Cooperative membership: Both the decision to participate in contract farming and the extent of participation were statistically significantly influenced by the cooperative membership variable. The marginal effect indicates that, as a farmer who is a member of an effective cooperative, the probability of participation in malt barley contract farming increases by 41%. The results are in line with those of Mishra et al. (2018), who discovered that cooperatives function as a middleman to facilitate transactions between farmers and major food processors. This is because these associations are adept at mediating conflicts of power between smallholder farmers and big enterprises. Moreover, farmer cooperatives are believed to facilitate agricultural service delivery, raise productivity, and link farmers to better markets (Ahmed and Mesfin, 2017).

Access to credit: Access to credit positively and significantly determined contract farming participation decisions, but against the expected signs and influence on intensity of participation. The study indicated that, if one changes from no credit access to credit access, the predicted probability of contract farming participation increases by 41%. As expected, farmers with access to credit, either in monetary terms or in kind, are likely to be motivated to participate in contract farming. Also, Mishra et al. (2018) support that contract farming offers incentives to boost a commodity's output through improved seeds, technical support, credit availability, and input access. It also improves the coordination of activities along value chains, the perceived favorability of transactions, dependability, and capacity to deliver on commitments.

Off/non-farm income: Off/non-farm income positively and significantly influenced intensity of contract participation at p<1%. Studies show mixed effects on contract farming participation. It is considered that high- and low-income earners can easily mobilize productive resources, devise more diversified enterprises and likely exit from farming (Randela *et al.*, 2008). Bellemare and Bloem (2018) provide further evidence that off-farm income alleviates financial

limitations, especially for resource-poor farmers, allowing them to buy items that increase production. Farmers who earn more income from off-farm or non-farm activities could seek to maximize that income, giving less attention to their farm activities, including malt barley production. Although this finding is inconsistent with many studies, a study by Osmani and Hossain (2015) found that they had reported similar findings.

Conclusion and Policy Implications

Participation in contract farming has been found to be determined by demographic characteristics, including age, gender, and household size. In addition to institutional factors like access to extension services, market information, cooperative membership, credit availability, and price and off-farm income, households' decisions to participate in contract farming have also been influenced by socioeconomic factors like educational attainment, the size of their landholding, and the number of livestock they own.

The following policy implications are emphasized for wider contract farming participation based on the evidence presented in this study:

- Farmers who engage in contract farming reveal that contract farming is as a platform that enables them to secure equitable marketing price for their production and boost sales volume that sustain malt industry and producer relationships.
- Landholding size strongly affects the extent of contract farming performance, so formulation of policies that encourage efficient land use and right transfer that ensure efficiency in allocation of factors of production, which is landholding.
- By encouraging farmers to share knowledge and experiences in their their cooperatives, malt barley farmers shall be able to increase their prospects of contract farming participation and extent of participation by selling their production in the scheme.
- Enhance access to rural financial services to motivate farmers' investment and participation in coordinated agri-food supply chains further.
- Access to inputs, including chemical fertilizers, is positively correlated with contract farming participation and involvement level. This shows that contract farming should be promoted by providing chances for input access. As a result, there will be more people involved in contract farming.
- Contract farming participation decision and its extent of participation will also be enhanced by efforts to devise off-income-generating interventions in the areas.

Declaration of competing interest

The authors declare that they have no competing interests.

Data availability

Data will be made available on request.

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Contributions

The corresponding author contributed to survey design, data collection, cleaned the data, analyzed the data, and wrote the first draft of the manuscript. The other authors contributed to reading, editing, and structuring the manuscript. All authors read and approved the final version of the manuscript.

Availability of data and materials

Data used for the analyses in this article are available from the corresponding author upon request.

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