American Journal of Theoretical and Applied Business
2023; 9(2): 44-56
http://www.sciencepublishinggroup.com/j/ajtab
doi: 10.11648/j.ajtab.20230902.14
ISSN: 2469-7834 (Print); ISSN: 2469-7842 (Online)

Determinants of Participation in Contract Farming Among Malt Marley Farmers in North-Western Ethiopia

Abebe Dagnew[1, 2, *], Degye Goshu[3], Lemma Zemedu[4], Million Sileshi[1]

[1]School of Agricultural Economics and Agribusiness, Haramaya University, Dire Dawa, Ethiopia

[2]Collge of Agriculture and Environmental Sciences, University of Gondar, Gondar, Ethiopia

[3]Ethiopian Economics Association, Addis Ababa, Ethiopia

[4]Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia

Email address:

adagnew268@gmail.com (Abebe Dagnew)

[*]Corresponding author

To cite this article:

Abebe Dagnew, Degye Goshu, Lemma Zemedu, Million Sileshi. Determinants of Participation in Contract Farming Among Malt Marley Farmers in North-Western Ethiopia. *American Journal of Theoretical and Applied Business*. Vol. 9, No. 2, 2023, pp. 44-56.
doi: 10.11648/j.ajtab.20230902.14

Received: April 27, 2023; **Accepted**: May 25, 2023; **Published**: June 15, 2023

Abstract: Contract farming (CF) has been one of the strategies employed to improve the commercialization of malt barley and substitute imported malt barley in Ethiopia, in addition to addressing production and marketing challenges. Additionally, the anticipated results include meeting domestic malt barley demand, enhancing the welfare of smallholder farmers, and conserving the nation's foreign exchange. However, there is a relatively low rate of participation in CF, that has yet to be thoroughly studied. Accordingly, the purpose of this study was to identify the variables influencing the level of participation in CF among malt barley farmers in Northwestern Ethiopia. A semi-structured interview schedule was used to collect data from 398 (189 CF participants and 209 non-participants) malt barley farmers randomly selected from 9 kebeles in 2 districts selected by multistage sampling procedures. The inferential statistics highlighted marked differences and associations between malt barley CF participants and non-participants. According to the results of a probit model, CF participation of malt barley farmers was positively correlated with the frequency of extension contact, field day and training participation, cooperative membership, access to credit, and household size. To strengthen and enhance the CF participation of malt barley farmers, the government and non-governmental organizations, and other concerned bodies should improve cooperative and financial performance and the agricultural extension system.

Keywords: Malt Barley, Contract Farming, Participation, Probit, Ethiopia

1. Introduction

Agriculture has led to economic growth that is connected to better livelihoods, and it can be a long-term solution to persistent poverty, and food and nutritional insecurity despite the economy's ongoing structural shift from agriculture to industry and services. Agriculture contributed to 33% of the GDP, 66% of rural employment, and generates 76% of foreign exchange [1]. Of this, crop production contributed to 65% of the GDP, employs 60% of the rural labor, and covers 80% of the land under cultivation [2]. The majority of crops are cereals, accounting for 81.4% of all crop area and 88% of all outputs [3]. This suggests that the economy's most important sector is smallholder farmers. However, Ethiopia has had very low agricultural productivity and production as compared to other nations [4]. To address this issue, the Ethiopian government developed and put into action an economic transformation program based on the framework of agricultural development-led industrialization (ADLI) with Growth and Transformation Plan (GTP) I and II [5]. As a result, by 2025, the economy is expected to have mostly transitioned from agriculture to industry and services [5]. Despite government efforts to shift the economy from agriculture to services and primary industry, the economy's performance is still thought to be behind expectations [6, 7]. Low agricultural productivity is caused by a lack of modern

inputs, limitations in scaling up a full package of crop technologies, inefficient resource utilization [5, 6, 8-11], adherence to traditional farming methods, poor irrigation technology, rain-fed agriculture, a lack of market orientation and infrastructure, low output modes of production, and internal inefficiency [8, 9, 12-14].

Barley is one of the major crops widely grown in different countries of the world. After rice, wheat, and maize, it is the fourth most produced crop worldwide [15]. Ethiopia is one of the ten top barley producers in the world and it also ranks first in Africa followed by Algeria [14]. In Ethiopia, barley ranked fifth next to teff, maize, wheat, and sorghum in 2019/20 [16]. The two types of barley are food barley for consumption and malt barley for the brewery in the country. In Ethiopia, more than 3.51 million smallholder farmers produced about 20.51 million quintals on 951993.15 ha with a productivity of 21.6 qt/ha in 2017 [3]. However, the productivity of Ethiopian barley is lower than that of best-performing African countries (for instance, Kenya and South Africa have average barley productivity of 32.6 and 29.3 qt/ha; respectively), and much lower than European countries (France, Germany, and the Netherlands produced more than 60 qt/ha of barley) [3, 14]. And also, low malt barley productivity follows similar trends of barley productivity [17].

The production of malt barley has become one of Ethiopia's fastest-growing industries because of the establishment of multinational brewery plants supported by expanding beer consumption and a favorable investment policy. According to ICARDA [18], the gap between malt barley production and demand is high due to its low productivity [19] coupled with increasing in beer demand due to increasing per-capita incomes ($124.5 in 2000 and $855.76 in 2019) [20], population growth, and urbanization [5] as well as the construction of new malt factories [21]. For instance, the average malt barley productivity in 2016/17 was 18.3 qt/ha for the Amhara region and 20.4 qt/ha for the country as a whole [3]. Several factors caused low productivity of malt barley including production inefficiency [17], a lack of improved technology (improved varieties and fertilizers), limited market access, and a lack of technical expertise [12, 13, 22], among others. Theoretically, increasing efficiency and/or diffusing technology can increase production and productivity. In this regard, CF is seen as a strategy for overcoming technical/ technological constraints [23], accessing and easing technology adoption [24], linking farmers to marketing agents [25], minimizing transaction costs [26], and creating open access to finance [27]. In other words, CF has the advantage of increasing agricultural productivity by enhancing farmers' production efficiency through technical help and supplying improved technology through financing and price support. Contract farming (CF) is an institutional arrangement in which a company contracts the production of agricultural products to farmers and guarantees a reliable supply of high-quality agricultural raw materials [28].

In many regions of Ethiopia, CF has been employed in the last 10 years as a solution for several agricultural commodities [6, 29, 30, 31, 32]. Malt barley CF was introduced by multinational malt and brewery firms in response to this need [33]. Malt barley contract farming (CF) is mainly implemented in Oromia (Arsi and West Arsi) and the Amhara region with brewery factories in 2013 to ensure local malt supply [6, 33]. However, the demand for raw malt barley is unmet. As a result, in 2015 and 2018, the national supply of malt barley was only 35% (14452 tons) and 44% (52000 tons) of the domestic demand of the breweries; respectively [6, 33, 34], with the remaining imported from abroad. Moreover, the import cost of malt barley is expected to reach $420 million in 2025 [19].

Previous studies proved that the participation status of farmers in different commodities over different parts of the country is low in qualitative terms due to socioeconomic, institutional, and demographic factors among others [6, 29, 31, 32, 35, 36, 37, 38]. Furthermore, these studies were focused on other commodities except for [3, 30], and [37] who conducted a study on the income impact of malt barley contract farming in Aris and West Arsi. These zones are well experienced and currently mechanized as compared to the Amhara region since Assela Malt Factory is the major buyer since 1984. Few studies show that CF is viewed as a tool used mostly by agribusiness firms to exploit farmers' resources, reducing the household gain from CF [24, 40, 41, 42].

In North Gondar Zone, the study area, the Dashen beer factory introduced CF malt in 2014 [6]. Since then, despite 5170 farmers actively engaged in the cultivation of malt barley, the Gondar Malt Factory's (GMF) demand for the grain remains unsatisfactory. The causes of low productivity could be socioeconomic factors among others. According to BoA [43], the number of producers including CF participants and non-participants, the volume of malt barley supply, and the area covered show a declining trend (2016/17 to 2020/21) (Table A1, Figure A1, and A2). A decreasing trend is seen in the area allocated and yield in North Gondar Zone too (Figure A3). However, the Gondar malt factory's demand for malt barley is increasing trend from the Oromia region (Table A1 and Figure A1). As a result, it is critical to pinpoint the factor that affects farmers' willingness to participate in contract farming in Northwestern Ethiopia so that region- and commodity-specific policies and strategies can be developed to strengthen and scale up malt barley production and productivity, among other things.

2. Methodology

2.1. Description of the Study Area

The study area, North Gondar Zone is found in Amhara National Regional State, located in the northwestern part of Ethiopia. Debark is the main town of the Zone, which is located 817 km and 90 Km from the capital Addis Ababa and Gondar Town, respectively. It has 6 rural Districts (Telemt, Adearaky, Dabat, Debark, Beyeda, and Janamora) and 2 urban administrations (Dabat and Debark) covering an area of 38685.79 square kilometers. It has a total population of 914266, of whom 452922 are men and 461344 women [44]. It

is bordered on the south by East Belesa, on the west by Tegede, Tach Armachiho, and Wogera Districts, on the north by the Tigray region, and on the east by Wag Hemra Zone. North Gondar Zone is located between 12.3° to 13.38° north latitudes and 35.5° east longitudes and the altitude ranges from 550 to 4620 meters above sea level (masl) in western lowland and north Semen Mountain (Ras Dashan), respectively. The average annual rainfall varies from 880 mm to 1772 mm, which is characterized by a unimodal type of distribution [45]. The mixed farming system; livestock rearing and crop production are the mainstream in the study area. The livestock population was 888938.30 TLU (tropical livestock unit). The main crops are the cereals such as teff, maize, wheat, millet, barley, and sorghum [44].

The highland parts of the Zone have the potential for both food and malt barley production. Malt barley is cultivated in Beyeda, Janamora, Debark, and Dabat Districts. Malt barley contract farming (CF) was introduced in 2014 by the Dashen brewery factory with the objective of local sourcing of malt barley. It is practiced in 9 Kebeles and 12 Kebeles of Dabat and Debark Districts, respectively [46]. The total number of malt barley producers was 5170; of which 2234 (43.2%) were CF participants. According to the Zone Department of Agriculture report, malt barley is the third most important crop among cereals. This indicates that malt barley is among the main cereal crops in the Zone. Figure 1 below indicates the study area; which is the North Gondar Zone of Debark and Dabat Districts.

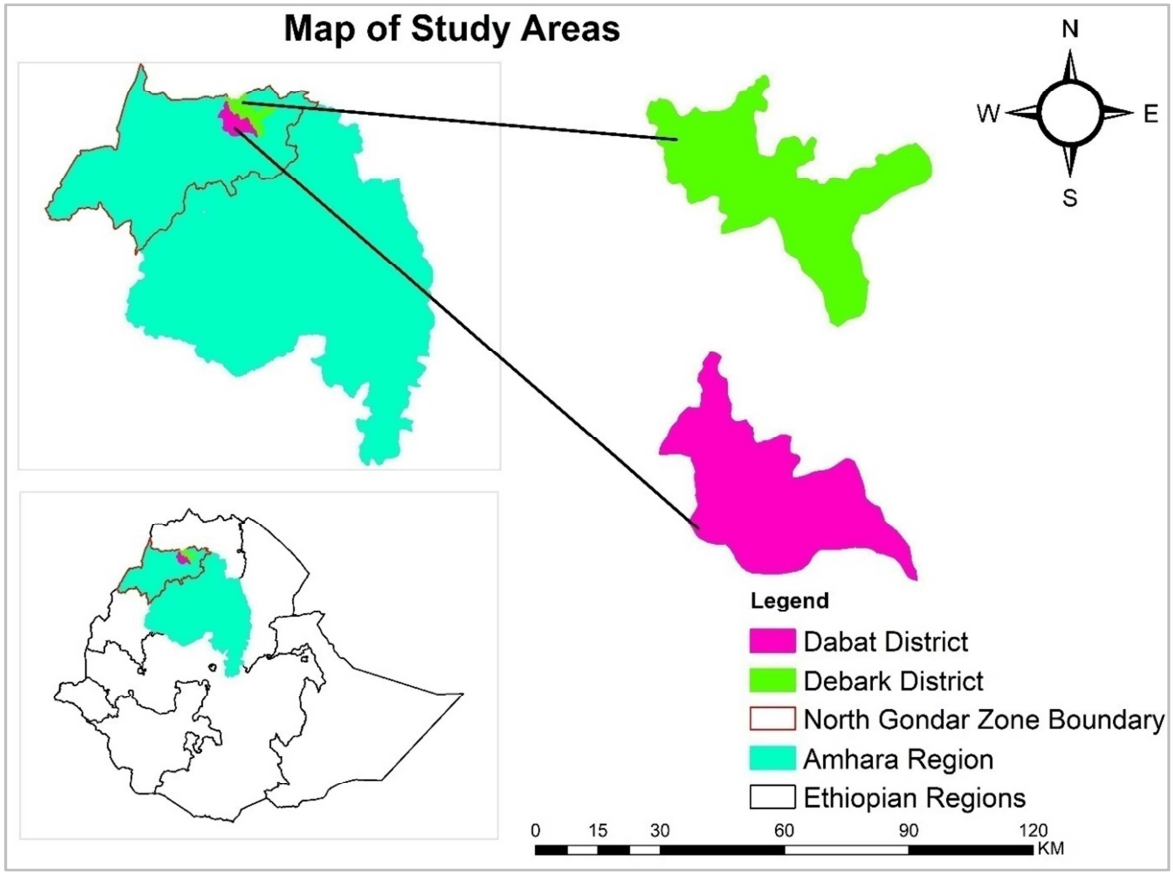

Figure 1. *Map of the Study Area (North Gondar Administrative Zone).*

2.2. Sample Size and Sampling Procedures

A multistage sampling procedure was implemented to draw the targeted sample of malt barley farmers who are CF participants and non-participants. In the first stage, among CF participants and non-participants malt barley producing Districts namely Debark and Dabat districts were selected purposively among 4 malt barley growing Districts since both malt barley CF participants and non-participants are found in these districts. In the second stage, 4 kebeles: Abtera, Dabat Zuria, Woken Zuraia, and Chena from the Dabat district; and 5 kebeles such as Arginjona, Miligebsa, Miqara, Yekirar, and Gomiya from Debark Districts were taken by following random sampling. Thirdly, the malt barley farmers were stratified into CF participants and non-participants by taking CF engagement as the criterion. Then, 189 CF participants and 209 non-participants malt barley farmers were selected randomly based on probability proportional to their size by having the lists of the farmers from the respective kebeles and districts.

2.3. Data Types, Sources, and Method of Data Collection

Pretested and revised semi-structured interview schedule was used to collect primary data on demographic,

socioeconomic, resource endowments, and environmental factors from a sample of CF participants and non-participant malt barley farmers. The interview schedule was prepared in English and it was translated into the local language, Amharic to ease the communication between the enumerator and farmers. Government and non-government reports, as well as online data sources like FAOSTAT, NBE, and CSA, were used to compile secondary data.

2.4. Data Analysis Method

2.4.1. Descriptive Statistics

The study used descriptive statistics (mean, standard deviation, frequency, and percentage) and inferential statistics (chi-square test and t-test). The chi-square test and t-test were used to determine statistical differences and the association between CF participants and non-participants on demographic, socioeconomic, institutional, and environmental factors. The former and the later tests were used for discrete and continuous variables; respectively.

2.4.2. Econometric Model

Logit and probit models are the commonly used approaches for studies with binary outcomes such as contract farming participation [47]. The main difference between these models is in the assumption about error distributions, with errors in a logit model assumed to have a standard logistic distribution while errors in probit have a standard normal distribution [48, 49]. Both models produce almost identical marginal effects, but the probit model was used to investigate the factors influencing the decision to participate in the malt barley CF. A logit model is frequently employed in biostatistics and the health sciences due to the interpretation of logit as odd ratios. The probit model, in contrast, is well-liked among economists since it is predicated on the notion that a normal random variable will have an impact on the model [49]. Also, many researchers have employed the probit regression model for studies with binary outcomes, such as the use of fertilizer [50], credit [51], and contract farming participation [30, 52]. As a result, the probit model was used to examine the variables affecting farmers' participation in CF. The goodness-to-fit test also favored the probit model (Table A2).

Following Louviere *et al*. [53], Ben-Akiva and Lerman [54], and Khonje *et al.* [55], the random utility theory is used to study farm households' decision to participate in CF. let I* represent the difference between the utility from participating in CF (W_{i1}) and not participating in CF (W_{i0}). It contends that rational economic agents (such as farm households) will decide to participate in CF if the utility gained when they participate (W_{i1}) is greater than the utility gained from not doing so (W_{i0}); W_{i1}- W_{i0}>0. However, as shown in Equation (1), the two utilities are unobservable, and the net benefit (utility) obtained from participating in CF (I^*_i) is a latent (an unobservable) variable determined by observed variables (such as socio-economic, institutional, and demographic factors) and also unobserved variables. The random utility (I_i^*) is depicted as follows in Equation (1):

$$I_i^* = X'\beta + \varepsilon_i \text{ where } I_i = \begin{cases} 1 \text{ if } I_i^* > 0 \\ 0 \text{ otherwise} \end{cases} = \begin{cases} 1 \text{ if } X'\beta + \varepsilon_i > 0 \\ o \text{ if } X'\beta + \varepsilon_i \leq 0 \end{cases} \quad (1)$$

Where P_i is the probability of participation in contract farming (CF) for the i^{th} malt barley farmer, which is binary (0,1) and equals 1 if farmers participated in CF and 0 otherwise; β represents unknown parameters to be estimated, Xi represents explanatory variables, εi is the error term that has a normal distribution i.e $\varepsilon_i \sim (0,1)$.

Thus, the probability of participating in CF (Y_i=1) is presented as:

$$\Pr(Y_i = 1|x) = \text{pr}(I^* > 0) = \text{pr}(X'\beta + \varepsilon_i > 0) = \text{pr}(\varepsilon_i < X'\beta) = F(X'\beta) \quad (2)$$

where F is the cumulative distribution function for εi, and Pr is the probability of participating in CF given the value of x variables.

According to Wooldridge [56], the probit model to estimate the probability of observing a farmer participating in CF is expressed in Equation (3):

$$\Pr(Y_i = 1|x) = F(X'\beta) = \int_{-\infty}^{X'\beta} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{Z^2}{2}\right) dZ \quad (3)$$

Where Pr is the probability of Yi being the binary choice variable (one for participants and zero for non-participants in CF), Z stands for the standard normal variable and others are as defined above.

The probit model's log-likelihood function is defined as follows:

$$\ln(\beta, Y, X) = \sum_{i=1}^{n} [Y_i \ln F(X'\beta) + (1 - Y_i)\ln(1 - F(X'\beta)] \quad (4)$$

where F, X, Y, and β are defined above.

Empirically, the probit model used to calculate farmers' CF participation decisions is expressed in equation (5):

$$Y_i = \beta_0 + \sum_{i=1}^{n} \beta_n X_{ni} + \mu_i \quad (5)$$

Y is the underlying and unobserved stimulus index for the i^{th} farmer, i=1, 2…. n, are observations on variables for the participation model, n being the number of explanatory variables in this study, β_0=an intercept, β_i=a regression coefficient (unknown parameters to be estimated for coefficients of the i^{th} independent variable), X_i represents the factors influencing the participation decision of farmers in CF and can be either dummy or continuous, and u_i a random error term. The maximum likelihood (ML) estimation approach can be used to estimate this model. The important explanatory factors do not have the same degree of influence on farmers' participation choices. By analyzing participation elasticity, the relative impact of a specific quantitative explanatory variable on the decision to participate was quantified.

For interpretation of the probit model result, the marginal effect is preferred and used in this study. Hence, the marginal

effect is:

$$ME = \frac{\partial \Phi}{\partial X} = \beta^* \phi(Z) \Rightarrow \phi(Z) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{Z^2}{2}\right) \quad (6)$$

2.5. Description of Dependent and Independent Variables

2.5.1. Dependent Variable

The participation status of the sample household in malt barley contract farming in 2021/22 was considered the dependent variable. It is a dummy that assumed one if the farm household head participated in CF in the 2021/22 production period, and otherwise zero.

2.5.2. Independent Variables

Independent Variables are summarized in Table 1 and briefly discussed as follows.

Sex: refers to the sex of the household head, if the household head is male, then it is one and zero otherwise. Sex is expected to have a positive influence on the participation of CF positively since a male-headed household has better access to information, control resources, and access to credit than a female-headed household [42]. Hence, sex was expected to be positively related to participation in malt barley CF.

The age of the household head: is a continuous variable in years; which is a proxy for experiences. It is learning by doing and improving the decision-making power of the household head. This means that older farm household heads have greater access to productive resources such as land and labor for use in the production process. As age increases, farmers also accumulate more experience and thus, be more participants in CF. According to reports, age is positively related to participation in CF [28, 30]. However; the farmer at a certain level of age may get physically weaker and ineffective in agronomic practices and lack access to information that has a negative influence on participation in CF. Studies have shown that age has an inverse impact on participation in CF [57, 58]. Hence, age was expected to have an indeterminate effect on malt barley CF participation.

Household size: is a continuous variable measured in the count of who is living within the household. It is directly related to CF participation [58] since CF is expected to be labor-intensive rather than capital-intensive. It is hypothesized that if labor contributions dominate consumption, the large family-sized household is expected to have better participation in malt barley CF. Therefore, household size was expected to have an indeterminate influence on malt barley CF participation.

Level of Education: refers to the level of education of the household head, which was measured by years of schooling. Education facilitates the management capacity, and ability of farmers to make informed decisions. It enhances the ability of the household head to gather, analyze and use relevant information, which is expected to have a direct relationship with the participation in malt barley CF. Studies indicated that the level of education is positively related to CF [39]. In this study, the level of education was expected to have a positive effect on the likelihood of participation in malt barley CF.

Total land holding of the household: -is a continuous variable measured in hectares (ha) under the control of the household head. In the current scenario, it has a positive correlation with participation in malt barley CF [37]. Hence, it was hypothesized that land size was expected to have a direct relationship with CF.

Off-farm is a dummy variable that takes a value of one if the household participated in the off-farm activities and zero otherwise. It refers to the involvement of the household members in off-farm activities; which is a proxy variable for off-farm income that may have negative and positive effects on the participation in malt barley CF. That is to say, a household head who is engaged in off-farm activities may not manage his/her malt barley farm timely due to labor competition [39], while as [58] reported off-farm income can be used to purchase inputs such as improved inputs (seed, fertilizer, chemicals) and labor for farm management activities. It is assumed that this variable was expected to have indeterminate effects on participation in malt barley CF.

Frequency of extension contact: refers to the number of contacts between the household head and extension experts per malt barley production season (2021/22). The extension improves the knowledge, attitude towards technology, and skills of household heads through consultation, demonstration, training, and field visits of model farmers. It was expected to have a direct relationship with the participation in malt barley CF because extension experts advise about the benefits of malt barley CF on market security and other supports [37, 39]. Hence, the more extension contacts the household head had likely participated in malt barley CF.

Participation in training is a dummy variable, if the household head participated in training; it would be one and zero otherwise. Training access can promote the knowledge and decision-making skills of the household head. Training and participation in malt barley CF were found to be directly related [59]. So, it was expected that having access to training would have a positive influence on the household head's participation in the malt barley CF.

Experience in malt barley production and marketing: the number of years the household head has been involved in the production of malt barley. According to Ganewo et al. [37], more experienced farmers participated in CF than less experienced ones. Hence, it was expected that malt barley production experience positively determines participation in malt barley CF.

Mobile ownership is a dummy variable that took one if the household head had a mobile phone and zero otherwise. It refers to having a mobile phone to improve the ability of the household head to obtain information. Owning a mobile phone increases the likelihood of farmers participating in malt barley CF by improving information access. It was also found that mobile phone ownership has a direct effect on CF participation [39]. Hence, having a mobile phone allows the household heads to participate in malt barley CF.

Credit access: it was a dummy variable that takes one for those who received credit from formal lending institutions in 2020/21 and zero otherwise. It gives the input purchasing power to the household heads. Credit access is directly related

to CF participation [30, 39]. Hence, credit access was hypothesized to encourage household heads to participate in malt barley CF.

Distance to market: is a continuous variable measured in walking minutes. It is a proxy variable for market access for malt barley producers. Market access encourages household heads to purchase and sell inputs and outputs; respectively [30, 33, 37]. In this study, distance from the market was hypothesized to have an inverse relationship with participation in malt barley CF.

Distance to FTC: is a continuous variable measured in walking minutes. The household heads nearest to the farmers' training center (FTC) have the opportunity to obverse the demonstration at the FTC, and, pieces of training, information, and advocacy services are easier to obtain than those who are far from FTC. It is inversely related to participation in CF [30, 37, 39]. It was expected to have a negative influence on malt barley CF participation decision of the household head.

Participation in social affairs refers to the leadership position in formal (*Gote*, village, and kebele) or informal organization (*edir*, *equb,* and *mahiber*) in the community. It is a dummy variable that takes the value of 1 if the household head participated at least in one of the various social statuses and zero otherwise. It was expected to have an indeterminate effect on participation in CF. For instance, this participation might have a positive effect in the sense that the household head may have information access, experience sharing, and labor as well as other resources sharing to participate in CF [60]. Contrarily, taking part in social activities may compete with the family's resources. Hence, the influence of participation in social affairs of the household head on CF participation was indeterminate.

Field day participation: is a dummy variable that takes one if the household head participated in the field day and zero otherwise. The households who had field day participation experiences were expected to participate in malt barley CF because seeing is believing. It is of course among the extension approaches to disseminating technologies through sharing the best experiences from their model peers and on-farm and on-station demonstration sites. According to Mesay *et al.* [61], and Mathewos *et al*. [62] field day participation has a direct relationship with technology adoption. Hence, participation in the field day was expected to motivate household heads to participate in malt barely CF.

Cooperative membership is a dummy variable that takes one if the household is a member of the cooperative and zero otherwise. Cooperatives are expected to offer malt barley producers viable information about production technologies, deliver improved inputs, and arrange ways of easy access to credit services to encourage farmers [30]. Hence, cooperative members are more likely to participate in malt barley CF.

Table 1. *Explanatory variables and their expected sign used in the probit model.*

Variables	Measurement	Expected sign
Sex of the household head	Dummy (1/0)	+
Age of the household head	Years	±
Household size	Count	±
Total land holding	Ha	+
Education status of the household head	Years of schooling	+
Off-farm participation of household	Dummy (1/0)	±
Participation in the social organization of the household head	Dummy (1/0)	±
Frequency of extension contact of household head	Count	+
Training participation of the household head	Dummy (1/0)	+
Malt barley farming experience of household head	Year	+
Mobile ownership of the household head	Dummy (1/0)	+
Cooperative membership of household	Dummy (1/0)	+
Credit access to household	Dummy (1/0)	+
Distance to market	Walking minutes	-
Distance to FTC	Walking minutes	-
Field day participation of the household head	Dummy (1/0)	+

3. Result and Discussion

3.1. Characterization of Sample Farmers

The equality means and association tests of continuous and discrete variables, respectively, are shown in Table 2 by contract participation. Regarding the continuous variables, there was a significant difference in average age, malt barley production experiences, household size, land holding, and frequency of extension contact between contract farming participants and non-participants.

Age of the household head: the average age of contract farming participants was 45.88 years, compared to 43.68 years for non-participants. At the 5% probability level, these differences were statistically significant. In other words; CF participants were older than non-participants.

Malt barley farming experiences: the average malt barley experiences of CF participants and non-participants were 5.42 and 4.59 years, respectively. These differences were statistically significant at a 5% probability level. This implies the participants had more experience in malt barley farming as

compared to the non-participants.

Household size: the average household size of CF participants was about 7 persons while it was 6.49 persons for non-participants. The household size of participants was dominant and statistically significant compared to the non-participants at a 1% probability level. The household size of both participants and non-participants was more than the national (6.23) and the regional average household size (4.53) [16].

Table 2. *Summary Statistics of Contract Farming Participants and Non-Participants.*

Variables		Pooled	CF	NCF	Mean difference	p-value
		Mean (S.D)	Mean (S.D)	Mean (S.D)		
Age of the household head		44.73 (9.59)	45.88 (9.24)	43.68 (9.79)	2.2	0.022[b]
Malt barley experience		4.99 (2.64)	5.42 (2.64)	4.59 (2.59)	0.83	0.002[a]
Household size#)		6.78 (2.27)	7.09 (2.3)	6.49 (2.21)	0.6	0.008[a]
Own land size (ha)		1.05 (0.72)	1.13 (0.76)	0.98 (0.68)	0.15	0.041[b]
Distance from market (minutes)		71.62 (46.73)	74.08 (50.56)	69.40 (42.99)	4.68	0.319
Distance from FTC (minutes)		35.81 (29.4)	34.5 (27.78)	37.00 (30.81)	-0.50	0.396
Annual extension contacts (#)		6.86 (3.47)	7.96 (2.92)	6.85 (3.84)	1.11	0.001[a]
Education status of the household head (year)		2.09 (2.82)	2.23 (2.98)	1.93 (2.67)	0.32	0.25
Variables		freq (%)	freq (%)	freq (%)		^{2} (p)
Access to credit	Yes	256 (64.3)	143 (75.7)	113 (54.1)		20.17 (0.000) [a]
	No	142 (35.7)	46 (24.3)	96 (45.9)		
Sex of the household head	Male	387 (97.2)	185 (97.9)	202 (96.7)		0.561 (0.454)
	Female	11 (2.8)	4 (2.1)	7 (3.3)		
Cooperative membership	Yes	280 (70)	147 (77.8)	133 (63.6)		9.52 (0.002) [a]
	No	118 (30)	42 (22.2)	76 (36.4)		
Participation in field day	Yes	283 (71)	174 (92.1)	109 (52.2)		55.26 (0.000) [a]
	No	115 (29)	15 (7.9)	100 (47.8)		
Mobile ownership	Yes	217 (54.5)	107 (56.6)	110 (52.6)		0.63 (0.426)
	No	181 (45.5)	82 (43.4)	99 (47.4)		
Participation in social affairs	Yes	111 (28)	57 (30.2)	54 (25.8)		1.91 (0.167)
	No	287 (72)	132 (69.8)	155 (74.2)		
Training participation	Yes	301 (75.6)	163 (86.2)	138 (66)		22.0 (0.000) [a]
	No	97 (24.4)	26 (13.8)	71 (34)		
Off-farm participation	Yes	214 (53.8)	103 (54.5)	111 (53.1)		0.0768 (0.782)
	No	184 (46.2)	86 (45.5)	98 (46.9).		

[a], [b], and [c] significant at 1, 5, and 10% probability levels, respectively; S.D refers to standard error
Source: Own Computation, 2022

Landholding: the average landholding of CF participants and non-participants was 1.13 and 0.98ha, respectively. The mean difference in the land holding of CF participants and non-participants was statistically significant at 5%. This implies that participants had more landholding compared to non-participants. The average land holding of both participants and non-participants was more than the national (0.84ha per household) and less than the regional average land holding (1.15ha per household) [16].

Frequency of extension contact: on average, CF participants had with extension experts, 7.96 times whereas non-participants had 6.85 times annually. This implies that CF participants had more extension contact than non-participants and were statistically significant at a 1% probability level. To sum up; participants were found to be had relatively more malt barley production experiences, land, household size, and frequency of extension contacts than their counterparts.

Participation in training: the production of malt barley requires a high level of managerial expertise, from pre-harvest land preparation to post-harvest handling. Thus, training farmers is crucial. Among the sample households, 75.6% had received training, compared to 86.2% of CF participants. There is a statistically significant association between training and CF participation at a 1% probability level.

Cooperative membership can reduce transaction costs by negotiating contracts with a large number of small farmers dispersed across several locations. They guarantee the timely, adequate, and high-quality delivery of goods to contractors and the distribution of inputs to farmers. In contrast to the 77.8% and 63.6% of CF participants and non-participants, respectively, 70% of sample households are cooperative members. This suggests that the majority of CF participants are cooperative members. At a 1% probability level, there was a statistically significant association between cooperative membership and CF participation.

Credit access: at a 1% probability level, there was a statistically significant association between credit access and CF participation. The percentage of sample households who received credit was 64.3, compared to 75.7 and 54.1% for CF participants and non-participants. This suggests that the

majority of CF participants had access to credit.

Participation in field days was significantly associated with CF participation at a 1% probability level. While 92.1% and 52.2% of CF participants and non-participants, respectively, engaged in the field day, only 71% of the sample houses did. In contrast to their counterparts, the majority of the CF participants had field day participation experiences. Generally, these indicate that, in comparison to their counterparts, most CF participants had more access to credit, took part in training and field days, and were cooperative members. This is essential for improving the yield and production of malt barley, which also will ultimately raise farmers' standard of living.

3.2. Determinants of Participation in Malt Barley Contract Farming

The parameters of the variables that are anticipated to influence malt barley farmers' decision to take part in contract farming were estimated using the maximum likelihood estimation approach. Before reporting the estimates of CF participation of malt barley, the selection of an appropriate binary model (either probit or logit) was performed. Accordingly, the Wald chi-square (16) values of probit and logit were 88.51 and 74.94, which indicates that at least one explanatory variable determines the involvement of farmers in the CF, indicating that both models adequately fitted the data at the 1% level of probability. According to the findings of probit and logit, farmers have been almost equally likely to participate in the malt barley CF (45.5% in the probit and 44.8% in the logit). Furthermore, the log-likelihood ratio test was insignificant indicating that both models fitted the data sets. Model specification tests such as the linktest also showed that the hat and hatsqr were statistically significant and insignificant, showing both models are correctly specified. The estat classification tests also indicated that both models were correctly specified by 74.12%. However, as indicated by the goodness-of-fit (gof) tests after probit and logit, the logit model's Pearson chi-square is significant at 10%, suggesting that the errors in the logistic regression are not logistically distributed. The contract farming participation decision of households, in this case, is best explained by the probit model because the assumption of normality of the errors is supported by the gof test (Table A2). The lower AIC value further supported the conclusion that the probit model provided the best fit for the data set (Table A2) [63]. Hence, the probit model has preferred to analyze the participation decision of malt barley farmers in CF and the results are shown in Table 3. Among sixteen variables, six of them namely frequency of extension contacts, training participation, cooperative membership, household size, participation in field day, and access to credit was found to significantly determine malt barley CF participation of the farmers with expected signs.

Household size had a positive and statistically significant at a 5% probability level influence on contract farming participation. This finding suggests that the large family-sized household's labor contribution dominated the consumption expenditure. It had also a marginal effect of 0.03. This suggests that the likelihood of malt barley farmers participating in CF increases by 0.03 for every additional person in a family. This result is consistent with what Genawo *et al.* [37] who demonstrate that household size directly affects participation in malt barley contract farming in Ethiopia.

Credit access: was found to be a positive influence on malt barley contract farming participation and it was statistically significant at a 1% probability level. It had a 0.26 marginal impact. This indicates that being a member of the cooperative raises the CF participation status of malt barley farmers by 0.26 (26%). This implies that farmers with credit access in cash or in kind as inputs are more likely participate in CF than others. This result agrees with those reported by Bezabih *et al.* [30], Tefera and Bijman [64], and Genawo *et al.* [37].

Field day participation positively and statistically significantly at a 1% probability level affected malt barley farmers' participation in contract farming, as was hypothesized. Its marginal effect was found to be 0.451. This suggests that the rate of CF participation increases by 0.451 for every farmer that participated in field day. This finding agrees with that of Mesay *et al*. [61], Abdurehman and Abdi [65], and Mathewos *et al*. [62], who revealed a direct relationship between field day participation and technology adoption.

The frequency of extension contacts had a positive and significant influence on malt barley contract farming. This implies that increasing the number of extensions contact motivated the malt barely farmers to join the CF than those who had less frequency of extension contact. The frequency of extension contact has a 0.03 marginal effect. This suggests that the probability of joining the CF increases by 0.03 for every unit increase in extension contact. The likelihood of malt barley farmers taking part in CF was statistically significantly influenced at a 5% level. Abera *et al.* [39], Tefera and Bijman [64], and Genawo *et al.* [37] reported similar findings.

Cooperative membership had a positive and statistically significant influence on CF at a 10% level of probability. This implies that cooperative members are more likely to participate in CF than their non-members' counterparts. The CF participation status of malt barley farmers is also increased by 0.14 when they are a member of a cooperative. This finding is consistent with prior research [33]. While contract farming for broilers in Indonesia has a negative relationship with cooperative service [60].

Training participation had a positive and statistically significant influence on CF participation, at a 1% probability level. This means that farmers with training access are more likely to participate in CF than those who don't have. Participation in training was found to have a marginal effect of 0.21. This suggests that the likelihood of CF participation improves by 0.21 for every unit change in the training access. This result is in line with research that shows that participation in the CF is positively tied to training [59].

Table 3. *Probit model results of determinants of participation in contract farming (CF).*

Variables	Coefficient	Robust S. Error	ME (dx/dy)
Constant	-4.15[a]	1.24	
Sex of the household head (male=1)	-0.566	0.467	-0.224
Age of the household head (year)	-0.007	0.009	-0.003
MB experience of the household head (year)	0.053	0.034	0.021
Household size (count)	0.072[b]	0.032	0.03
Land size (ha)	-0.072	0.13	-0.03
Frequency of extension contact (count)	0.08[b]	0.04	0.03
Distance from the market (walking minutes)	0.001	0.001	0.0003
Distance from the FTC (walking minutes)	-0.004	0.003	-0.002
Mobile ownership (Yes=1)	-0.29	0.25	-0.061
Social participation (Yes=1)	0.103	0.277	0.041
Cooperative membership (Yes=1)	0.351[c]	0.186	0.14
Off-farm participation (Yes=1)	-0.111	0.167	-0.044
Education status (year)	0.235	0.148	0.10
Training access (Yes=1)	0.519[a]	0.195	0.21
Credit access (Yes=1)	0.652[a]	0.152	0.26
Field day participation (Yes=1)	1.14 [a]	0.19	0.451
Wald chi^2 (16)	88.51[a]		
Prob > chi^2	0.0000		
Pseudo R^2	0.2029		
Log pseudolikelihood	-219.49		
Marginal effects after probit (mfx)	0.455		
Marginal effects after logit (mfx)	0.448		
Number of observations	398		

[a], [b,] and [c] significant at 1, 5, and 10% probability levels, respectively
Source; Own Computation, 2023

4. Conclusion and Recommendation

Contract farming (CF) is one of the strategies implemented to commercialize malt barley in Ethiopia since 2013 with the intention of malt barley import substitution. Contract farming enhances the productivity of smallholder farmers by introducing improved farming practices through the provision of inputs, credit, extension services, and other support services. The expected outcome is meeting the domestic demand for malt barley, improving the welfare of smallholder farmers, and saving the foreign exchange of Ethiopia. Despite this contribution, participation in CF is very low; which is not well investigated. Hence; the study was designed to determine the variables that influence the status of participation of farmers in malt barley CF.

A combination of household and farm-specific, demographic, socioeconomic, institutional, and locational characteristics influenced the participation of malt barley farmers in contract farming (CF). The inferential statistics revealed significant variations and associations between malt barley CF participants and non-participants in terms of household size, land size, extension contact, experiences, training, credit, field day, and cooperative membership. The data set was found that fit the probit model better. The probit model shows that the rate of participation of malt barley farmers in CF was 45.5%, which is below 50%. The probit model also revealed that household size, frequency of extension contacts, participation in training, field day participation, membership in cooperatives, and access to credit positively affected the decision to participate in malt barley CF. Hence; demographic and institutional variables were crucial in affecting the farmers' decision to participate in CF.

Based on the finding of this study the following recommendations were forwarded. Considering the extension has contributed significantly to the decision to participate in CF of malt barley farmers, it is imperative to strengthen the existing extension system. Given the vital role of training in CF participation, it is essential to improve its access and frequency by enhancing and creating a functioning farmers' training center (FTC). To further increase the participation rate of CF, it is necessary to exchange experiences through field days at farms and demonstration sites where they can realize the benefits of malt barley production since “seeing is believing”. To facilitate the positive contribution of the CF, cooperatives play a major role in creating market access to inputs and outputs because cooperatives are the major supportive actors in the malt barley value chain. Additionally, it was discovered that having access to credit was vital for implementing the contract farming of malt barley. Therefore, the government and other concerned organizations should strengthen the credit sources (like credit and saving cooperatives, microfinance organizations, etc.).

Acronyms and Abbreviations

ATA	Agricultural Transformation Agency	FTC	Farmers Training Center
ATI	Agricultural Transformation Institute	FAO	Food and Agriculture Organization
BoA	Bureau of Agriculture	GMF	Gondar Malt Factory
CSA	Central Statistical Agency	MoE	Ministry of Education
CF	Contract Farming	RUM	Random Utility Model

Acknowledgements

We expressed our gratitude to the Ministry of Education for funding this study, the North Gondar Agricultural Office for providing general information, the Agricultural Offices of the Dabat and Debark Districts for facilitating data collection and the provision of secondary data, and the farmers who provide primary data.

Appendix

Table A1. *Amhara Region's Malt Barley Supply, Demand, Area Coverage, and Beneficiaries.*

Malt barley production and Supply in Amhara region 2011/12 to 2020/21 Crop season

Year	Land allocated (ha)	MB collected by GMF (Qt)	Beneficiary Farmers		
			Contract	Non-contract	Total
2011/2	5,272.00	15,400.00			
2012/3	3,345.00	22,091.00			
2013/4	4,928.00	28,732.93			
2014/5	4,445.00	57,259.67			
2015/6	11,794.00	83,068.62			
2016/7	14,119.00	89,650.71	5,202.00	28,580.00	33,782.00
2017/8	15,056.50	57,421.81	6,293.00	30,976.00	37,269.00
2018/9	12,581.00	35,825.00	4,917.00	30,695.00	35,612.00
2019/20	9,793.75	27,319.46	2,644.00	28,498.00	31,142.00
2020/21	7,929.75	32,203.86	2,070.00	22,955.00	25,025.00

The Supplies of malt barley (Qt) to Gondar Malt Factory

Year	Amhara	Oromia	Imported	Or+Im	Total
2012/3	37,491.00		95,212.21	95,212.21	132,703.21
2013/4	28,732.93		189,212.39	189,212.39	217,945.32
2014/5	57,259.67		164,321.77	164,321.77	221,581.44
2015/6	83,068.62		136,000.00	136,000.00	219,068.62
2016/7	89,650.71	44,258.41	92,486.32	136,744.73	226,395.44
2017/8	57,421.81	51,237.21	120,840.98	172,078.19	229,500.00
2018/9	35,825.00	76,218.99	102,313.40	178,532.39	214,357.39
2019/20	27,319.46	131,111.37	82,456.12	213,567.49	240,886.95
2020/21	32,203.86	81,215.98	25,217.41	206,433.39	238,637.25

The Average annual malt barley (MB) Demand of Gondar Malt Factory (GMF) is approximate 230,000Qt
Source: GMF report; 2022

Table A2. *Post-estimation tests of the probit and logit model (n=398).*

Type of test	Parameters	Binary models		Stata command
		Probit	Logit	
goodness-of-fit	Pearson chi^2 (381)	410.90	416.95[c]	estat gof
	Prob> chi^2	0.1401	0.0990	
Model specification	_hat (Z)	8.64[a]	8.15[a]	Linktest
	_hatsqr (Z)	0.83	1.04	
Specification	Correctly specified	74.12%	74.12%	estat classification
Model fitness	AIC	472.9757	471.9778	estat ic
	BIC	540.7453	539.7475	

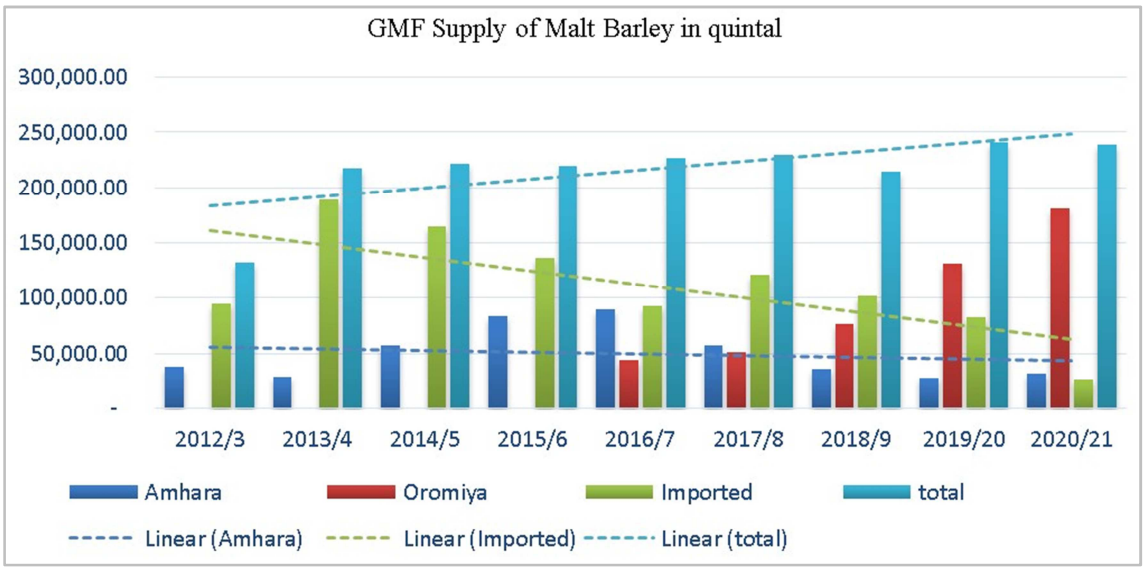

Figure A1. *Malt Barley (MB) Supply to Gondar Malt Factory (GMF) in Amhara Region.*

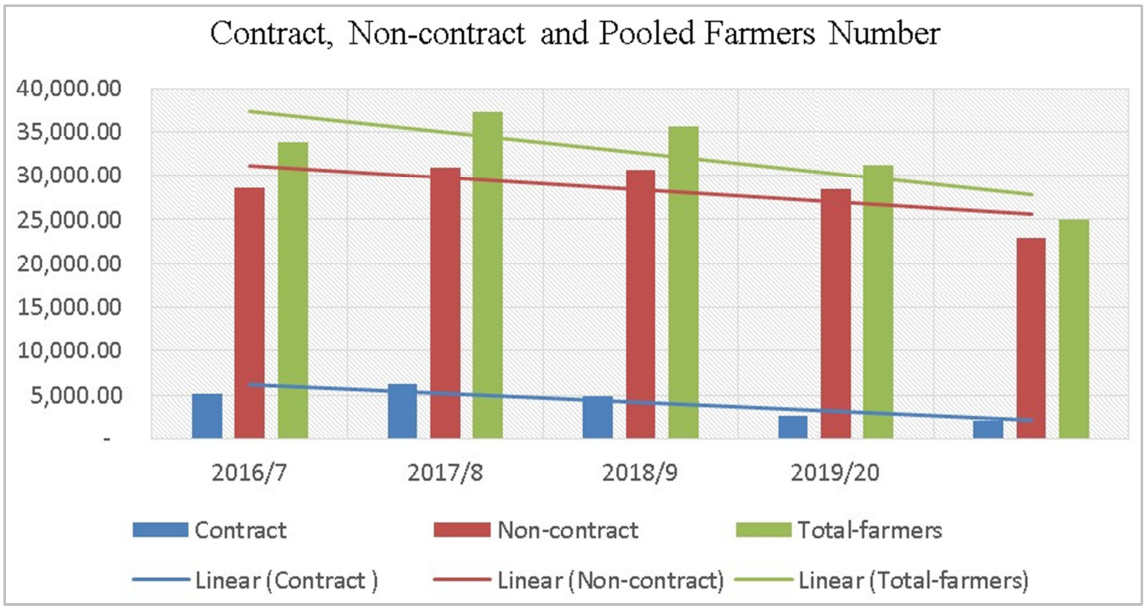

Figure A2. *Malt Barley (MB) Beneficiaries in Amhara Region.*

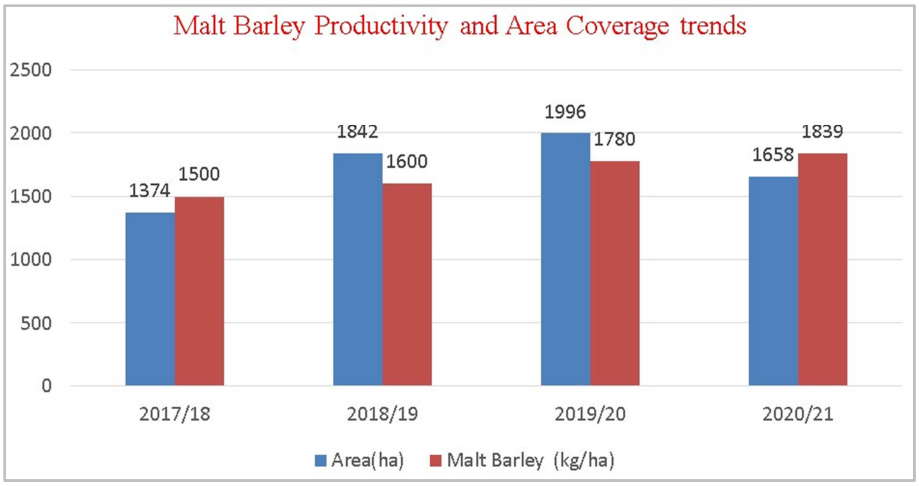

Figure A3. *North Gondar Zone malt barley productivity and Area coverage trends for the last four years (2017/18- 2020/21).*

References

[1] ATI (Agricultural Transformation Institute). increasing agricultural productivity across SSA. Our world in data. 2022.

[2] ITA (International trade admiration). Ethiopia- a country commercial guideline, Addis Ababa, Ethiopia. 2022.

[3] CSA (Central Statistical Agency). The federal democratic republic of Ethiopia central statistical agency area and production of major crops (private peasant holdings, *Meher* season), Addis Ababa 586 statistical bulletin 586 cv-coefficient of variation. 2018.

[4] Hannah Ritchie. Increasing agricultural productivity across SSA. Our world in data. 2022.

[5] ATA (Ethiopian agricultural transformation agency). Transforming Agriculture in Ethiopia 2016/17. Annual Report, Addis Ababa, Ethiopia. 2017.

[6] BIF (Business Innovation Facility). Assessment of the Malting Barley Market System in Ethiopia. 2018.

[7] NPC (National Planning Commission). The Federal Democratic Republic of Ethiopia Growth and Transformation Plan II (GTP II). 2016.

[8] Bishaw Z and, Molla A. *Deployment of Malt Barley Technologies in Ethiopia Achievements and Lessons Learned*. 2020.

[9] Tilaye Bekele. How to involve smallholder farmers in commercial agriculture/horticulture. Ethiopian Producers and exporters association, Addis Ababa, Ethiopia. 2010.

[10] Yigezu YA, Yirga C, Tesfaye A and, Aw-Hassan A. *Adoption Study of Improved Barley Varieties in Ethiopia,* Draft Report Ethiopian Institute of Agricultural Research (EIAR) International Center for Agricultural Research in the Dry Areas (ICARDA). 2014.

[11] Mohammed JH, Tigabie A, Yirga C and, Haji J. Diffusion and Impacts of Improved Varieties in Africa (DIIVA). 2017.

[12] Tadesse D and, Derso B. The status and constraints of food barley production in the North Gondar highlands, North Western Ethiopia. *Agric Food Secur* 2019; 8.

[13] Ferede M, and Demsie Z. Participatory evaluation of malt barley (*Hordium disticum* L.) varieties in barley-growing highland areas of Northwestern Ethiopia. *Cogent Food Agric* 2020; 6.

[14] FAO (Food and Agriculture Organization). FAOSTAT Database, Rome, Italy, retrieved July 2020 from www.faostat.org. 2018.

[15] FAO (Food and Agriculture Organization). FAOSTAT Database, Rome, Italy, retrieved May 2023 from www.faostat.org. 2021.

[16] CSA (Central Statistical Agency). The federal democratic republic of Ethiopia's central statistical agency farm management practices (private peasant holdings, *Meher* season) statistical bulletin. 2021.

[17] Shiferaw S, Haji J, Ketema M, and, Sileshi M. Technical, allocative and economic efficiency of malt barley producers in Arsi zone, Ethiopia. *Cogent Food Agric* 2022; 8: 1–17.

[18] ICARDA (International Center for Agricultural Research in the Dry Areas). Seed Info: *Official newsletter of West Asia and North Africa (WANA) seed network*. Issue No. 56, Seed Section, ICARDA. 2019.

[19] Rashid S, Abate GT, Lemma S, Warner J, Kasa L and, Minot N. *The Barley Value Chain in Ethiopia*. 2015.

[20] WB (World Bank). World Bank data. Retrieved on April 2023 from worldbank.org. 2021.

[21] GAIN (Global Agriculture Information Network). *Assessments of commodity and trade issues. Government policy*. 2021.

[22] Mpeta D, Kuzilwa J and, Sebyiga B. Analysis of Contract Farming Effects on Efficiency and Productivity of Small-Scale Sunflower Farmers in Tanzania – a Propensity Score Method Approach. *Acta Scientiarum Polonorum Oeconomia* 2018; 17.

[23] Swinnen J, and, Kuijpers R. Value chain innovations for technology transfer in developing and emerging economies: Conceptual issues, typology, and policy implications. *Food Policy*, 83 (c): 298–309. 2019.

[24] Ragasa C, Lambrecht I and, Kufoalor DS. Limitations of Contract Farming as a Pro-poor Strategy: The Case of Maize Out-grower Schemes in Upper West Ghana. *World Dev* 2018; 102.

[25] Wiggins S and, Keats S. Leaping and Learning: *Linking smallholders to markets in Africa*. London: Agriculture for Impact, Imperial College and Overseas Development Institute (ODI). 2013.

[26] Bellemare MF. As You Sow, So Shall You Reap: The Welfare Impacts of Contract Farming. *World Dev* 2012; 40.

[27] Carletto C, Corral P and, Guelfi A. Agricultural commercialization and nutrition revisited: Empirical evidence from three African countries. *Food Policy* 2017; 67: 106–118.

[28] Bellemare MF and, Novak L. Contract farming and food security. *Am J Agric Econ* 2017; 99.

[29] Flores M and, Holtland G. *Contract farming in Ethiopia: concept and practice*. 2017.

[30] Bezabeh A, Beyene F, Haji J, and, Lemma T. Impact of contract farming on income of smallholder malt barley farmers in Arsi and West Arsi zones of Oromia region, Ethiopia. *Cogent Food Agric* 2020; 6.

[31] Biggeri M, Burchi F, Ciani F and, Herrmann R. Linking small-scale farmers to the durum wheat value chain in Ethiopia: Assessing the effects on production and wellbeing. *Food Policy* 2018; 79.

[32] Yeshitila M, Isriya B., Prapinwadee S., and, Auttapol S. The Impact of Contract Farming on Technical Efficiency in Ethiopia's Smallholder Sesame Production. *Journal of the Austrian Society of Agricultural Economics* 2020; 16: 57–66.

[33] Addisu BA. Malt barley commercialization through contract farming scheme: A systematic review of experiences and prospects in Ethiopia. *Afr J Agric Res* 2018; 13: 2957–2971.

[34] NBE (New Business Ethiopia). Ethiopia to end malt import boosting local production. Retrieved from https://newbusinessethiopia.com/manufacturing/ethiopia-to-end-malt-import-boosting-local-production/. 2017.

[35] Mulatu G, Haji J, Legesse B, and, Ketema M. Impact of Participation in Vegetables' Contract Farming on Household's Income in the Central Rift Valley of Ethiopia. *American Journal of Rural Development* 2017; 5: 90–96.

[36] Hirpesa M, Legesse B, Haji J and, Bekele K. Determinants of Participation in Contract Farming Among Smallholder Dairy Farmers: The Case of North Shewa Zone of Oromia National Regional State, Ethiopia. *Sustainable Agriculture Research* 2020; 10: 10.

[37] Ganewo Z, Balguda T, Alemu A *et al.* Are smallholder farmers benefiting from malt barley contract farming engagement in Ethiopia? *Agriculture Food Security* 2022; 11.

[38] Girma Meshesha and Gardebroek K. Impact of contract farming on the household income of smallholder farmers: The case of organic honey production in South West Ethiopia, Sheka Zone. MSc Thesis, Wageningen University and Research, Wageningen, Netherland. 2015.

[39] Abera D, Bijman J, Slingerland M, Van Der Velde G and, Onno Omta P. *Beer Multinationals Enhance Agricultural Commercialization in Africa*: Empirical Evidence from Ethiopia. 2018.

[40] Seerp W. Income Intervention Quick Scan: Out grower Schemes and Contract farming; Farmer Income Lab Intervention Quick Scan. Wageningen Centre for Development Innovation, Wageningen University & Research. Report WCDI-18-032. Wageningen. 2018.

[41] Abdulai Y and, Al-Hassan S. Effects of Contract Farming on Small-Holder Soybean Farmers' Income in the Eastern Corridor of the Northern Region, Ghana. Online, 2016.

[42] Assefa M, Henningsen A and, Gibbon P. *Sugarcane Out growers in Ethiopia: 'Forced' to Remain Poor?* 2016.

[43] BoA (Beauro of Agriculture). Annual Report. Bahir Dar, Ethiopia. 2020.

[44] NGZ (north Gondar Zone). Annual agricultural production performance report, Debark, Ethiopia. 2020.

[45] NMA (National Meteorological Agency). Annual Climatic Bulletin for the year 2011, National Metrological Agency of Ethiopia. 2011.

[46] GMF (Gondar Malt Factory). Annual report, Bahir Dar, Ethiopia. 2021.

[47] Horowitz JL and Savin NE. Binary response models: logits, probits, and semiparametric review of linear, logit, and probit models. *Journal of Economic Perspective* 2001; 15: 43–56.

[48] Adekanmbi D. B. Comparison of Probit and Logit Models for Binary Response Variable with Applications to Birth Data in South-Western, Nigeria. *American Journal of Mathematics and Statistics* 2017; 199–208.

[49] Cameron AC and, Trivedi PK. *Microeconometrics: methods and applications*. Cambridge university press. 2005.

[50] Anang B. A Probit Analysis of the Determinants of Fertilizer Adoption by Cocoa Farmers in Ghana. *Asian Journal of Agricultural Extension, Economics & Sociology* 2016; 8: 1–8.

[51] Sebopetji TO, and Belete A. An Application of Probit Analysis to Factors Affecting Small-Scale Farmers' Decision to Take Credit: A Case Study of the Greater Letaba Local Municipality in South Africa. *Afr J Agric Res* 2009; 718–723.

[52] Ntaganira E, Shukla J, Mbeche R, Mbabzize M, and Taremwa K. Determinants of Participation in Contract Farming Among Small Holder Diary Farmers in Rwanda. 2017.

[53] Louviere JJ, Hensher DA, Swait JD and, Adamowicz W. Stated Choice Methods. *Cambridge University Press*, 2000.

[54] Ben-Akiva ME and, Lerman SR. Discrete Choice Analysis: Theory and Application to Travel Demand. Cambridge, Ma., *MIT Press*, 1985.

[55] Khonje M, Manda J, Alene AD and, Kassie M. Analysis of Adoption and Impacts of Improved Maize Varieties in Eastern Zambia. *World Dev* 2015; 66: 695 706–706.

[56] Wooldridge JM. *Econometric Analysis of Cross Section and Panel Data*. 2010.

[57] Maertens M and, Vande Velde K. Contract-farming in Staple Food Chains: The Case of Rice in Benin. *World Dev* 2017; 95.

[58] Olounlade OA, Li GC, Kokoye SEH *et al.* Impact of participation in contract farming on smallholder farmers' income and food security in rural Benin: PSM and LATE parameter combined. *Sustainability* (Switzerland) 2020; 12.

[59] Dube EG. Analysis of Farmers' Resource Use Efficiency on Malt Barley Production and Its Impact on Food Security in Lemuna-Bilbilo Wereda, Ethiopia. 2019.

[60] Rondhi M, Aji JMM, Khasan AF and, Yanuarti R. Factors affecting farmers' participation in contract farming: The case of broiler sector in Indonesia. *Tropical Animal Science Journal* 2020; 43.

[61] Mesay Yami, Teklu Tesfaye and, Adam Bekele. Determinants of Farmers' Participation Decision on Local Seed Multiplication in Amhara Region, Ethiopia: A Double Hurdle Approach. *International Journal of Science and Research* 2013; 2: 2319–7064.

[62] Mathewos T, Temesgen D, Hamza D and, Fesseha H. Determinants of Smallholder Farmers' Participation in Improved Sheep Production: The Case of Doyogena District, Kembata Tembaro Zone, Southern Ethiopia. *Advances in Agriculture* 2021; 2021.

[63] Gujarati DN. *Basic Econometrics*. 4th ed. Irwin: McGraw-Hill. 2004.

[64] Tefera DA and, Bijman J. Economics of contracts in African food systems: evidence from the malt barley sector in Ethiopia. *Agricultural and Food Economics* 2021; 9: 1–21.

[65] Abdurehman M, and, Abdi M. Determinants of farmers adoption decision of improved crop varieties in Ethiopia: Systematic review. *Afr J Agric Res* 2021; 17: 953–960.