Determinants of cereal crops commercialization among smallholder farmers in Guji Zone, Ethiopia

Tariku Ayele1*, Dagnaygebaw Goshme1 and Haile Tamiru1

Abstract: In the Guji Zone, even though cereal crop production volume has shown an increasing trend by 100.5% between 2011 and 2020, the proportion of cereal crops that are marketed has declined by 12.9% during the same years. This study was designed to analyze determinants of cereal crop commercialization in the Guji Zone. The study used cross-sectional data collected in 2019 from a sample of 288 farm households. The study showed that farmers in the Guji Zone were semi-commercially oriented in the cereal crops output market with an average level of cereal crops commercialization of 48.33%. The ordered probit model result revealed that the level of cereal crops commercialization was significantly explained by sex of the household heads, ownership of equines, cultivated land size, the frequency of extension contact, credit use, the value of crops produced, and household’s medium perception about lagged crop price. Thus, the level of cereal crops commercialization can be improved by increasing the frequency of extension contact, agricultural credit supply at low cost, and use of strategies that promote intensive agriculture such as warranting of the availability of modern agro-inputs at affordable prices, and promotion of the adoption and use of modern agro-inputs by farm households.

ABOUT THE AUTHORS

Tariku Ayele is a lecturer at Bule Hora University, Ethiopia. He has a BSc degree in Agricultural Resource Economics and Management and an MSc degree in Agricultural Economics. His areas of research are agribusiness management, agricultural marketing, agricultural technology, economic efficiency, and impact analysis. He has published papers in different journals.

Dagnaygebaw Goshme is a lecturer at Bule Hora University, Ethiopia. He has a BSc degree in Agricultural Resource Economics and Management and an MSc degree in Agricultural Economics. His areas of research are farm management, value chain analysis, agribusiness management, and food security. He has published papers in different journals.

Haile Tamiru is a lecturer at Bule Hora University, Ethiopia. He has a BSc degree in Geography and Economics, and an MSc degree in Agricultural Economics. His areas of research are food security, farm management, resource economics, climate change, and technical efficiency analysis. He has published papers in different journals.

PUBLIC INTEREST STATEMENT

In cereal crops dominated farming system, if farmers have to enjoy a better life beyond subsistence levels, they must earn high income by increasing their level of commercialization in the output market. One of the approaches to increase their income is through progressively evaluating their status of commercialization and, identifying and rectifying the problems facing them through research endeavors. Cognizant of the role of the commercialization of smallholder farming, the government of Ethiopia has given due attention to agricultural commercialization to bring a dynamic change in smallholder agriculture. Motivated by these facts and the gaps of previous studies, this study analyzed determinants of cereal crop commercialization in the Guji Zone. Therefore, the information generated from this study will be helpful to increase the income of smallholder farmer’s in the Guji Zone through scaling up their level of cereal crops commercialization.
1. Introduction

Smallholder farming is a means of livelihood for many rural households in developing economies, like Africa and it has been the mainstay of the rural economy serving mainly as a source of income and food supply (Omiti et al., 2007). Similarly, in Ethiopia, the agriculture sector which is dominated by smallholder farmers still takes a large share in Ethiopia’s economy as evident from its contribution to national GDP (33.3%) (NBE, 2019), export earnings (87%), and total employment (72.7%) (UNDP, 2015). However, notwithstanding its role in the national economy, smallholder farming which constitutes large lots of agricultural production in the country is characterized by a lack of resources, poor agricultural intensification, and vulnerability to production and marketing-related shocks. Moreover, even if by and large, smallholder farmer’s market integration is taken as a key for growth in the agricultural sector and a means to reduce poverty incidence, the vast majority of smallholder farmers in developing nations could not able to fully exploit the existing potential of the markets and thus, they are constrained by different problems (Tesso, 2017).

To solve problems sustainably facing smallholder farmers, many countries and international development agencies focused on modernization and commercialization of the smallholder agricultural sector as a means for reducing food insecurity and poverty among smallholders in developing countries (Tesso, 2017). Likewise, in Ethiopia, smallholder farmer’s commercialization and integration into the market has been one of the policy directions to transform farmers from subsistent oriented production, progress out of poverty, and maintain sustainable development through capacitating smallholder farmers with necessary resources, knowledge, and skills, and support needed to transition smallholder farmers from a traditional subsistence orientation to market-based and commercial orientation (ATA, 2016; Hagos & Geta, 2016). To achieve this, Ethiopia is following a two-approach in the smallholder agriculture commercialization process. The first approach is to increase the proportion of marketed surplus by smallholder farmers in food crop surplus producing areas over a period of time, and the second approach is to insist smallholder farmers in food deficit areas to produce for the market and rely on cash income to purchase food crops from the market (Gabre-Madhin, 2001).

In Ethiopia, cereal production is a dominant form of agricultural practice over other types of crop production (CSA, 2019). According to CSA (2019), the percentage area share of crops production shows that cereals constituted (71.57%), pulses (11.20%), oilseeds (5.17), vegetables (1.67%), root crops (1.60%), fruit crops (0.83%), and coffee (5.28%) of total crop production area. Out of regional states in the country, Oromia ranks first both in terms of land area allocation (45.41% of national crop production area) and crop production (49.24% of national crop production) (CSA, 2019). Like many parts of Ethiopia, crop production is a common means of livelihood in the Guji Zone. The smallholder farmers in the zone majorly produce cereals such as tef, barley, wheat, and maize and others like pulses, oilseeds, vegetables, root crops, fruit crops, coffee, etc. In 2017, out of 122,975.55 ha of land covered under grain production, cereals account for 87,667.59 ha. The total amount of grain produced in the same year was 2,506,864.20 quintals of which 72.2% was accounted by cereals (CSA, 2017). This indicates that cereal crop production is the important source of livelihood for smallholder farmers in the zone and thus, smallholder farmer’s food security and welfare status depends on the extent of development in this subsector.

Notwithstanding the importance of the cereal sub-sector, and the positive outcome of better market integration, the trends of cereals production and marketing in the Guji Zone shows that while the size of cereals production has shown an increasing trend by 100.5% between 2011 and 2020, the proportion of cereal crops that are marketed has declined by 12.9% from 34.17% in 2011 to
29.77% in 2020 indicating the intensity of market participation is still low which could be attributed to various factors (CSA, 2011, 2020a). Moreover, even though the zone has a huge cereal production potential, smallholder farmers are still producing cereals mostly for subsistence purposes (56.12% of the cereals production used for consumption) (CSA, 2020a). As a result, they are unable to earn high income from their production though the commercial transformation of this subsistence production is an important pathway to alleviate poverty both at the national and household level (Mitiku, 2014).

There is little or dearth of empirical evidence on enabling factors and potential sources of stagnation in levels of market participation. For instance, a study by Kadir et al. (2016), Kebede and Korji (2017), and Kebede et al. (2017) respectively addressed the adaptability test of improved varieties of tef, demonstration of improved tef varieties, and factors affecting the productivity of smallholder potato growers respectively at Adola Rede, Adola Rede and Ana Sora, and Bore districts. Altogether, these studies only addressed the means for increasing agricultural production and productivity with a little emphasis on the marketing dimension of the crops especially of cereals which account for 87.6% of grain production in the zone (CSA, 2020b). Therefore, a study of determinants of cereal crop commercialization can help smallholder farmers benefit more from the market through commercial production (Medhane, 2014). Moreover, it has a positive spillover effect on the input market and agricultural technology adoption (Endalew et al., 2020). Cognizant of the aforementioned literature gaps and the importance of cereal crops commercialization, this study was designed to examine the current state of smallholder farmer's cereal crops commercialization, and identify factors affecting the level of cereal crops commercialization in the Guji Zone. The study covered the major cereal crops produced in the Guji Zone such as tef, barley, maize, and wheat.

2. Literature review
Empirical evidence on determinants of smallholder farmers' crop commercialization has been extensively considered for a variety of agricultural products at various locations. Therefore, a review of these factors helped in choosing basic variables for the study taking the study site into account. Fischer and Qaim (2012) identified several factors influencing agricultural commercialization. These factors can be grouped into long-term or short-term and can either facilitate or impede the process of commercialization. The long-term factors are population growth and rural infrastructural development. Some studies show that population growth can increase the quantity of marketable surplus while other studies find that rural infrastructure affected agricultural commercialization through its impact on prices, diffusion of technology, and efficient combination of inputs and outputs (Barrett, 2008).

The factors affecting the market participation decision and marketable supply of agricultural commodities have been identified by different authors using different analytical models based on their nature of the data set. For instance, Bekele and Alemu (2015) used the Tobit estimation method to identify determinants of Haricot bean commercialization in their analysis of farm-level determinants of output commercialization in Haricot bean-based farming systems. They found that the age of household heads, dependency ratio, family size, cultivated land, and livestock ownership (TLU) were factors influencing the intensity of Haricot bean commercialization.

Tufa et al. (2014) used a truncated regression model to identify factors that affect a household’s horticultural crops commercialization level. The result shows the education of the household head, irrigation availability, farm size, and livestock ownership by the head affected the level of commercialization of horticultural crops positively and significantly. However, household size and distance to the market affected commercialization levels negatively and significantly. Ademe et al. (2017) used Heckman’s two-step estimation procedure to identify factors affecting decisions to participate in the crop output market and level of participation. Their finding reveals that farm households’ decision to participate in crop output markets was influenced by the sex of household head, farming experience, livestock holding, cultivated land size, off/non-farm income, fertilizer used, on-farm income, market distance, and crop diversification. On the other hand, dependency ratio, cultivated land size, education status, chemical fertilizer, and distance to the market were factors influencing farm households’ intensity of crop output market participation.
Heckman estimation was used by Abafita et al. (2016) to identify factors affecting smallholders' commercialization. Accordingly, they found the value of crop produced, ownership of ox, number of adult family members, all-weather road, access to credit, fertilizer use, and cooperatives in peasant association were factors affecting market participation positively and age and family size were negatively affected market participation. The intensity of commercialization was affected by the value of crop produced, ownership of ox, land, all-weather road, access to credit, fertilizer use, market orientation index positively and by age and family size negatively. Tufa et al. (2014) employed truncated regression to identify factors affecting the level of commercialization. The authors found education, irrigation, farm size, and livestock were affected the level of commercialization positively while household size and distance to the nearest market were negatively affected the level of commercialization. Moreover, Ele et al. (2013) found that total quantity of food crops produced, farming experience, access to agricultural extension service; the size of land used for cultivation, membership in cooperatives, and household family size are important factors determining the level of commercialization of smallholder farms.

Generally, factors that affect crop commercialization are in respect to the broad categorization of these factors into household characteristics, private assets, and public assets/social capital and transaction cost variables. These factors were also expected to affect the level of cereal crop commercialization in the Guji Zone of Ethiopia and thus, this study was aimed to identify those factors and the magnitude of their effect.

3. Materials and methods

3.1. Description of the study area

The study was conducted in Guji Zone, Ethiopia (Figure 1). Specifically, it was conducted in Adola Rede, Odo Shakiso, and Ana Sora districts of Guji Zone. Adola Rede is one of the districts found in Guji zone at a distance of 475 km from Addis Ababa. It has 28 rural kebeles and 3 urban kebeles, and it is characterized by three agro-climatic zones, namely lowland (60%), midland (29%), and highland (11%) (ARANRO, 2020). Traditional agriculture is still practiced by many farm households in this district. However, a semi-nomadic economic activity is also practiced as a means of livelihood by some of its residents. The mean annual rainfall of the district is about 1000 mm and the mean annual temperature of the district is 28°C. The farmers of this district produce both in meher and belg seasons. They produce cereals such as tef, wheat, barley, and maize, pulses such as haricot bean, and others such as fruits and vegetables. They also engaged in the production of coffee and chat as means of livelihood. Moreover, this district has a huge potential for livestock production as witnessed by farmer's livestock ownership. Cattle, goats, sheep, horses, mules, donkeys, and poultry are livestock types that the district is endowed with (ARBoFED, 2017).

Odo Shakiso is located at a distance of 490 km southeast from Finfinne (Addis Ababa) capital city of Ethiopia and the Regional State of Oromia and 139 km from the zone capital city Negele town. The main economic activity of the district is farming, mining, construction, etc. The district is characterized by three agro-climatic zones, namely highland (locally known as Bada or Dega), midland (locally known as Bada Dore), and lowland or (locally known as Gamoji). The percentage coverage of each climatic zone is highland (33%), midland (47%) and lowland (20%). It receives the mean annual rainfall of about 900 mm and the annual temperature of the district is 25°C. Different types of crops which include tef, wheat, barley, maize, haricot beans, rapeseed, fruits, and vegetables are produced in the district. Moreover, the district is known by livestock population such as cattle, sheep, goats, horses, donkeys, mules, camels, and poultry. All agricultural activities are under small-scale peasant holdings. Agricultural systems are characterized by traditional methods and the uses of modern agricultural inputs are very low. Hand-dug and oxen driven are commonly employed methods of plowing in the district (OSBoFED, 2020).

Ana Sora district is found at a distance of 414 km from Finfinne (Addis Ababa) and 180 km from the zonal town, Nagelle. It receives an annual rainfall of about 1400-1800 mm and the annual
temperatures of the district ranged from 17.5°C—28°C and the altitude ranges from 1900 to 2850 meters above sea level (Dinkale & Semman, 2019; Kebede et al., 2017). The district is classified under 26 rural kebeles and 4 rural towns. The agroecology of the district is 27% highland, 70% midland, and 3% lowland. The district is characterized by mixed economic activities, mainly agricultural practices which constitute the major livelihood of the people. It produces diverse crops such as maize, tef, bread wheat, barley, horticultural and root crops like potato, enset, garlic, onion, carrot, chilies, sweet potato, beetroots, and head cabbage, and highland pulse crops like faba bean, haricot bean, and field pea (ASANRO, 2020).

3.2. Sampling procedure

The sample respondents were selected at various stages using multistage sampling techniques. In the first stage, three districts out of eight well-known crop producer districts were selected using a simple random sampling technique by excluding six pastoral and three town districts in the zone where crop production is practiced rarely or not occurring at all. The simple random sampling technique was chosen over the other sampling techniques because it provides equal chances for the districts to be included in the sampling frame (Singh & Masuku, 2014). The other reason why simple random sampling is reasonably appropriate at this stage is that all districts in a sampling frame are producers of the cereal crops even if there exists agro-ecological difference and impossibility to avoid these heterogeneities at the district level. In the second stage, four kebeles1 from each district were selected using the stratified random sampling technique. The strata were formed based on agro-ecological zones as lowland, midland, and highland to draw representative samples from each strata. The purpose of employing the stratified random sampling technique in this study is to account for the size distribution of each stratum and to ensure homogeneity within the strata. The researchers limited the size of sample kebeles from each districts into four because as cereal crops are predominantly produced in all kebeles in the sample districts, we believed that they can be representative.
Moreover, it was done based on the perception that the selection procedure can assure their representativeness. In the third stage, sample households were selected using a simple random sampling technique by taking into account the size distribution of households in the sample kebeles. A sample size determination statistic developed by Cochran (1977) given hereunder was used to determine the maximum number of respondents.

\[ n = \frac{Z^2 + (p)(q)}{d^2} \]  

(1)

Where; \( n \) is the desired sample size, \( Z \) is the abscissa of a normal curve that cuts off an area \( \alpha \) at the tails. The desired confidence level equals 1—\( \alpha \). In this study, 95% confidence level is considered at \( \alpha = 5\% \). Therefore, \( Z = 1.96 \), \( p \) is the estimated proportion of attributes present in the population, and \( q = 1—p \). For the study under consideration, \( p \) is assumed to be the proportion of crop commercialized households in the zone (Proportion of households with HCI > 50%). Due to the dearth of information on the proportion of commercialized households in the study area, the researchers faced difficulty in fixing the estimate of \( p \) as per the rule. As explained in Singh and Masuku (2014), the estimate of \( p \) and \( q \) should equally be fixed to 0.5 where variability in \( p \) is unknown. This gives a large sample size. In this study, due to the budget and time constraint to deal with the large sample size, the variability in \( p \) was fixed to 0.25 and the total sample size is estimated to 288, based on the judgment that the employed sampling technique could ensure representativeness of the sample. Table 1 presents the size distribution of the sample kebeles and farm households by sample districts.

### Table 1. Distribution of sample households by districts and kebeles

| Sample Districts | Sample kebeles | Number of HHs (no.) | Proportion of Sampled HHs (%) | Number of Sampled HHs |
|------------------|----------------|---------------------|-------------------------------|----------------------|
| Ana Sora         | (i) Sahe Chichu | 4,006               | 23.79                         | 45                   |
|                  | (i) Gidicho Chabi | 2,574              | 15.29                         | 29                   |
|                  | (i) Ababa Kobo   | 5,020               | 29.81                         | 56                   |
|                  | (i) Raya Boda    | 5,238               | 31.11                         | 59                   |
|                  | Sub-total        | 16,838              | 100                           | 189                  |
| Odo Shakiso      | (i) Korba        | 716                 | 12.84                         | 8                    |
|                  | (i) Wolaba       | 2,234               | 40.06                         | 25                   |
|                  | (i) Reji         | 1,118               | 20.05                         | 12                   |
|                  | (i) Tara Badiya  | 1,508               | 27.05                         | 17                   |
|                  | Sub-total        | 5576                | 100                           | 62                   |
| Adola Rede       | (i) Maleka       | 673                 | 20.25                         | 7                    |
|                  | (i) Darartu      | 957                 | 28.79                         | 11                   |
|                  | (i) Michicha     | 906                 | 27.25                         | 10                   |
|                  | (i) Bachara      | 788                 | 23.71                         | 9                    |
|                  | Sub-total        | 3324                | 100                           | 37                   |
|                  | Total            | 25,738              |                                | 288                  |

Source: Own computation based on data from each districts’ ANRO
3.3. Methods of data collection

A cross-sectional data collected from randomly selected sample households in Odo Shakiso, Adola Rede, and Ana Sora districts of the Guji Zone was used in this study. The study used both primary and secondary data. Before actual data collection, a preliminary assessment to sample kebeles in the districts was made and enumerators were identified and trained on interview procedures. Then, a semi-structured questionnaire consisting of both open and close-ended questions in line with the objective of the study was developed, refined, and administered on sampled households by trained enumerators to collect primary data on household characteristics, asset holdings, crop production, and marketing, and access to institutional services. The primary data was mainly used for analysis and making inferences about cereal crops commercialization status, determinants of the level of cereal crops commercialization in the study area. The secondary data relevant for comparative analysis, gap identification, identifying, and deciding on analytical and research methods was gathered from statistical abstracts of sampled districts, journal articles, research findings, and official reports.

3.4. Methods of data analysis

3.4.1. Descriptive analysis

The objectives of the study were achieved using two types of statistical analysis, namely descriptive and inferential (econometric) analysis. The descriptive-analytical tools such as arithmetic means, frequency, one-way ANOVA, and chi-square test were used for analyzing the collected data. The one-way ANOVA was employed to compare the mean values of continuous variables across different levels of commercialization while the chi-square test was employed to test the association between dummy variables and levels of commercialization. The household-level degree of cereal crop commercialization in the Guji zone was estimated using the household commercialization index given in equation (2).

\[
\text{HCI}_i = \frac{\text{Gross value of crop sales of hh i in year } j}{\text{Gross value of crop production of hh i in year } j} \times 100
\]  

(2)

According to Govereh et al. (1999), the household commercialization index (HCI) measures household-specific levels of commercialization. In this study, the index measures the ratio of the gross value of cereal crop sales by household \( i \) in year \( j \) to the gross value of cereal crop produced by the same household \( i \) in the same year \( j \) expressed as a percentage. The index also measures the extent to which household cereal crop production is oriented toward the market. A value of zero would signify a subsistence-oriented household and the closer the index is to 100, the higher the degree of commercialization in the cereals output market.

3.4.2. Econometric model

So far, various analytical models have been employed to identify determinants of the intensity of crop commercialization depending on the nature of the dataset. The Heckman two-step estimation procedure was employed by Ademe et al. (2017) to identify factors affecting decisions to participate in crop output market and level of commercialization. A study by Medhane (2014), Hailua et al. (2015), and Tirra (2019) modelled factors affecting the level of commercialization using Ordinary Least Squares (OLS), Tobit, and Ordered Probit model respectively.

Tobit model is based upon the assumption that both the decision to participate in activity and intensity of participation are determined by the same variables and with the same sign. It is estimated when the dependent variable is clustered/censored at zero for some sample respondents and assumes a continuous value for the remaining samples (Wooldridge, 2002). The Ordinary Least Squares (OLS) as opposed to Tobit and Heckman sample selection models, is applicable in cases where the dependent variable is measured as continuous and zero levels of crop commercialization are not reported by sample respondents. Therefore, with the dataset at hand, these models are not appropriate to estimate as the dependent variable is measured as an ordinal variable.
An empirical analysis of the determinants of smallholder farmer’s decision to participate in a market and level of participation using Heckman sample selection and double hurdle model comes from the fact that market participation is a two-stage process (Cragg, 1971; Heckman, 1979). In this respect, households (or individuals) face different types of decisions about participation, a discrete decision over whether or not to participate in a given market as either a buyer or a seller, and a continuous decision as to how much to buy or sell (Intensity of commercialization) conditional on market participation. Variables affecting the latter, continuous decision may affect the discrete participation decision while some factors may not. Moreover, the Heckman selection model is appropriate if there is a censoring process in measuring the intensity of commercialization (Humphreys, 2010).

As many cereal crops are considered in this study, it is assumed that decision to participate in a market and intensity of sale are simultaneously determined, and hence, crop commercialization is a not two-stage process as opposed to the case where Heckman sample selection and double hurdle model is applicable. Hence, it is not appropriate to estimate Heckman sample selection and double hurdle models. Therefore, based upon these justifications and the nature of dependent variable (level of commercialization, which is measured as an ordinal variable), the ordered probit model was considered to address the causal relationship between the dependent and explanatory variable. One of the advantage of employing ordered probit model is besides identifying the causal relationships between explanatory variables and a dependent variable, it also discerns unequal differences between ordinal classes in the dependent variable (Garridoa et al., 2014).

As stipulated in Greene (2002), the ordered probit estimator of the causal relationship between the dependent and explanatory variables which built around a latent variable is given by:

$$Y_j^* = X_i \beta + \epsilon, \epsilon \sim N(0,1)$$  \hspace{1cm} (3)

Where $Y_j^*$ is latent variable for level of cereal crops commercialization which is measured in ordinal scale (0, 1, 2, \ldots, j), and $Y_i$ is observed in j categories, in this case, low ($Y_i = 0$), moderate ($Y_i = 1$), and high level of commercialization ($Y_i = 2$), $X$ is the vector of explanatory variables hypothesized to affect the level of cereal crops commercialization, $\theta$ is the vector of parameters estimated by the model which determines the magnitude and the direction of the relationship between the explanatory and the dependent variable, and $\epsilon$ is a normally distributed error term to capture random influences on this relationship. The response of category $j$ is observed when the underlying continuous response falls in the j-th interval as:

$$Y_j^* = 0 \text{ if } Y_j^* \leq \alpha_0$$ \hspace{1cm} (4)

$$Y_j^* = 1 \text{ if } \alpha_0 \leq Y_j^* \leq \alpha_1$$ \hspace{1cm} (5)

$$Y_j^* = 2 \text{ if } \alpha_1 \leq Y_j^* \leq \alpha_2$$ \hspace{1cm} (6)

Where $Y_j^*$ ($i = 0, 1, 2$) are the unobservable threshold parameters separating the adjacent categories that were estimated together with other parameters in the model. The probabilities for each of the observed ordinal scale, that is, low, moderate, and high with ordinal values of 0, 1, and 2 was given as:

$$\text{prob}(Y = 0) = P(\beta'X + \epsilon \leq 0) = \Phi(-\beta'X)$$ \hspace{1cm} (7)

$$\text{prob}(Y = 1) = \Phi(\alpha_1 - \beta'X) - \Phi(-\beta'X)$$ \hspace{1cm} (8)

$$\text{prob}(Y = 2) = 1 - \Phi(\alpha_1 - \beta'X)$$ \hspace{1cm} (9)
Where \(0 < Y_1^* < Y_2^* < \ldots < Y_n^* \) is the cumulative normal distribution function such that the sum of the above probabilities is equal to one. The marginal probabilities could be calculated from the ordered probit model as:

\[
\frac{d\text{prob}[Y_j]}{dx_j} = \theta(\beta_0 - \beta' X_j) - \theta((\beta_0 - \beta' X_j) + \beta)
\]

(10)

Where \(\theta\) is the normal density function, \(j\) is the threshold parameter and \(X_j\) is \(j\)-th explanatory variable.

Prior to the estimation of the model, it is mandatory to validate the assumptions of the model. This is because, under the non-satisfaction of basic assumptions of regression models, estimated coefficients do not have the desirable properties of unbiasedness, consistency, and efficiency which could lead to the drawing of wrong inferences to problems under consideration (Salvatore & Reagle, 2002). Based on this fact and the rationale provided in methods of data analysis, ordered probit model was estimated after validating for model assumptions and by rectifying the problems where necessary.

The multicollinearity problem was checked using the Variance Inflating Factor which is the inverse of the difference between 1 and \(R^2\), where \(R^2\) is the coefficient of correlation derived when one of the explanatory variables regressed over all the other explanatory variables. The VIF approaches infinity with an increase in multicollinearity and it equals 1 with a complete absence of multicollinearity problem. As a rule of thumb, a variable is said to be highly collinear if its VIF is greater than ten (Gujarati, 2004). In this study, for all explanatory variables included in the model, the VIF was less than 10 and the mean VIF was 1.41 indicating that there was no serious problem of multicollinearity among explanatory variables. The estimated model was also free of the omitted variable bias problem (\(p = 0.2898\)). To account for heteroscedasticity problems, the standard errors were obtained using a robust covariance matrix estimation.

The other important assumption in ordinal regression is the parallel lines assumption. It states that the estimated parameters are the same for different categories. If the assumption does not hold, it leads to wrong interpretations and conclusions about the results (Ari & Yildiz, 2014). But, the parallel lines assumption of the ordinal models may be too restrictive because sometimes it does not hold (Brant, 1990). Therefore, to account for the differences, category-specific marginal effects were estimated for all explanatory variables by relaxing the assumption.

### 3.4.3. Definition of variables and hypothesis

#### 3.4.3.1. Dependent variable

**Level of cereal crop commercialization.** It is an ordinal variable that has been set into three distinct categories comprising: low (\(Y = 0\)), moderate (\(Y = 1\)), and high (\(Y = 2\)) level of commercialization. The Household Commercialization Index (HCI) which ranges from 0 to 100% was used to categorize smallholder farmers. Thus, \(Y = 0\) if HCI < 35%, \(Y = 1\) if 35% ≤ HCI ≤ 65%, and \(Y = 2\) if HCI > 65%.

#### 3.4.3.2. Explanatory variables.

It includes demographic, socio-economic, institutional, and production-related factors affecting the degree of crop commercialization. Table 2 presents a list of explanatory variables expected to affect the level of cereal crop commercialization in the Guji Zone, and hypothesized direction of association with the dependent variable. They were hypothesized based on reviewed literature (see part 2) and economic theory.

1ETB (Ethiopian Birr) = 0.0344 USD during survey period. A high perception of lagged price was used as a reference. The hypothesized effect is for a moderate and high commercialization category. The reverse sign effect was hypothesized for a low commercialization category.
Table 2. Model variables and hypothesis

| Variables                              | Units of measurement | Expected effect |
|----------------------------------------|----------------------|-----------------|
| **Dependent variable**                 |                      |                 |
| Level of commercialization            | Ordinal (0 = low, 1 = moderate, 2 = high) |                 |
| **Independent variables**             |                      |                 |
| Sex of household heads (1 = Male)     | Binary               | +               |
| Family size                           | Adult Equivalent     | -               |
| Education level                       | Years of Schooling   | +               |
| Farm experience                       | Years                | +               |
| Non-farm income                       | ETB                  | +               |
| Livestock holding                     | TLU                  | +               |
| Ownership of equines (1 = Owned)      | Binary               | +               |
| Cultivated land size                  | Ha                   | +               |
| Membership in cooperative (1 = Member)| Binary               | +               |
| Distance to the district market       | Km                   | -               |
| Frequency of extension contact        | Number               | +               |
| Credit use (1 = Used)                 | Binary               | +               |
| Chemical fertilizer (DAP + UREA)      | 100 kg               | +               |
| Value of crops produced              | Birr                 | +               |
| Low perception of lagged price (1 = low) | Binary            | -               |
| Medium perception of lagged price (1 = medium) | Binary | -               |

4. Results and discussion

4.1. Description of model variables

The summary statistics of demographic and socio-economic characteristics of sample households are presented in Table 3. Out of 288 sample households, 17.01%, 67.36%, and 16.63% respectively were households with a low (HCl ≤ 35), moderate (35 < HCl < 65), and a high commercial status (HCl > 65) indicating that most of the sample households were skewed towards a semi-commercial farming system in the cereal crops output market. About 89.6% were male-headed households while the remaining 10.4% were female-headed households. The mean family size measured in adult equivalent units was 5.50. This value is above the national average of 4.6 per household indicated in CSA (2014). On average, sample household heads in the study area had spent 6.09 years in formal education. The household head’s mean experience in crop production and marketing was about 14.47 years. The mean cultivated land size by sample household heads was 3.32 ha. The livestock is another important socio-economic indicator in the Guji Zone. The mean livestock holding except equines was 5.56 TLU, and about 47.9% of sample household heads had equine animals.

The mean amount of chemical fertilizer applied by sample households in the study area was 241 kg. One-way ANOVA test result shows that there is a statistically significant variation in the quantity of fertilizer used at different levels of cereal crops commercialization. In addition to production factors, it is important to understand farmer’s perception about the lagged crop price as it acts as an incentive for farm households to participate in a market, especially where adaptive expectations are supposed to be formed by agricultural households. Accordingly, the survey result shows about 32.3% and 52.4% of the sample household heads were perceived crop prices in the base year as low and medium respectively. The chi-square test of proportional difference indicates
that there was a statistically significant difference across different commercial statuses among households who perceived lagged product price as low and medium respectively at 10% and 5% significance level.

On average, sample household heads traveled 8.41 kilometers to arrive at the district market. Moreover, the finding indicates that only 6% of sample household heads used credit from formal credit sources. About 62.5% of sample households were members of cooperatives and the average amount of contact made with agricultural extension service providers was 3.04. It implies that, on average, farmers in the study area had contact with development agents thrice a year. There was

| Variables                                      | Commercial Status                  | F/χ² |
|------------------------------------------------|-----------------------------------|------|
| Number of samples                              | Low (≤35%)                        | 49   |
|                                                | Moderate (35–65%)                 | 194  |
|                                                | High (>65%)                       | 45   |
|                                                | Total                             | 288  |
|                                                | Sex of household heads (1 = Male) | 0.775|
|                                                | Family size (Adult equivalent)    | 5.15 |
|                                                | Education level (Years)           | 5.71 |
|                                                | Farm experiences (Years)          | 15.24|
|                                                | Cultivated land size (ha)         | 2.97 |
|                                                | Livestock ownership (TLU)         | 5.60 |
|                                                | Equines (1 = Had)                 | 0.326|
|                                                | Chemical fertilizer (kg)          | 152  |
|                                                | Low perception on lagged crop price | 0.24 |
|                                                | Medium perception on lagged crop price | 0.59 |
|                                                | Distance to the district market (km) | 8.33 |
|                                                | Credit use (1 = used)             | 0.00 |
|                                                | Membership in cooperatives (1 = member) | 0.51 |
|                                                | Frequency of extension contact (no.) | 3.63 |

** and * indicate significance at 5% and 10% respectively

Source: Computed from survey data
Table 4. Crop-specific level of commercialization

| Crop Type       | Level of Commercialization | Total | F-value |
|-----------------|----------------------------|-------|---------|
|                 | Low (≤35%) | Moderate (35–65%) | High (>65%) | Min. | Max. |       |
| Cereal crops (%)| 30         | 47           | 71       | 15    | 88   | 48.42 | 421.87*** |
| Tef (%)         | 14         | 39           | 65       | 0     | 96.3 | 40    | 34.89***  |
| Maize (%)       | 28         | 37           | 52       | 5.7   | 94.4 | 37    | 18.81***  |
| Wheat (%)       | 25         | 33           | 32       | 0     | 96.8 | 32    | 1.26     |
| Barley (%)      | 18         | 33           | 32       | 0     | 96.7 | 31    | 5.11***  |

*** indicate significance at 1%

a statistically significant difference in cooperative membership and frequency of extension contact across different commercial statuses at a 5% significance level.

4.2. Level of cereal crops commercialization

Results showing smallholder farmer’s level of cereal crop commercialization in the Guji Zone are presented in Table 4. The level of cereal crop commercialization averaged for all sample households was 48.42% implying farm households in the Guji Zone sold 48.42% of their cereal crops production to the market. It has ranged from a minimum cereal crop sale of 15% to a maximum of 88% out of total cereal crop production value. The level of cereal crop commercialization by category of crops produced indicates sample household head’s level of crop commercialization in tef (Eragrostis tef (Zucci.)), maize (Zea mays L.), wheat (Triticum aestivum L.), and barley (Hordeum vulgare L.) is 40%, 37%, 32%, and 31% respectively. This implies that, relatively, tef and maize are commercial crops in the Guji Zone. The one-way ANOVA test of mean difference was statistically significant at 1% except for the scale of commercialization in wheat production.

4.3. Determinants of the level of cereal crops commercialization

The ordered probit estimation results for the determinants of smallholder farmers’ level of commercialization in cereal crops are displayed in Table 5. The Wald-statistic (85.27) was strongly significant leading us to the rejection of the null hypothesis of zero coefficient of all explanatory variables included in the model. The estimation result from the ordered probit model revealed that out of the sixteen explanatory variables used in the regression analysis, seven explanatory variables were found statistically significant variables influencing the level of cereal crops commercialization in the study area. The Pseudo R-square value of 0.1756 implies 17.56% of the variation in the level of cereal crops commercialization was explained by explanatory variables included in the model. The predicted probability that the farmers are being in a low, moderate, and high level of cereal crops commercialization respectively were 17%, 67.6%, and 15.4%. This implies that farm households in the Guji Zone were more likely moderately or semi-commercially oriented in the cereal crops output market than the rest of the category. The factors affecting the level of cereal crop commercialization in the study area are discussed as follows.

4.3.1. Sex of the household heads

It was found one of the explanatory variables affecting the probability of being in a high commercial status positively, and the probability of being in a low commercial status negatively at a 1% significance level. The marginal effect of the sex of the household heads for high commercial status (0.165) implies that, relative to female-headed households, the probability of achieving a high level of commercialization for male household heads increases by 16.5%. Conversely, the likelihood of male households being in a low commercial status decreases by 17.8% compared to female households. This could be due to the fact that male household heads relatively own more assets necessary to operate and manage their farm. Moreover, as compared to female household heads whose crop
production objective is primarily to meet the food needs of the family, male household heads produce crops for earning income in addition to meeting family consumption requirements making them more market-oriented than female-headed households. This result was in line with prior expectations and the findings of Assefa et al. (2015), and Fentaw (2015) that states being male-headed households had a positive association with coffee marketed surplus and value of crops marketed respectively than female-headed households.

4.3.2. Ownership of equines
The ownership of equine animals as a proxy for transportation access is statistically significant at a 5% significance level and had a positive influence on the probability of being in a high commercial state. It was negatively associated with the probability of being in a low commercialization category. A shift from lack of equine animals increases the probability of achieving a high level of cereal crop commercialization by 6.4%. It also decreases the probability of being in a low commercialization category by 6.9%. It implies that household heads who owned equine animals are more likely to be commercialized in the cereal crops market as compared to household heads who did not have equine animals. This is because, especially
during harvest season, equine animals help the farmer transport their produce from farm to home after harvest thereby contributing to the reduction of transportation cost. Moreover, given the nature of rural road infrastructure in developing countries, most of the time farmers face difficulty in accessing public transport to transport their produce from their homes to the market. Thus, ownership of equine animals increases the farmer's likelihood of attaining a high level of cereal crop commercialization. This result concurs with the findings reported by Medhane (2014) and Gobena et al. (2016) which revealed the importance of ownership of equine animals and transportation equipment in enhancing marketed surplus by farmers.

4.3.3. Cultivated land size
The size of cultivated land was positively and significantly related to the probability of being in a high commercialization category, and it was negatively and significantly associated with the probability of being in a low commercialization category at a 5% significance level. This implies that the more (lesser) the size of the land cultivated under cereal crops, the more (lesser) will be the level of commercialization achieved by farmers. The land is one of the major and the key production asset having a direct effect on surplus production in agrarian households (Tufa et al., 2014). Thus, the decision made by households is highly influenced by their landholding size (Kefyalew, 2012). Households who allocate a large size of land for cereal crops are more likely to increase their production level and thus, increase their level of commercialization. The marginal effect of the cultivated land size for the high commercialization category suggests that a hectare increase in the size of land cultivated will result in an 8.1% increase in the probability of attaining a high level of commercialization. The probability of being in a low commercial status decreases by 8.7% for a unit increase in the size of land cultivated. The result was consistent with findings of the Tufa et al. (2014) which state the positive effect of farm size on the level of horticultural crop commercialization. Moreover, this finding seems to correspond with the findings of Ademe et al. (2017) who found a significant positive effect of cultivated land size on both decisions and level of participation of smallholder farmers in the crop output markets.

4.3.4. Frequency of extension contact
Consistent with the prior expectation, it was significantly and positively associated with the probability of being in a high state of commercialization at a 1% significance level. It also had a negative significant effect on the probability of being a low commercial state at a 1% significance level. As farmer's contact with extension service providers increases by a day, the probability of being more commercialized in a cereal crops output market increases by 2.3% and decreases the probability of being in a low commercialization category by 2.5%. In smallholder farming, the role of agricultural extension in enhancing agricultural production and productivity through agricultural technology promotion and dissemination is inevitable. Therefore, more contact with extension agents enables farmers to adopt production-enhancing technologies and methods of production which increase their level of commercialization through positively affecting the amount of production. In favor of this finding, a study by Diyana (2014) also reveals the positive effect of extension contact on enhancing the commercial status of smallholder farmers.

4.3.5. Credit use
The amount of credit used for the production and marketing of crops during the previous year had influenced the probability of being in a high commercial status positively, and the probability of being in a low state of commercialization negatively at a 1% significance level. The marginal effect of credit use for the high commercialization category implies the probability of attaining a high level of commercialization for households who used credit increases by 27%. With credit use, the likelihood of being in a low commercial status decreases by 29.1%. The empirical evidence on determinants of agricultural commercialization indicates, better credit system can help smallholder farmers to build assets that enhance the level of adoption of the new technology and price risks. Moreover, the availability of credit services contributes to market orientation by easing the liquidity constraints of households (Abafita et al., 2016; Gebremedhin & Hoekstra, 2007). This is because, use of credit increases farm household's financial capability to cover farm operating costs and associated marketing costs especially during seed sowing, harvest and post-harvest periods thereby contribute to an increase in surplus production by increasing agricultural investment and reducing post-harvest losses which in turn increase their level of crop
commercialization. The result was consistent with the finding by Abafita et al. (2016) which states the probability of market participation and intensity of commercialization increases with credit use.

4.3.6. Value of crops produced
Consistent with the findings of Abafita et al. (2016) the value of crops produced also had a positive significant effect for high commercial status and it had a negative significant effect for low commercial status respectively at a 5% and 10% significance level. The positive marginal effect of the value of crops produced implies the probability of being more commercialized in the cereal crops output market increases as farm households face higher crop value. The probability of attaining a high level of commercialization increases by 4.3% for every 1% increase in the value of crops produced. It decreases the probability of being in a low state of commercialization by 4.7%

4.3.7. Medium perception on lagged crop price
The level of cereal crop commercialization was also influenced by household heads’ medium perception about lagged crop price. The result showed that the probability of attaining a high level of commercialization decreases by 8.2%, whereas the probability of being in a low state of commercialization increases by 8.8% for household heads who perceived lagged crop price as a medium as compared to households who perceived lagged crop price as high. This implies that household heads who perceived lagged crop price as a medium are less likely to be commercialized in the cereal crops output market as compared to household heads whose perception of lagged crop price is high. The smallholder farmer's decision to produce a crop and their intensity of market participation is highly related to the price they expect from the market. This is especially a common practice when the farmer forms an expectation based on an adaptive expectation model. The result confirms the finding of Gobena et al. (2016) that states the lagged price can act as a motivation for farmers to participate or not to participate in the market and they are motivated more to produce a crop and have surpluses to supply to the market when the perception of lagged market price by farmers is high.

5. Conclusions and recommendations
The study revealed that the probability of being in a high state of commercialization was positively and significantly influenced by the sex of the household heads, cultivated land size, the ownership of equines, the frequency of extension contact, credit use, the value of crops produced and, it was negatively and significantly influenced by household’s medium perception about lagged crop price. Conversely, the probability of being in a low state of commercialization was negatively influenced by the aforementioned factors except for the household’s medium perception about lagged crop price which had a significant positive effect. Of these variables, the sex of the household heads, cultivated land size, and medium perception about lagged crop price had a higher parametric effect on the probability of being in a low, and high category of cereal crop commercialization in the Guji zone. The study also indicated that farmers in the Guji Zone were semi-commercially oriented in the cereal crops output market. However, there was significant variation in the level of cereal crops commercialization among the sample households (ranged from 15% to 88%) which calls for further efforts by concerned stakeholders to uplift households with a low degree of cereal crops commercialization. This can be achieved through ensuring the access and quality of extension services provided by development agents and by investing in the human capital of agricultural extension service providers, ensuring the access and promotion of agricultural credit through creating awareness, and by refining bottlenecks in agricultural credit policy and administration, use of strategies that promote intensive agricultural practices such as warranting of the availability of modern agro-inputs (improved seeds, fertilizer, herbicide, small scale mechanizations, etc) at affordable prices and, promotion of the adoption and use of these agro-inputs by farm households, and by empowering female-headed households through provision of institutional support services, and regular training related to crop production methods and marketing strategies through Farmers Training Center (FTC).
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Note
1. Smallest administration unit in Ethiopia

Disclosure statement
There is no conflict of interest declared by the author(s).

Data availability statement
The authors confirm that the data supporting the findings of this study are available as a STATA software formatted file in mendely data repository. https://data.mendeley.com/drafts/y2g25pnczf. DOI: http://dx.doi.org/10.17632/y2g25pnczf.2

Ethical considerations
The researchers have considered all scientific ethical issues by citing the ideas and findings of the others, and by engaging the research participants based on voluntarism. During the interview process, the coding system was employed instead of the respondent’s name. Moreover, the researchers assured the confidentiality of the information given by participants so as protect them from any possible harm.

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