Determinants of Cereal Crop Commercialization Among Smallholder Farmers in Central and Southern Oromia, Ethiopia

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Abstract

Although agricultural commercialization is widely recognized as a key driver of sustainable economic growth and rural transformation in Ethiopia, its level remains relatively low. Based on cross-sectional primary data collected from 685 smallholder farmers in central and southern Oromia, examined the determinants of both the level and extent of cereal crop commercialization. An Ordered Logit model was used to analyze the level of commercialization, measured by household commercialization categories (low, medium, and high), while a Tobit model was employed to assess the extent of commercialization, measured by the continuous Household Commercialization Index (HCI). Results showed an average HCI of 0.54, with 38.54% of households classified as highly commercialized, 27.45% as subsistence-oriented, and 34.01% as moderately commercialized, indicating substantial variation in market participation. Key factors positively influencing commercialization included education, extension services, access to market information, access to credit, irrigation, training, farm size, livestock holdings, and crop diversification, while it was negatively affected by household size and residence in North Shewa, West Arsi, and West Shewa. The findings suggest that policies aimed at strengthening human capital, extension systems, and access to productive assets can significantly enhance cereal commercialization. Expanding irrigation infrastructure, promoting efficient land use, and improving access to mechanization and market information are critical for advancing sustainable commercialization and improving rural livelihoods.

Keywords: Commercialization; Cereal crops; Ordered logit; Tobit model; Ethiopia

JEL Classification: Q12, Q13, Q18.

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1. Introduction

Agricultural commercialization is widely recognized as a critical driver of economic growth and rural transformation in developing countries (Von Braun and Kennedy, 1994; Pingali and Rosegrant, 1995; Dureti et al., 2023; Jaleta et al., 2009; Carletto et al., 2017). Several studies highlight that commercialization has considerable potential to reduce rural poverty, improve household welfare, and foster overall economic development (Birhanu et al., 2021; Deshmukh et al., 2021; Getahun, 2020; Haji, 2022). Empirical evidence across Africa further shows that commercialization positively influences income generation, food and nutritional security, and resilience to shocks (Ruhbara and Mudhara, 2019; Tabe et al., 2022; Haji, 2022; Ogutu et al., 2020).

Like many developing countries, Ethiopia relies heavily on agriculture, which remains the backbone of the economy by employing the majority of the population, contributing substantially to GDP, and providing livelihoods for millions of smallholder farmers (CSA, 2020; World Bank, 2020; Dorosh and Rashid, 2013). Therefore, agricultural commercialization is not merely a policy preference but a critical requirement for achieving sustainable development and reducing poverty (Neme and Tefera, 2021). In addition to benefiting farm households, commercialization creates considerable spillovers for the broader economy (Linderhof et al., 2019; Kadiri, 2025). For example, it generates demand for agricultural input suppliers, transport services, processing industries, wholesale and retail markets (Haggblade et al., 2011; Ayele, 2022; Jaleta et al., 2009). This also creates job opportunities and income for actors in value chains with potential implications for structural transformation (Ayele, 2022).

Accordingly, agricultural commercialization constitutes a key priority within Ethiopia's rural development agenda. Policy frameworks such as the Agricultural Development-Led Industrialization (ADLI) strategy, the Growth and Transformation Plans I and II (2011 and 2015), the recent Agriculture and Rural Development Policy, and the 10-year development plan have consistently highlighted agricultural commercialization as a cornerstone for accelerating economic transformation in Ethiopia (FDRE, 2010, 2015, 2021). Despite these initiatives and policy direction, agricultural commercialization in Ethiopia remains low and below its potential (Minot et al., 2022; Dureti et al., 2023). Most smallholder farmers continue to produce primarily for subsistence rather than for the market, with only a limited share of their output entering commercial channels, a pattern that is common not only in Ethiopia but also in other

developing countries (Carletto et al., 2017; Gebiso et al., 2023; Minot et al., 2022; Chegere and Kauky, 2022; Dureti et al., 2023).

For instance, agricultural commercialization in Ethiopia remains generally low, with the national crop commercialization index averaging only 25.03 percent (CSA, 2021). However, commercialization levels vary widely across crop types and regions due to differences in market access, production systems, and product characteristics. For example, despite cereal crop lowest commercialization level (21.09%) than other categories (pulses, vegetable, and high-value cash crop), teff exhibits relatively high commercialization rates (34.79%) because of strong urban demand, whereas wheat (24.37%), barley (17.57%) and maize (16.1%) are largely retained for household consumption, which relatively limits their market participation (CSA, 2021; Ayele, 2021; Minot et al., 2022). Vegetable crops (23.18) tend to have higher commercialization potential than cereal crops, while high-value cash crops such as coffee (50.88%), chat (70.2%), and oilseeds (54.81%) achieve better market access due to strong local and export demand (CSA, 2021; Minot et al., 2022). Regional disparities are also evident: farmers in SNNP (29.17%) generally report relatively higher cereal crops commercialization than those in Oromia (21.4 %) and Amhara (18.32 %), while commercialization remains low in Benishangul-Gumuz (18.83%), Gambela (12.35%), Tigray (11.33%), and Somali (15.63%) due to limited markets, high transaction costs, climatic shocks, and insecurity (CSA, 2021; Minot et al., 2022). In general, the level of commercialization in Ethiopia remains very low and uneven.

Assessing the determinants of agricultural commercialization is crucial for understanding rural transformation in Ethiopia. The country's agricultural sector is overwhelmingly dominated by cereals, which account for approximately 88.13% of the total cultivated area and 81.03% of land allocated to grain crops, yet commercialization levels remain low (CSA, 2021). Oromia plays a particularly central role in this context, as it accounts for about 45.41% of the country's agricultural land and contributes 51.2% of total crop production (CSA, 2020; Mehare et al., 2024). Examining the commercialization of major cereal crops and its determinants in Oromia, especially in central and southern Oromia, provides important insights into the structural constraints and opportunities for agricultural transformation in Ethiopia.

Several empirical studies have examined the level and determinants of agricultural commercialization in Ethiopia and other Sub-Saharan African countries, with a strong focus on specific crops and localized settings. For instance, (Guye et al., 2025; Wassihun et al., 2022; Asfaw et al., 2022; Dangia et al., 2019) analyze maize commercialization and consistently show that land size, market access, education, off/non-farm income activity, and institutional support increase market participation, while transaction costs and risk discourage sales. Studies on teff commercialization (Gidelew et al., 2022) report that access to extension services, improved inputs, and the size of land allocated to teff significantly increase commercialization intensity, but the analysis remains limited to single districts. Wheat-focused studies by Mamo et al. (2017) and Abate et al. (2022) find that farm size, access to markets/information, access to credit, and livestock ownership positively affect commercialization, though their evidence is limited to specific areas. Previous research on barley (Ali et al., 2018; Bezabeh et al., 2022) highlights the role of contract farming and vertical coordination in improving market orientation, but these studies focus primarily on niche value chains. Similarly, tomato studies by (Ejeta et al., 2020; Wondim and Geyo, 2024), potato analysis by (Wakaba et al., 2022), and banana research by (Eshbel et al., 2023) emphasize education, market agreement, technology adoption, and market access along with other factors, yet remain crop-specific and geographically narrow. While these studies provide valuable insights for policy, their crop-specific focus and limited regional coverage constrain broader generalization and leave gaps in understanding commercialization patterns across multiple cereal crops and diverse agro-ecological zones.

In addition, some studies focus only on market participation and examine whether households sell output, without considering the volume sold (Abate et al., 2022; Hlatshwayo et al., 2022; Megerssa et al., 2020). Other studies classify households by participation level but do not measure the intensity of commercialization (Ayele, 2022; Demeke and Haji, 2014). In contrast, another group of studies analyzes only the extent of commercialization by focusing on the share of output sold (Guye et al., 2025; Bezabeh et al., 2022; Endalew et al., 2020; Mamo et al., 2022). This segmented approach limits understanding of commercialization as a sequential and continuous process.

The purpose of this study is to examine the determinants of both the level and extent of cereal crop commercialization among farm households in Central and Southern Oromia, Ethiopia. This focus addresses gaps in the literature that call

for broader regional coverage, the inclusion of multiple crop systems, and a joint analysis of commercialization level and intensity to generate stronger evidence for policy design in Ethiopia and comparable contexts. The analysis covers all major cereal crops across five zones with diverse agroecological conditions, allowing a more representative assessment of regional variation. The study applies an ordered logit model to analyze the level of commercialization and a two-limit Tobit model to examine the intensity of commercialization.

The scientific contribution of this study lies in addressing key limitations in the existing literature on cereal commercialization in Ethiopia. First, the study extends geographic coverage by providing empirical evidence from Central and Southern Oromia, regions that remain insufficiently examined in earlier studies. Second, it applies to a joint modeling framework that analyzes both the status and intensity of commercialization, offering a more comprehensive assessment of smallholder market behavior than studies that treat these dimensions separately. Third, the study focuses on major cereal crops rather than on crop-specific analyses, enabling broader insights into overall commercialization processes. Through these contributions, the study partially and fully closes important gaps in prior research and provides new evidence that improves understanding of the determinants of cereal commercialization in smallholder farming systems. This integrated approach strengthens the robustness of the analysis and provides clearer empirical insights. The findings offer relevant evidence to support the design and implementation of interventions that enhance cereal commercialization, improve productivity, strengthen food security, and support rural livelihoods.

2. Materials and Methods

2.1. Study area

The study was conducted in the Oromia Regional State of Ethiopia and focused on five zones in the central and southern parts of the region: West Shewa, East Shewa, North Shewa, Arsi, and West Arsi (**Figure 1**). These zones were selected on methodological grounds rather than purely descriptive criteria. Specifically, they represent major cereal-producing areas with substantial variation in agroecological conditions, market access, population density, and infrastructure, which makes them suitable for analyzing differences in cereal commercialization behavior across heterogeneous settings.

Oromia is the largest regional state in Ethiopia, with a population exceeding 40 million, accounting for more than one-third of the national population (Mehare et al., 2024). Geographically, the region lies between 3°40′ and 10°46′ N latitude and 34°08′ and 42°55′ E longitude. It shares borders with all regional states of Ethiopia except Tigray. Oromia covers approximately 363,007 square kilometers, representing about 34% of the country's total land area (Mehare et al., 2024). The region plays a leading role in Ethiopia's economy, contributing about 40% of national gross domestic product. Oromia accounts for 51.2% of total crop production, 45.1% of cultivated cereal area, and about 44% of the national livestock population (CSA, 2020). Agriculture remains the backbone of the regional economy and employs the majority of the population (CSA, 2020; Dorosh and Rashid, 2013). Major crops produced in the region include cereals such as teff, wheat, maize, and barley, alongside cash crops such as coffee, which contributes substantially to national export earnings (CSA 2021; Mehare et al., 2024).

Despite the central and southern zones of Oromia having high production potential and favorable location advantages, the level of cereal crop commercialization remains relatively low and uneven across zones. For example, cereal commercialization rates in West Shewa, East Shewa, North Shewa, Arsi, and West Arsi are estimated at 23.69%, 38.14%, 19.02%, 24.38%, and 26.73%, respectively (CSA, 2021). This contrast between strong production capacity and limited market engagement provides a clear justification for focusing on these zones. It highlights the need to identify factors that constrain or promote the commercialization of cereal crops among smallholder farmers in the region. In Ethiopia, smallholder farmers cultivate approximately 95% of the total cropped land and produce over 90% of the country's agricultural output. The average landholding per farm household is 1.18 hectares (CSA, 2007), which aligns with the conventional definition of small farms as those under two hectares. In contrast, the households sampled in this study have an average landholding of 2.6 hectares, indicating that they are relatively larger than the typical smallholder farm in the country.

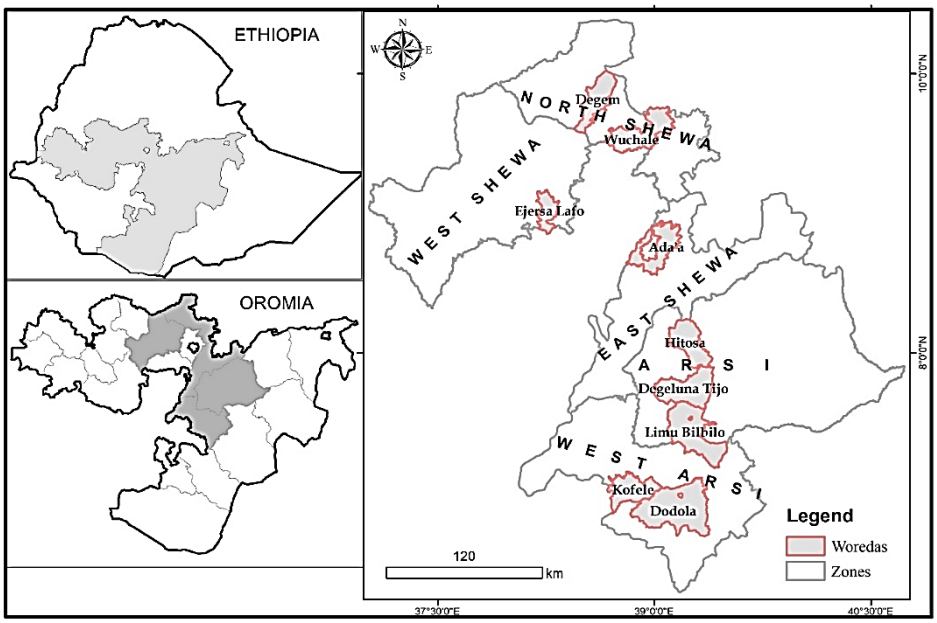

Figure 1: Map of the study area

2.2. Data type and sources

The data for this study were obtained from both primary and secondary sources. Primary data were collected from a sample of farm households using a structured questionnaire. The household survey captured information on demographic, socioeconomic, and institutional characteristics, agricultural production, land allocation, levels of commercialization, and consumption patterns. In addition, a checklist was used to collect data at the kebele and district levels.

Before the actual survey, a pilot test was conducted with randomly selected smallholder farmers to ensure the questionnaire's clarity and reliability, after which necessary adjustments were made. Data collection was carried out by trained enumerators who were familiar with the study areas, understood the local language, and had prior experience in data gathering. Their work was closely coordinated and supervised by the principal investigator to ensure accuracy and consistency of the data. Secondary data were obtained from relevant reports, publications, and databases, including the Central Statistical Agency (CSA), the Ministry of Agriculture, and other institutional sources, to complement and validate the primary data.

2.3. Sampling procedure and sample size

This study employed a robust multistage sampling technique to ensure the final sample of 685 farm households that represent the target population, cereal producers in key agricultural areas of the Oromia region. In the first stage, five zones, namely West Shewa, East Shewa, North Shewa, Arsi, and West Arsi, were purposively selected. This selection was based on their demonstrated high potential in cereal production and their importance for enhancing commercialization. This initial purposive choice ensured that the study was conducted in areas where commercialization, diversification, and productivity were most active and relevant, thereby maximizing the practical applicability of the findings to policy interventions aimed at agricultural transformation in Oromia.

In the second stage, major cereal-producing districts were identified in each zone, and nine of these districts were randomly selected based on probability proportional to the size (PPS) of cereal production within each of the five zones. This procedure was mirrored in the third stage, where 18 kebeles (the smallest administrative units) were randomly selected from the selected districts, again strictly adhering to the PPS principle to ensure fair representation. Finally, a total of 685 cereal-producing farm households were randomly selected from the sampled kebeles, using PPS to finalize the data collection units. This system ensures the data is both statistically valid and contextually relevant.

To determine the minimum required sample size, Cochran's sample size determination formula was employed, as presented in **Equation (1)**.

$$N = \frac{z^2 pq}{e^2} = \frac{(1.96)^2(0.5)(0.5)}{0.05^2} \approx 385 \qquad \textbf{(1)}$$

As shown in **Equation (1)**, N is the desired sample size; Z is the standard normal value corresponding to the chosen confidence level (1.96); and e is an acceptable error (level of precision). Variable q is the weighting variable, and it would be computed as (1-P), and p is the estimated proportion of the population possessing the attribute of interest, set at a 95% confidence level and a 5% margin of error. The computation yielded a sample size of 385 households. However, to increase the reliability and representativeness of the findings, the study collected data from 685 respondents, exceeding the minimum requirement. This larger sample enhances the robustness of the analysis and reduces potential sampling errors.

The sample distribution at the zone and district levels is presented in **Table 1**.

Table 1: Sample districts, zones, and number of sample households.

Zones	Districts	Sample Households	Percent
Arsi	Digeluna Tijo	26	3.80
	Hetosa	103	15.04
	Lemuna and Bilbilo	54	7.88
West Arsi	Dodola	108	15.77
	Kofele	53	7.74
North Shewa	Degem	64	9.34
	Wuchale	59	8.61
East Shewa	Ada'a	92	13.43
West Shewa	Ejere	126	18.39
Total		685	100

2.4. Method of data analysis

2.4.1. Measurement of smallholder cereal commercialization level

In the literature, the Household Commercialization Index (HCI) is widely used to measure agricultural commercialization (Jaleta et al., 2009; Gebreselassie and Sharp, 2007; Mamo et al., 2017; Zondi et al., 2022; Nwafor and van der Westhuizen, 2020; Gebiso et al., 2023). This study applied the HCI to measure the level of smallholder cereal commercialization.

The Household Commercialization Index (HCI) is defined as the ratio of the total value of crops sold to the total value of crops produced by a household during a given year (Jones Govereh et al., 1999; Strasberg et al., 1999). In this study, the index focuses on the major cereal crops cultivated in central and southern Oromia, namely wheat, maize, teff, and barley. Accordingly, the HCI is computed as the proportion of the aggregate value of these cereal crops sold relative to the total value of the same cereal crops produced by the household during the same production year. The HCI is calculated using **Equation (2)**.

$$HCI_i = \left[\frac{Gross\ quantity\ of\ cereal\ crops\ sold}{Gross\ quantity\ of cereal\ crops\ harvested}\right] \times 100 \qquad \textbf{(2)}$$

As shown in Equation (2), the commercialization index ranges from 0 to 100 percent, where higher values indicate greater market orientation. Rather than

using a binary classification of households as commercial or non-commercial, the HCI allows categorization across different commercialization levels. Accordingly, households with an HCI of 0 to 30 percent are classified as subsistence-oriented, those with 30 to 65 percent as semi-commercial, and those with more than 65 percent as commercially oriented (Gebreselassie and Sharp, 2007; Gebiso et al., 2023).

In this study, both the categorical classification of commercialization levels and the continuous HCI were used to capture the status and extent of cereal commercialization among producing households.

2.4.2. Determinants of cereal crops commercialization level and extent

To identify the determinants of cereal crop commercialization in the study areas, both the ordered logit and two-limit Tobit models were employed. The ordered logit model was used to capture households' commercialization status (low, moderate, or high), while the two-limit Tobit model was used to measure the extent of commercialization and to assess the robustness and consistency of the results. For both models, diagnostic tests were conducted to assess multicollinearity and heteroscedasticity using the variance inflation factor (VIF) and the Breusch-Pagan/Cook-Weisberg test, respectively.

The analysis of commercialization status is grounded in expected utility maximization theory, which suggests that a farm household i chooses a higher level of commercialization if the expected utility from doing so (U_i^*) exceeds the expected utility from remaining at a lower commercialization level or subsistence production (U_i) (Grant and Van Zandt, 2007; Quiggin, 2012; Bolarinwa et al., 202). Following Hussayn et al. (2020), Ogutu et al. (2020), Otekunrin et al. (2022), and Oluwatayo and Rachoene (2017), the latent utility function is specified in **Equation (3).** Accordingly, the latent variable Y_i^*, which represents the unobserved net benefit derived from commercialization, is defined as:

$$Y_i^* = U_i^* - U_i > 0 \qquad \textbf{(3)}$$

In this study, commercialization is categorized into low, moderate, and high levels. These categories are naturally ordered, making the ordered logit model appropriate for estimation. The model assumes a continuous latent variable (Y_i*) that represents the household's true but unobserved level of commercialization.

What is observed, however, is the discrete category into which this latent score falls, determined by threshold values (μ). The relationship between the latent variable and the observed commercialization categories is defined by threshold values, as presented in **Equation (4).**

$$Y_i^* = \beta X_i - \varepsilon_i \; where \; Y_i = \begin{cases} 0 \quad if \quad Y_i^* < \mu_1 \; (low \; commercialization) \\ 1 \; if \; \mu_1 < Y_i^* < \mu_2 \; (moderate \; commercialization) \\ 2 \quad if \quad Y_i^* \geq \mu_2 \; (high \; commercialization) \end{cases} \quad \textbf{(4)}$$

According to Dangia et al. (2019), the probability that a household belongs to each commercialization category is estimated using the ordered logit probability function shown in **Equation (5).**

$$\Pr(Y_i > j) = \frac{\exp(a_j + X_i\beta)}{1+\exp(a_j + X_i\beta)}, \quad j = 0, 1, 2 \quad \textbf{(5)}$$

In **Equation (5),** Y_i is the dependent variable representing the level of commercialization for household i, categorized into three ordered levels: low, medium, and high. X_i is a vector of explanatory variables, including household demographic, socioeconomic and institutional characteristics that influence the household's commercialization decision. β represents the effect of each explanatory variable on the likelihood of a household being in a higher commercialization category, while $a_j$are the threshold parameters that separate the ordered categories. This formulation allows the model to capture the probability that a household transitions to higher levels of commercialization, thereby identifying the factors that either hinder or facilitate the move from subsistence-oriented farming toward greater commercialization.

Furthermore, the study also employed the two-limit Tobit model to validate and complement the results obtained from the ordered logit model, and vice versa. The model, originally developed by Tobin (1958), is widely used in empirical studies to estimate consistent parameter estimates for censored or truncated data. It is particularly suitable for dependent variables that are bounded between upper and lower limits, as is the case with the HCI, which ranges from 0 to 1 or 0 to 100% (Mamo et al., 2017; Makombe et al., 2017; Martey et al., 2012; Tafesse et al., 2020; Bekele and Alemu, 2015). Given these characteristics, the two-limit

Tobit model was deemed appropriate for this study to generate consistent and efficient estimates of the factors influencing the level of commercialization among smallholder cereal crops farmers (Mamo et al., 2017; Makombe et al., 2017; Martey et al., 2012; Tafesse et al., 2020; Bekele and Alemu 2015). Following Maddala (1999), the latent Tobit regression model is presented in **Equation (6).**

$$Y_i^* = \beta' X_i + \varepsilon_i, \quad \varepsilon_i \sim N(0, \sigma^2) \tag{6}$$

where Y_i^* is the latent (unobserved) variable, X_i is a vector of explanatory variables, β' is the parameter vector, and ε_i is the error term. The observed commercialization index is obtained from the censoring rule specified in **Equation (7).**

$$Y_i = \begin{cases} 0 & if \quad Y_i^* < 0 \\ Y_i^* & if \quad 0 < Y_i^* < 1 \\ 1 & if \quad Y_i^* \geq 1 \end{cases} \tag{7}$$

where Y_i is the observed dependent variable, which in this study represents the commercialization index of cereal crops production for household *i*. The variable is censored at the lower bound (0) and the upper bound (1), since the index is expressed as a proportion of output sold. According to Tobin (1958), the latent regression model used in this study was specified in **Equation (8).**

$$Y_i = \beta_0 + \beta_i X_i + \varepsilon_i \tag{8}$$

where Y_I is cereal crops commercialization level of i^{th} farm household and X_i is a vector of explanatory variables. According to Maddala (2012), the likelihood function of the two-limit Tobit model is presented in **Equation (9).**

$$L(\beta, \delta | Y_i, X_i, L_{1i}\, L_{2i}) = \prod_{Y_i - L_{1i}} \varphi\left(\frac{L_{1i} - \beta' X_i}{\delta}\right) \prod_{Y_i - Y^*{}_i} \varphi\left(\frac{Y_i - \beta' X_i}{\delta}\right) \prod_{Y_i - L_{2i}} \varphi \tag{9}$$

Where L_{1i} = 0 (lower limit) and L_{2i} = 1 (upper limit); Y_i is observed dependent variable for the i^{th} observation; β' is vector of regression coefficients to be estimated; $\varphi(\cdot)$ are normal and standard normal density functions; and δ is Scale parameter (standard deviation) of the error term in the model.

2.4.3. Description of variables and expected influence

This study identifies a set of socioeconomic, demographic, and institutional factors as potential determinants of cereal crop commercialization. Each variable is selected based on an extensive review of the relevant literature, theoretical frameworks, and contextual knowledge of smallholder farming in Ethiopia. The expected mechanism by which each main independent variable influences commercialization is described below.

Sex of Household Head (SEX): A dummy variable 1 for male-headed and 0 for female-headed households. Male-headed households are hypothesized to achieve higher levels of commercialization because female-headed households often face greater constraints in accessing resources, which limits their market-oriented production (Gidelew et al., 2022; Demeke and Haji, 2014).

Age of Household Head (AGE): Measured in years, this variable captures the effect of farming experience and decision-making capacity. Older household heads may have accumulated knowledge that supports market participation, but increasing age can also reduce labor capacity and adoption of new practices (Wakaba et al., 2022; Demeke and Haji, 2014). Therefore, age is expected to have an ambiguous effect on commercialization.

Household Size (HSIZE): Measured in adult-equivalent units, this variable represents household labor availability. Larger households can provide sufficient labor for land preparation, crop management, and harvesting, thereby supporting higher production and a greater marketable surplus. However, larger households may also increase consumption needs, reducing the proportion of produce available for sale. Therefore, household size is hypothesized to have either a positive or a negative effect on cereal crop commercialization (Wondim and Geyo, 2024; Gebiso et al., 2023).

Land Size (LANDH): Total land area controlled by the household (hectares), including rented or sharecropped land. Larger landholdings allow households to produce surplus output beyond subsistence needs, adopt improved technologies, and manage multiple crops, all of which enhance marketable surplus. Therefore, land size is expected to positively affect commercialization (Gidele et al., 2022).

Education Level (EDUC): Measured in years of formal schooling, this variable reflects the household head's ability to acquire, process, and apply information. Higher education improves the capacity to adopt modern technologies, interpret

market signals, and make informed commercialization decisions (Mamo et al., 2017; Ojulu, 2021). Education is hypothesized to have a positive effect on the commercialization of cereal crops.

Participation in Training (TRAIN): Dummy variable coded 1 if the household head attended formal agricultural training in the past three years. Training enhances knowledge of production techniques, marketing strategies, and risk management, enabling farmers to increase marketable surplus. Therefore, training is expected to positively influence commercialization (Nguyen et al., 2024).

Access to Market Information (MRKTINFO): Dummy variable coded 1 if the household has access to price and market information. Information access allows farmers to align production with market demand, optimize sales timing, and identify profitable crops, directly supporting higher levels of commercialization (Zondi et al., 2022).

Irrigation Access (IRR): Dummy variable coded 1 if the household has irrigation facilities. Irrigation mitigates rainfall uncertainty, increases production, and enables consistent supply to markets, thereby supporting commercialization (Temesgen, 2014; Tufa et al., 2014).

Credit Access (CRDTA): Dummy variable coded 1 if the household received formal credit. Credit enables investment in inputs and technologies that increase production and marketable surplus, facilitating commercialization (Mamo et al., 2017).

Extension Contact (EXCONT): Dummy variable coded 1 if the household received extension services. Extension improves technical knowledge and adoption of modern practices, leading to higher yields and greater marketable surplus, which enhances commercialization (Gidelew et al., 2022; Tekalign, 2014.

Livestock Holdings (TLU): Total livestock measured in Tropical Livestock Units. Livestock provides draft power, manure, and liquid capital, increasing production efficiency and capacity to market surplus cereals, thereby supporting commercialization (Gebiso et al., 2023; Mamo et al., 2017).

Crop diversification (CROPDIV): Crop diversity, defined as the cultivation of multiple crops on the same farm within a year, was measured using the Herfindahl Index (HI). Greater crop diversification may improve land and labor

use efficiency and increase productivity and marketable output, whereas specialization allows households to concentrate resources on a limited number of commercial crops (Abebaw et al., 2023; Thejashree and Umesh, 2022). This study hypothesizes that these differences influence household outcomes.

Use of Mechanization (MECH): Dummy variable coded 1 if mechanized tools are used. Mechanization reduces labor constraints, increases efficiency, and enables the cultivation of larger areas, thereby increasing marketable surplus and enhancing commercialization (Gebiso et al., 2023).

Fertilizer Use (FERT): Dummy variable coded 1 if chemical or organic fertilizer is applied. Fertilizers increase crop yields, reduce production risk, and enable surplus production, supporting commercialization (Gidelew et al., 2022).

Use of Improved Seed (IMPSEED): Dummy variable coded 1 if improved or certified seeds are used. Improved seeds increase productivity, reduce risk, and allow commercialization, thereby enhancing the capacity to sell surplus in the market (Wakaba et al., 2022).

Zone (ZONE): This categorical variable identifies the administrative zone in which the sampled household is located. It takes the values of 1, 2, 3, 4, and 5 for Arsi, East Shewa, North Shewa, West Arsi, and West Shewa, respectively. Zonal location captures differences in agroecological conditions, climate, soil fertility, market access, infrastructure, institutional support, and agricultural production systems. Therefore, zonal is hypothesized to have a positive or negative effect on cereal crop commercialization (Abafita et al., 2016; Tufa et al., 2014).

Table 2 presents a summary of the independent variables included in the model, along with their measurements and expected signs.

Table 2: Summary of description of variables and expected influence.

Variable	Type of variable	Definition and Measurement	Expected sign
Sex of household head	Dummy	1=Male; 0=Otherwise	+
Age of household head	Continuous	Age of household head in years	+/-
Educational status	Continuous	Years of education of the household head	+
Landholding	Continuous	Total land holding in hectares	+
Total livestock owned	Continuous	measured in tropical livestock units	+
Extension agent contact	Dummy	1=Service user 0, otherwise	+
Irrigation use	Dummy	1=Use irrigation, 0 otherwise	+
Improved seed use	Dummy	1=Use Improved seed, 0 otherwise	+
Fertilizer use	Dummy	1=Use fertilizer, 0 otherwise	+
Use of mechanization	Dummy	1=Use mechanization, 0 otherwise	+
Credit access	Dummy	1=Access to credit, 0 otherwise	+
Training	Dummy	1= yes 0 otherwise	+
Household size	Continuous	Measured in number	+
Access to market information		1=Access to market, 0 otherwise	+
Shocks due to environmental calamities	Dummy	1=household experienced shocks due to environmental calamities, 0 otherwise	-
Crop Rotation	Dummy	1=household rotates crop production, 0 otherwise	+
Crop diversification	Continuous	Crop Diversification Index	+/-
Commercialization	Categorical	0=low; 1=medium and 2=high	+/-
Zone	Categorical	1=Aris; East Shewa=2; North Shewa=3; West Arsi=4; and West Shewa=5	

3. Results and Discussion

3.1. Measuring the level of cereal commercialization

As noted earlier, the Household Commercialization Index (HCI) was used to measure the level of commercialization among cereal-producing farmers in the study areas. As presented in **Figure 2**, the average HCI was 0.54, meaning that, on average, sampled households sold 54% of their total cereal harvest, placing them in the moderately commercialized category. This level is considerably higher than the national and regional average commercialization levels for cereal crops, which stand at 21.09% and 16.63%, respectively (26). Furthermore, the study categorized households into three commercialization groups: low (subsistence), moderate, and high. Results showed that 38.54% (264) of households were highly commercialized, reflecting strong market integration and significant cereal sales, while 27.45% (188) were subsistence-oriented, producing mainly for household consumption with limited commercialization of crops. The remaining 34.01% (233) fell into the moderate commercialization category, representing a transition group that sells part of its output but is not fully market-oriented. The findings suggest that while the area shows potential for commercialization above the national average, more than 61% (27.45% + 34.01%) of households remain in subsistence or moderate commercialization, indicating that targeted policies and interventions are still needed to support these farmers in moving toward higher levels of commercialization.

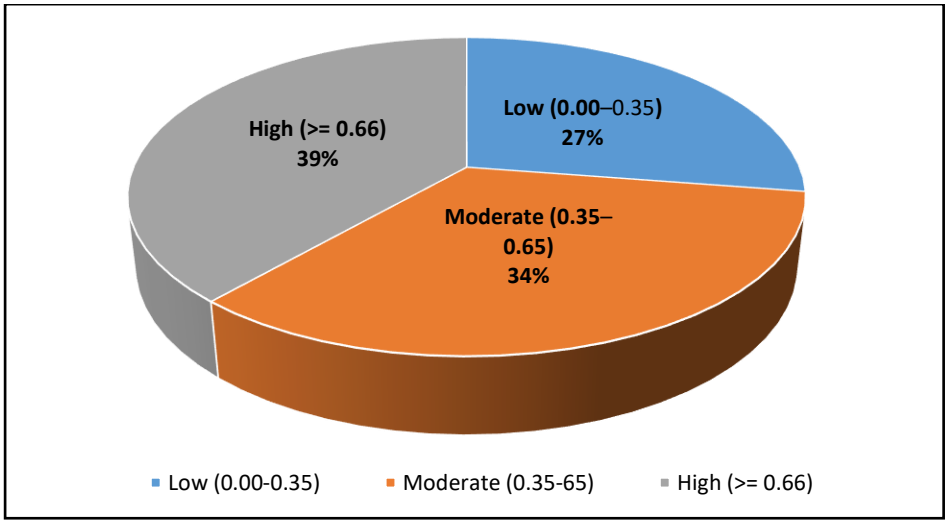

Figure 2: Commercialization level of cereal crops.

2.3. Household's socio-economic and institutional characteristics

Following the classification of households into distinct commercialization tiers using the Household Commercialization Index (HCI), it is essential to examine the underlying profiles of these tiers. Accordingly, the summary descriptive statistics of the demographic, socioeconomic, farm, and institutional variables hypothesized to influence market participation are presented across these categories in **Table 3**.

The descriptive results indicate that among the continuous variables, education level, household size, landholding, livestock ownership, and the number of crops grown exhibited statistically significant differences across the three commercialization categories. Similarly, among the categorical variables, access to training, use of mechanization, irrigation, and market information showed significant associations with commercialization status.

Despite the generally low education levels among the sample respondents (an average of 3.47 years of formal schooling), households in the high commercialization group attained more years of formal education, averaging 4.23 years, followed by the moderate (3.38 years) and low (2.51 years) groups. Household size averaged 7.14 persons across all households, with high commercialization households having smaller families (6.83 members) than those in the moderate (7.32) and low (7.36) groups. Land is a critical resource for agricultural production and commercialization (Gidelew et al., 2022). The results further indicate notable variations in land size among the groups: while the overall sample average was 2.60 hectares, households in the high commercialization group cultivated larger plots (3.08 hectares) than those in the moderate (2.35 hectares) and low (2.24 hectares) commercialization groups. Similarly, livestock holdings, measured in Tropical Livestock Units (TLU), averaged 6.11 across the sample, with high commercialization households owning more livestock (6.81 TLU) than moderate (6.12 TLU) and low (5.13 TLU) households. Crop diversification index averaged 0.48 crops per household, but low (0.41) and moderate (0.47) commercialization households grew slightly more crops than those in the high commercialization group (0.53). The age of household heads was fairly uniform, averaging 43.62 years, with low, moderate, and high commercialization groups averaging 44.80, 43.23, and 43.11 years, respectively.

Table 1: **Explanatory variables, including commercialization analysis**

Variables	**Low (n=188)**		**Moderate (n=233)**		**High (n=264)**			**Total sample (n=685)**	
Continuous variables	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**F-test**	**Mean**	**S.D.**
Age of household head (years)	44.80	10.81	43.23	10.32	43.11	10.98	1.59	43.62	10.72
Education level (years)	2.51	3.29	3.38	3.63	4.23	3.97	12.24***	3.47	3.74
Household size (numbers)	7.36	3.15	7.32	3.24	6.83	2.62	2.37*	7.14	3.00
Land size (Ha)	2.24	2.16	2.35	1.70	3.08	2.58	10.36***	2.60	2.23
Livestock holding (TLU)	5.13	3.04	6.12	3.54	6.81	3.85	12.44***	6.11	3.60
Crop Diversification Index	0.41	0.22	0.47	0.22	0.53	0.27	16.14***	0.48	0.24
Categorical Variables	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**	**χ^2-test**	**Freq.**	**%**
Sex of the household head (Male=1)	170	90.43	199	85.41	229	86.74	2.48	598	87.30
Access to training (Yes=1)	66	35.11	149	63.95	204	77.27	83.34***	419	61.17
Use of improved seed (Yes=1)	172	91.49	214	91.85	241	87.12	3.75	616	89.93
Use of fertilizer (Yes=1)	174	92.55	220	94.42	241	91.29	1.80	635	92.70
Received credit (Yes=1)	53	28.19	63	27.04	67	25.38	0.46	183	26.72
Use of mechanization (Yes=1)	58	30.85	116	49.79	135	51.14	21.37***	309	45.11
Use of irrigation (Yes=1)	44	23.40	74	31.76	92	34.85	6.97**	210	30.66
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**	**χ^2-test**	**Freq.**	**%**
Access to extension (Yes=1)	181	96.28	227	97.42	258	97.73	0.91	666	97.23
Market information (Yes=1)	99	52.66	170	72.96	211	79.92	40.33***	480	70.07
Climate shock (Yes=1)	49	26.06	73	31.33	78	29.55	1.42	200	29.20
Crop rotation (Yes=1)	104	55.32	102	43.78	113	42.80	8.02**	319	46.57
Zones Arsi	38	20.21	60	25.75	92	34.85		190	27.74
East Shewa	19	10.11	31	13.30	42	1.91		92	13.43
North Shewa	70	37.23	29	12.45	24	9.09	74.46***	123	17.96
West Arsi	36	19.15	65	27.90	53	20.08		126	18.39
West Shewa	25	13.30	48	20.60	53	20.08		126	18.39

***, ** and * signify statistically significant at the 1, 5, and 10 percent probability levels, respectively

Note: *F*-test and χ^2-tests were used for continuous and categorical variables, respectively.

Regarding categorical variables, access to training is a crucial factor for improving both productivity and commercialization. The results show that receiving training is significantly associated with commercialization status at the 1% level, with 35.1%, 63.9%, and 77.3% of households in the low, moderate, and high commercialization categories, respectively. Similarly, the use of mechanization was significantly associated with commercialization status at the 1% level, with 30.9%, 49.8%, and 51.1% of households in the low, moderate, and high commercialization groups, respectively, indicating that households in the high commercialization group made better use of mechanization than the others. Access to irrigation was also significantly associated with commercialization at the 5% level, with 23.4%, 31.8%, and 34.9% of households across the three groups, and those in the high commercialization category having better access than households in the lower groups. Market information access exhibited the strongest institutional association at the 1% level, with 52.7%, 73.0%, and 79.9% of households in the low, moderate, and high commercialization groups, respectively, confirming that timely and reliable market information is essential for commercial engagement (Kyaw et al., 2018; Muzemil, 2020). In contrast, the sex of the household head showed no significant variation, with male-headed households predominating across all groups (90.4%, 85.4%, and 86.7% for low, moderate, and high commercialization, respectively).

The distribution of households across commercialization categories varies considerably among the study zones, indicating significant spatial differences in cereal crop commercialization. Among households in the low commercialization category, North Shewa accounted for the largest share (37.23%), followed by Arsi (20.21%), West Arsi (19.15%), West Shewa (13.30%), and East Shewa (10.11%). This suggests that a relatively large proportion of farmers in North Shewa remain less integrated into output markets. In the moderate commercialization category, West Arsi represented the highest proportion of households (27.90%), followed by Arsi (25.75%), West Shewa (20.60%), East Shewa (13.30%), and North Shewa (12.45%). The distribution indicates a more balanced level of market participation across these zones. For the high commercialization category, Arsi had the largest share of households (34.85%), followed by West Arsi (20.08%), West Shewa (20.08%), East Shewa (15.91%), and North Shewa (9.09%). The relatively high concentration of highly commercialized households in Arsi may be attributed to its strong cereal production base, better market integration, and greater access to agricultural

services and infrastructure. Access to extension services was nearly universal (96.3%, 97.4%, and 97.7%), with no significant differences across groups, although extension likely contributed to the overall high adoption of inputs. Similarly, other variables, including credit and use of improved seed, were largely consistent across all commercialization groups.

2.4. Determinants of crop commercialization

The determinants of cereal crop commercialization status and extent were analyzed using an ordered logit model and a two-limit Tobit model, respectively. Before proceeding with the analysis, diagnostic tests were conducted to check for major econometric problems. The model estimation results in **Table 4** show that the likelihood functions for both models were highly significant at the 1% level: Wald chi² (21) = 208.69 for commercialization status (ordered logit model) and LR chi²(21) = 305.81, Prob > chi² = 0.000 for commercialization extent (two-limit Tobit model). This confirms the strong explanatory power of the independent variables in explaining the determinants of the commercialization status and extent of cereal crops. The parallel lines (proportional odds) assumption of the ordered logit model was also tested, and the results indicated a non-significant test statistic ($\chi^2(21) = 19.80$, Prob > $\chi^2 = 0.4067$), confirming that the assumption was not violated. Thus, the use of ordered logistic regression was appropriate. To further assess multicollinearity, the Variance Inflation Factor (VIF) was calculated. The results showed no serious multicollinearity problem, with a mean VIF of 1.31. To address potential heteroscedasticity, robust standard errors were employed. As shown in Table 5, cereal crop commercialization status and extent were significantly and positively influenced by the household head's education level, farm size, livestock holdings, access to training, irrigation use, access to credit, extension services, and market information, while these were negatively affected by household size and residence in North Shewa, West Arsi, and West Shewa.

The ordered logit and tobit models revealed that the education level of the household head is positively and significantly associated with the likelihood of being in higher levels of cereal crop commercialization and with the extent of commercialization at the 1% probability level. The results show that household heads with more years of formal education were more likely to commercialize than their less-educated counterparts. This finding suggests that education enhances bargaining skills, access to knowledge, and the capacity to process and apply information, enabling households to use resources more effectively.

Educated heads are also better positioned to adopt improved farming practices and strategies, thereby increasing commercialization. These results are consistent with earlier studies by Mamo et al. (2017), Meleaku et al. (2020), and Wassihun et al. (2022), which reported that formal education significantly improved the commercialization of cereal crops.

The results indicate that land size has a positive and significant effect on both the likelihood of being in higher levels of cereal crop commercialization and the extent of commercialization, at the 1% probability level. This could be because land size is typically associated with higher production and the capacity to produce beyond household consumption, thereby generating surpluses for sale. This result is consistent with previous studies (Gebre et al., 2021; Gidelew, 2022; Gebiso, 2023), which confirm that households cultivating larger areas of land are more likely to engage in crop commercialization. This is because such households can allocate part of their land to food production and part to market-oriented production, thereby enhancing their commercialization status.

Livestock holding was another important variable, showing a positive and significant effect on both the likelihood of households being in the high cereal crop commercialization category and the overall extent of commercialization at the 1% significance level. This could be because livestock is a key component of household wealth and resource endowment, providing farmers with draft power, manure, and additional income, thereby increasing the likelihood that households engage in high cereal crop commercialization. These findings are consistent with those of Gebiso et al. (2023), who reported that livestock serve as sources of draft power and manure, both of which enhance agricultural production and productivity, thereby increasing the likelihood of greater commercialization.

The results from both models indicate that crop diversification, measured using the crop diversification index and classified into three levels, has a positive and significant effect on both the likelihood of being in the high commercialization category and the extent of commercialization at the 1% significance level. Households that grow a wider variety of crops can optimize the use of their resources, labor, and land across crops, enhancing overall productivity and generating higher volumes of marketable produce. Diversification allows farmers to tap into multiple market opportunities, reduce risks associated with price fluctuations or crop failure, and capture higher incomes from both staple and high-value crops. This positive relationship suggests that diversified cropping systems can support both risk management and commercialization

objectives simultaneously. These findings are similar to those of Thejashree and Umesh (2022), who suggest that in the study area, diversification supports both risk management and commercial objectives simultaneously.

Table 4: Determinants of status and extent of commercialization.

Ordered logistic regression				**Tobit regression**		
Number of obs=685				**Number of obs=685**		
Wald chi2(21)=208.69				**LR chi2(21)=305.81**		
Prob > chi2=0				**Prob > chi2=0**		
Pseudo R2=0.1679				**Pseudo R2=0.7152**		
Log pseudo likelihood =-620.778				**Log likelihood= -60.876**		
Variables	**Coef.**	**R. Std. Err.**	**Z**	**Coef.**	**R. Std. Err.**	**t**
Age of household head	-0.0016	0.0092	-0.18	-0.0001	0.0011	-0.05
Education level	0.0616***	0.0225	2.74	0.0065***	0.0026	2.46
Household size	-0.0690**	0.0328	-2.1	-0.0064	0.0040	-1.59
Land size	0.2369***	0.0558	4.25	0.0227***	0.0045	5.02
Livestock holding	0.0803***	0.0234	3.43	0.0096***	0.0027	3.6
Crop diversification	0.4125***	0.1101	3.75	0.0467***	0.0128	3.63
Sex of the household head	0.0833	0.2355	0.35	0.0265	0.0292	0.91
Access to training	1.2961***	0.1634	7.93	0.1864***	0.0195	9.55
Use of improved seed	-0.3887	0.2964	-1.31	-0.0610	0.0374	-1.63
Use of fertilizer	0.3836	0.3634	1.06	0.0454	0.0432	1.05
Received credit	0.1789	0.1917	0.93	0.0382*	0.0230	1.67
Use of mechanization	-0.0038	0.1806	-0.02	0.0055	0.0227	0.24
Use of irrigation	0.2453	0.1751	1.4	0.0513***	0.0208	2.47
Access to extension	0.3908	0.4848	0.81	0.1149*	0.0605	1.9
Market information	0.8528***	0.1806	4.72	0.1213***	0.0211	5.76
Climate Shock	-0.0115	0.1784	-0.06	0.0098	0.0214	0.46
Crop rotation	-0.2274	0.1593	-1.43	-0.0291	0.0195	-1.49
Zone (Ref.=Arsi)						
East Shewa	-0.3294	0.2796	-1.18	-0.0482	0.0328	-1.47
North Shewa	-1.4323***	0.2928	-4.89	-0.2434**	0.0331	-7.36
West Arsi	-0.4591**	0.2326	-1.97	-0.0532**	0.0285	-1.87
West Shewa	-0.2376	0.2546	-0.93	-0.0597**	0.0298	-2.00
_cons	-0.0016	0.0092	-0.18	0.0851	0.0904	0.94
/cut1	1.6897	0.7924				
/cut2	3.6230	0.8002				
var(e.CCI)				0.0034	0.0521	0.065

***, ** and * signify statistically significant at the 1, 5, and 10 percent probability levels, respectively

At the 1% significance level, access to training is positively and significantly associated with both the likelihood of households engaging in high levels of crop commercialization and the extent of commercialization. The reason could be that training equips farmers with knowledge about improved agricultural technologies, effective marketing strategies, and the advantages of cooperative membership, thereby enhancing their ability to negotiate for inputs and sell their products. Moreover, trained farmers are more aware of market opportunities and better able to adopt innovations, which increases productivity and marketable surplus. These findings are consistent with the results of studies by Nguyen et al. (2014) and Rabbi et al. (2019), who indicated that training enhances farmers' ability to adopt modern technologies and use resources efficiently, leading to higher production and greater commercialization.

Market information is another vital factor that positively and significantly influences both the likelihood of participating in high-level cereal crop commercialization and the extent of commercialization at the 1% significance level. The reason could be that access to market information enables smallholder farmers to make informed decisions about the level and extent of commercialization, where and to whom to sell their crops, at what price, and the quantity and most efficient mode of transportation. This knowledge helps farmers plan their sales strategically and maximize returns from their produce. The findings align with Kyaw et al. (2018) and Zondi et al. (2022), who report that access to market information significantly increases the volume of rice and indigenous vegetables sold.

One of the major challenges to agricultural productivity is poor, irregular, and unevenly distributed rainfall. Access to irrigation mitigates this constraint by increasing production, allowing farmers to supply more crops than those relying solely on rainfed agriculture. Irrigation also reduces the risk of crop loss from unpredictable rainfall and enhances farmers' confidence in using agricultural inputs and in engaging in market-oriented production (Tessema, 2015; Tufa et al., 2014; Ng'ombe et al., 2025). Van Ittersum et al. (2016) and Ng'ombe et al. (2025) further highlight that irrigation enables farmers to cultivate year-round, thereby supporting greater commercialization. Consistent with these findings, our results indicate that irrigation use positively and significantly influences the extent of commercialization at the 1% significance level.

Access to extension services is another important institutional factor that positively influences the extent of cereal crop commercialization, as shown at the 10 % significance level. Extension services play a crucial role in building farmers' managerial capacity by providing relevant information, technical knowledge, and practical skills for adopting improved agricultural technologies. Farmers with access to extension advice are better able to understand and apply modern farming practices, which enhance productivity and generate marketable surplus, thereby promoting commercialization. These findings are consistent with Gidelew et al. (2022), who emphasize that extension services are essential for facilitating agricultural transformation and market-oriented production among smallholder farmers.

Access to credit plays an important role in promoting agricultural commercialization by easing liquidity constraints faced by smallholder farmers. It enables farmers to purchase productivity-enhancing inputs, hire labor, and invest in transport and storage facilities, all of which are essential for producing a marketable surplus. Credit also supports timely harvesting and reduces post-harvest losses, thereby increasing the proportion of output that can be sold in markets. In addition, it strengthens farmers' capacity to take advantage of market opportunities and respond to price incentives, which enhances their participation in commercial agriculture (Mabiratu et al., 2019). Consistent with these arguments, the study results indicate that access to credit has a positive and statistically significant effect on the extent of agricultural commercialization at the 1% significance level.

Zone was found to be an important determinant of the commercialization of cereal crops. Using Arsi as the reference category, households in North Shewa were significantly less likely to achieve higher levels of commercialization, and households in West Arsi also exhibited lower levels of commercialization. Similarly, the Tobit model indicated that households in West Shewa had a significantly lower commercialization index than those in Arsi, whereas no significant difference was observed between East Shewa and Arsi. These findings suggest that smallholder farmers in Arsi are more commercially oriented than those in the other study zones. The observed differences may reflect variations in agroecological conditions, market access, infrastructure, institutional support, and production potential across zones. Arsi has a strong cereal production base and relatively better market integration, which may enhance farmers' ability to generate marketable surpluses and participate in

output markets. Therefore, the results highlight the importance of location-specific factors in shaping commercialization decisions and underscore the need for zone-specific interventions to promote market participation among smallholder farmers (Jaleta et al., 2009; Abafita et al., 2016; Tufa et al., 2014).

3. Conclusion and Recommendations

This study was conducted to examine the levels and extent of cereal crop commercialization in the central and southern regions of Oromia, Ethiopia. Primary data were collected from 685 households using semi-structured questionnaires. The Household Commercialization Index (HCI) was employed to measure the level of commercialization. Additionally, Ordered Logit and two-limit Tobit models were used to identify the determinants of both the level and extent of cereal crop commercialization among smallholder farmers in the study area. The results revealed an average HCI of 0.54, with 38.54% of households classified as highly commercialized, 27.45% as subsistence-oriented, and 34.01% as moderately commercialized, highlighting substantial variation in market participation. Moreover, the model results revealed that the commercialization of cereal crops among smallholder farmers in central and southern Oromia is significantly influenced by household, farm, and institutional factors. Education, extension services, access to market information, credit, irrigation, training, farm size, livestock holdings, and crop diversification were found to have a positive and significant effect on commercialization. In contrast, household size and residence in North Shewa, West Arsi, and West Shewa were negatively associated with commercialization, suggesting that households with larger family sizes and those residing in these areas tend to prioritize subsistence production over market-oriented activities. Meanwhile, age of the household head, household size, sex of the household head, use of improved seed, use of fertilizer, and receipt of credit were not significantly associated with either the level or intensity of commercialization, indicating that these factors may not play a decisive role in smallholder commercialization in the study area.

Hence, the study findings suggest that improving access to irrigation, agricultural training, extension services, market information, and credit is essential for enhancing commercialization among smallholder farmers. To implement these interventions effectively and safely, the Ministry of Agriculture, regional agricultural bureaus, and rural financial institutions must take coordinated action. Policy interventions should strengthen farm-level resources by promoting

efficient land use, sustainable land management, and livestock development to increase crop commercialization. In addition, the agricultural extension system should encourage crop diversification as a core strategy to enhance productivity and expand market opportunities while mitigating production and price risks, thereby safeguarding household food security. Furthermore, strengthening rural institutions, particularly cooperative, private, and agribusiness company promotion agencies, is critical to delivering pluralistic extension services, robust market information platforms, and targeted financial services that support the sustainable and secure commercialization of smallholder agriculture.

Future Research Directions: Future studies could employ panel data to capture the dynamics of cereal crop commercialization over time, allowing for a better understanding of causal relationships. Expanding the geographic scope to include additional regions of Ethiopia would improve the generalizability of the findings. Moreover, investigating other crops beyond cereals, including pulses, oilseeds, vegetables and cash crops, could provide a more comprehensive view of commercialization patterns and the factors influencing market participation across diverse agricultural systems.

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