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Commercialization of Cow Milk Production in West Hararghe Zone, Oromia National Regional State, Ethiopia

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Abstract

Livestock plays a vital role in the livelihood of many people in Ethiopia. However, a number of challenges hindered the development of the dairy sector along with its commercialization. Advancing commercialization of the rural generations was a foundation of the advancement and poverty reduction policies of Ethiopia. Cross-sectional data from 385 randomly selected households in Eastern Ethiopia were used in this study to assess the commercialization of cow milk producers. Descriptive statistics and the two limit Tobit econometric models were used to analyze the data. The average commercialization index was 0.434, indicating that each household sold 43.4 percent of the milk produced during the survey period. Ownership of improved breed cow, cooperative participation, access to market information, and quantity of milk produce influenced milk commercialization positively, but household size and distance to the nearest market influenced it negatively. The study suggests strengthening policies to improve rural family planning, strengthening farmer cooperatives to reinforce knowledge sharing among farmers for enhancing farmer resource endowment, and promoting improved breed varieties. The commercialization of milk producers will also expand as a result of policies that try to lower the transaction costs of accessing markets, improve the capacity of rural institutions, and encourage value addition and market links among various market players.

Keywords

Commercialization, Cow Milk, Tobit, West Hararghe Zone

1. Introduction

The livestock industry makes a significant contribution to Ethiopia's economy,

provides a living for many Ethiopians, and shows signs of continuing to support the nation's economic growth. Livestock contributes 150.7 billion Ethiopian Birr per year, which amounts to 12 - 17 percent of the total and 30 - 35 percent of agricultural GDP (Gross Domestic Products), respectively [1]. The dairy industry is not as developed as it may be given its considerable potential and the importance of cattle to farmers' livelihoods. This is due to the traditional milk production system, which is dominated by indigenous breeds of low genetic potential for milk production, accounts for about 95 percent of the country's total annual milk production [2].

Recent estimates on livestock populations by the [3] indicate that there are about 65 million cattle, of which 44.7 percent are male and 55.3 percent are female. The same further indicates that the total annual production is 3.5 billion liters from 11.38 million dairy cows of milk was produced in the year 2021 out of which 42.8 percent was used for household consumption this shows the production of milk and demand for milk are not balanced so to work on these high demands we have to increase the production and productivity of milk in the countries.

The government has identified smallholder farmers' commercialization as the primary driver of Ethiopia's agricultural progress. The fundamental objective of the Ethiopian government's implementation of agricultural commercialization clusters was the commercialization of smallholder farmers' agriculture and the growth of the agro-industrial sector, providing a key entry point for private sector involvement [4].

Since dairy inputs and services are still in their infant stage and the expansion of improved dairy cows is constrained in the country, empirical literatures argue that the total annual milk production has been increasing at a moderately slow rate. This is primarily because the increase in milk production may have come from the increased number of milking cows rather than from increased productivity [5]. This study finds that the indigenous breeds have an average milk production of between 1 and 3 liters per day (the average in 2021 was 1.56 liters per cow per day) for an average lactation period of six months. This shows that the country does not meet the demand for this product and spends a tremendous amount of hard currency per annum to import milk in different forms.

According to [6] report from 2009 to 2018, the country imported dairy products worth over 2.615 billion Ethiopian Birr from 69 different nations totaling over 24.11 million liters. With their respective contributions of 76.04%, 12.38%, and 7.48%, the three continents with the most imports are Europe, Asia, and Africa. This needs attention in order to increase milk production and productivity and to promote the commercialization of this product.

While reviewing various sources of literature related to the study area the author found that various studies had been done on various crops, such as commercial farming in the vegetable-based farming system of the west Hararghe [7]

value chain analyses of livestock and their products, such as [8] and [9]. To the best of the researchers' knowledge, no research has been found on the estimation of milk's level of commercialization. Therefore, the purpose of this study is to evaluate the determinants of milk commercialization constraints and estimate the level of milk commercialization among farmers using the commercialization index.

2. Research Methodology

2.1. Description of the Study Area

The three districts; Gemechis, Oda Bultum, and Mieso in the West Hararghe zone of Ethiopia's Oromia National Regional State were the sites of the study. Astronomically, the zone is located between latitudes of 70˚08'58" and 80˚49'00"N and longitudes of 38˚41'55" and 40˚43'56"E. The Shebelle River, which separates it from Bale on the south, Arsi to the southwest, the Afar Region to the northwest, the Somali Region to the north, and East Hararghe Zone to the east, all encircle the zone and also the zone has 15 districts and its zonal town is Chiro [10] (**Figure 1**).

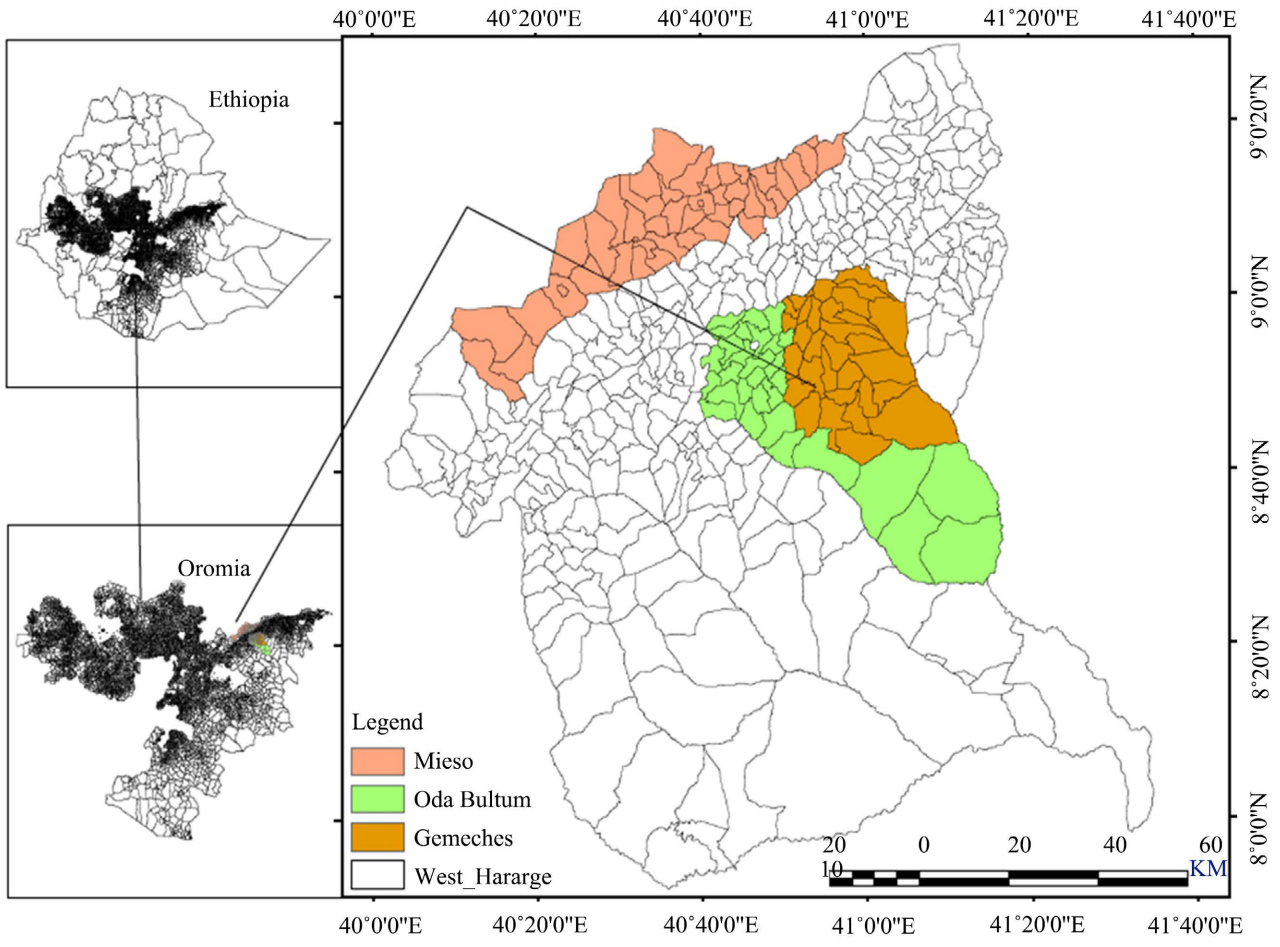

Figure 1. Map of the study areas.

The altitude of the zone ranges from 1400 to 2300 meters above sea level. The temperature and rainfall of the district range from 9 - 25 degree Celsius and 700 - 1200 millimeters, respectively, [11]. The Zone is characterized by a crop-animals mixed farming system in which dairy production, in particular, and livestock in general, significantly contribute to farmers' livelihoods and serve as sources of income. Sorghum, maize, barley, wheat, and pulses are among the main crops farmed in the zone. Additionally, this zone main cash crops are coffee and khat [12].

2.2. Data Requirement and Sources

As sources of information, both primary and secondary data sources were used. The primary data was collected using structured questionnaire that was administered by the trained enumerators. Before starting the actual data collection, pre-testing the questionnaire were under taken so that appropriate refinements and modification in the questionnaire were made. The process of primary data collection was conducted through multiple visits, which enabled us to gather timely and reliable information on the overall milk production in the study area. Both quantitative and qualitative information was collected through face-to-face interviews with individuals. Secondary data were collected from relevant sources such as related journals and other related documents from the bureau of agriculture of the districts and other relevant institutions.

2.3. Sampling Technique

The study was undertaken following the formal survey procedure where data collection for quantitative information is gathered using a prepared questionnaire. To draw a representative sample multi-stage random sampling technique was implemented; in the first stage, three districts, namely Gemeches, Odabultum and Mieso were randomly selected from the 15 milk producing districts of West Harerge zone. And, nine kebeles were finally selected from the indicated districts in the second step based on probability proportional to size. In the third stage, the kebeles' sample frame was updated, and a total of 385 household were selected randomly using a probability proportional to the size of the population. The study used [13] sample size determination formula to determine a representative sample size:

$$N = \frac{Z^2 pq}{e^2} = \frac{1.96^2 \times 0.5 \times 0.5}{0.05^2} = 385$$

where N is the sample size, Z is the inverse of the standard cumulative distribution that corresponds to the level of confidence, e is the desired level of precision, p is the estimated proportion of an attribute that is present in the population and $q = 1 - p$. The value of Z is found from a statistical table that contains the area under the normal curve of 95% confidence level (**Table 1**).

Table 1. Distribution of the sample in districts kebeles, and households.

Districts	Kebele	Total number of households	Sample size
Gemechis	Sororo	7019	40
	Segeriya	8126	43
	Laga Lafto	9735	50
Mieso	Gorbo	9222	44
	Dibala	10,060	47
	Hara Maro	10,221	50
OdaBultum	Oda Roba	7858	37
	Goda Hora	8650	40
	Kara	6665	34
Grand Total		**77,556**	**385**

Source: Own computation from 2021 data.

2.4. Methods of Data Analysis

Both descriptive and econometrics methods of data analysis were employed to assess the overall levels of commercialization, and determinants of commercialization. Descriptive statistical analysis such as mean, percentages, and standard deviations and econometric methods of data analysis were used and stated below.

2.4.1. Measurements of Commercialization

The most widely adopted measurements of agricultural commercialization are the three household level indices developed by [14] this are, output and input side commercialization; rural economy commercialization; and degree of household integration into the cash economy. The focus of this study is agricultural commercialization measured by the proportion of the value of agricultural output sold in the market to total value of agricultural production (Equation (1a)).

$$\text{Commercialization of Agriculture(Output side)} = \frac{\text{Gross vaule ofagricultural sales in the market}}{\text{Gross value of agricultural production}} \quad (1a)$$

$$\text{Commercialization of Agriculture(Input side)} = \frac{\text{Gross vaule ofinput aquired from the market}}{\text{Gross value of agricultural production}} \quad (1b)$$

$$\text{Commercialization of rural economy} = \frac{\text{Gross value of goods and services acquired through market transaction}}{\text{Total Income}} \quad (2)$$

$$\text{Degree of integration into cash economy} = \frac{\text{Gross value of goods and services acquired through cash transaction}}{\text{Total Income}} \quad (3)$$

2.4.2. Econometric Data Analysis

The two-limit Tobit model was employed to examine the impact of demographic, socioeconomic, farm features, and institutional variables on the degree of commercialization. Due to the nature of the dependent variable (output commercialization index), which has values between 0 and 1, and produces reliable estimates for the unknown parameter vector, this model is best suited for such research [15].

Following [16] the model can be specified as

$$E_i^* = \sum_{i=1}^{n} \beta_j X_j + V_i \tag{4}$$

$$E_i = \begin{cases} 1 & \text{if } E_i^* \geq 1 \\ E_i^* & \text{if } 0 < E_i^* < 1 \\ 0 & \text{if } E_i^* \leq 0 \end{cases}$$

where E_i^* is a latent variable (unobserved for values smaller than 0 and greater than 1) representing subsistence or fully commercial index; X_js a vector of independent variables, which includes factors affecting output sold; β is a vector of unknown parameters; and v_is a disturbance term assumed to be independently and normally distributed with zero mean and constant variance σ^2; and $i = 1, 2, \cdots, n$ (n = the number of observations). Following [17] approach the three types marginal effects considered in the analysis of the Tobit model are shown below. These are:

1) The marginal effect on the latent variable (unconditional expected value)

$$\frac{\partial E(Y/X)}{\partial x_k} = \beta_k \Phi\left(\frac{x\beta}{\sigma}\right) \tag{5}$$

2) The marginal effect on the expected value of observations conditional on being uncensored

$$\partial E\left(\frac{Y/X, y>0}{\partial x_k}\right) = \beta_k + \beta_k \frac{\partial \lambda(c)}{\partial c} = \beta_k \left\{1 - \lambda(c)\left[c + \lambda(c)\right]\right\} < \beta_k \tag{6}$$

where, $\lambda(c)$ is called the inverse mill's ratio. It captures the change in the dependent variable (conditioned on $y > 0$) when changing x.

3) The marginal effect on the probability that the observations are uncensored

$$\frac{\partial Pr(y>0/x)}{\partial x_k} = \phi\left(\frac{x\beta}{\sigma}\right)\frac{\beta_k}{\sigma} \tag{7}$$

The interpretations of these marginal effects depend on the point of interest-based on the focus of the study.

3. Results and Discussion

3.1. Demographic and Socio-Economic Characteristics of Sample Households

It is important to describe the socioeconomic, institutional, and farm characteristics of the sample households before embarking to the commercialization sta-

tus of sample households. Concerning sex of the sample farm household heads, about 79.2% were male-headed and the remaining 20.8% were female-headed. The result indicated in Table 2 showed that about 70.1% of the farmers had contact with the development agents with dairy production issues where as the remaining 29.9% did not contact with development agents. Moreover, 70.4% of the sampled households have accessed market information for cow milk marketing from different sources. And the major sources of market information on dairy products supply include traders, markets, hotels/restaurants, neighbors, cooperative and also contractors especially when market price is low.

Accordingly, the result in the study area indicated that about 70.4% of respondents get market information from different sources (traders, customers, cafes). As can be seen from the table below, about 64.4% of the sampled household heads were members of farmers' cooperatives where participation in cooperatives was believed to enhance the information exchange and experience sharing among farm households on the use of improved agricultural technologies and recommended milk production practices and milk handling practices and also marketing.

About 44.2% of farmers in the study area have engaged themselves in various off/nonfarm activities parallel with the main farming activities during the farming season. Petty trading, brewing or selling of traditional alcohol, and selling of wood are the main works that the farmers were engaging in beside the farming activities.

Table 2. Summary statistics of dummy variables.

Variable	Description	No. of respondents (n = 385)	Percent
Sex of household head	Female	80	20.8
	Male	305	79.2
Extension participation	Yes	270	70.1
Coops membership	Yes	248	64.4
Market information	Yes	271	70.4
Off/non-farm participation	Yes	170	44.2
Ownership of improved cow	Yes	83	21.6

Source: Computed from survey data 2021.

The age of the sample respondents ranges from 20 to 73 years with the average age of 48.07 years. The household size ranges from 2 to 16 members per family and the average household size per sample household was 6.7. The average years of schooling of sample respondents were 2.20. In addition, the sampled households walked on average 36.76 and 57.21 minutes to reach the main road and arrive at the nearest market center respectively (Table 3).

The average landholding size in the sample study area was 0.94 hectares per household which was much lower than the national average land holding size of

Table 3. Summary statistics of continuous variables.

Variables	Min	Max	Mean	Std. Err
Age (years)	20	73	48.07	0.507
Education (grade)	0	9	2.20	0.131
Household size (adult equivalent)	3	14	6.81	0.121
Distance milk market (walking minute)	20	80	56.21	0.581
Distance to main road (walking minute)	15	55	36.76	1.23
Farm size (ha)	0.34	1.15	0.68	0.15
Extension contacts (No. contact per year)	1	9	6.53	1.54
Credit (Birr)	0	7300.00	1146.23	1287.01
Total number of livestock (TLU)	1.34	18.05	5.31	0.15

Source: Computation from 2021 survey data.

1.17 ha per household [12] and the average land allocated for major crop is 0.68 ha during the survey period. Farmers received 6.53 of extension services per year on average such services are veterinary and combination of forage use, crossbred cows and milk value addition. As presented in **Table 3**, the average livestock holding of the sample household heads was 5.31 TLU ranging from 1.34 to 18.05.

3.2. Measurement of Milk Commercialization

As indicated in **Table 4**, the average commercialization level in the study area is 0.434 and standard deviation of 0.216.

3.3. Determinants of Milk Commercialization

To identify factors affecting commercialization level of cow milk in the study areas the variables included in the model were tested for the problems of multicollinearity and the result shows there was no problem of multicollinearity among the variables since the value of mean VIF (Variance Inflation Factor) obtained for those variables was found (1.69).

A test for normality of commercial index (CI) was made using Kernel density plot residuals. The Kernel density plot provide smooth curve that closely resembles a normally distributed curve, indicating that the normality assumption was not violated (**Figure 2**).

As indicated in **Table 5**, farm households' milk commercialization was positively influenced by ownership of improved cow, cooperative membership, access to market information and quantity of milk produced and it was also negatively influenced by household size and distance to the nearest market. The R^2 (The Goodness of fit test) values are 0.521 it means that about 52% of the variations in the dependent variables are explained by the independent variables, indicating relatively high explanatory power of the model.

Table 4. Commercialization status of sample households by district.

Description	Frequency	Mean	Std. Deviation
Gemechis	133	0.367	0.17
Mieso	141	0.438	0.27
Oda Bultum	111	0.496	0.21
Total	385	0.434	0.216
Commercialization status of milk sample households			
	Number	Percent	
Commercialization status	Low	139	36.1
	Medium	179	46.5
	High	67	17.4

Source: Computation from 2021 survey data.

Table 5. Determinants of milk commercialization.

Variables	Marginal effect	Std. Err	Z-value
Sex	0.143	0.096	1.49
Age	−0.003	0.002	−1.50
Household size	−0.065**	0.030	−2.16
Education	0.007	0.005	1.40
Children under six	−0.012	0.014	−0.85
No of lactating cow	0.005	0.007	0.71
Distance to road	0.016	0.024	0.67
Distance to market	−0.083*	0.045	−1.84
Ownership of improved cow	0.192***	0.046	4.17
Farm size	0.027	0.032	0.84
Cooperative membership	0.020*	0.011	1.82
Access to market information	0.085**	0.041	2.07
Frequency extension contact	0.044***	0.013	3.38
Supplementary feed	0.014	0.019	0.73
Off-farm participation	−0.006	0.013	−0.47
Tropical livestock unit (TLU)	−0.026	0.022	−1.19
Total milk produced	0.051***	0.013	3.92
Constant	0.168*	0.091	1.85
Sigma		0.560	
LR chi^2 (17) = 458.23			

Continued

Prob > chi^2 = 0.000	
Log likelihood = 215.42	
Psedo R^2 = 0.521	
Number of observations = 385	

***, ** and * indicate significance at 1%, 5% and 10% levels, respectively. Source: Computation from 2021 survey data.

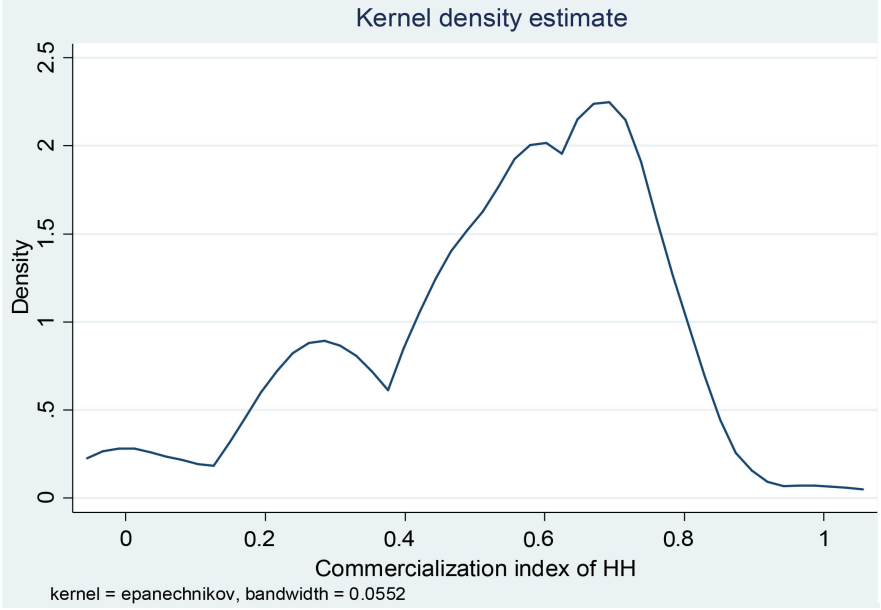

Figure 2. Kernel density estimate for commercialization index. Source: Computed from survey data (2021).

Household size: This is measured in terms of the number of adult equivalents in a household. It influenced the level of household commercialization negatively and significantly at 5% level of significance. The possible reason was that as the number of household size increases, the level of consumption of households will increase to the extent that it will have noticeable negative impact on the available output with the consequences of limited produce available for sale due to increased consumption. The survey result indicated that for one additional adult equivalent family member, the level of output sale decreases by 6.5%. This result was consistent with the result of [7] and [18] which suggest that households with large household sizes need to feed their family first and take the remaining small portion surplus to the market.

Distance to market: This variable influenced the level of milk commercialization negatively and significantly at 10% level of significance. This might be the farmers located in distant from the market was limited access to the market and the closer to the market the lesser will be the transportation cost and time spent. The result from **Table 5** indicated that for one additional distance in kilometers the level of output sale decreases by 8.3%. This finding is consistent with the

finding of [19] and [20] which indicated that as the distance from producers' homestead is far, which in turn influenced the level of commercialization negatively and significantly.

Ownership of improved cow: Ownership of improved cow affected milk commercialization positively and significantly at less than 1%. Accordingly, ownership of improved cows yields higher production and possibly higher selling price for the milk output. This means that ownership of improved cow plays a key role in promoting commercialization which will enable the farmers to produce more and increase the quantity of supply to the market. The survey result indicated that milk producers who were accessed to improved cow increase the commercialization level by 19.2%. This study result resembles with the findings of [21] who found that access to improved breed cow significantly and positively influence the quantity of milk supply to the market.

Cooperative membership: It affects the level of milk output commercialization positively and significantly at 10% level of significance. This might be farmers' cooperatives contributed to the practice of output market participation via its advantage of obtaining better information access for farmers' member. This could avoid more milk to consume at home and also add the life of milk since they add value by boiling the milk when they bring together from different households and the farmers benefit more from being member of cooperative. The survey result revealed that the households being members of farmers' cooperatives increase the level of commercialization by 2.0%. This finding is consistent with the results of [22] which suggest that strengthening dairy cooperatives, can play an increased role in milk collection, processing, and supplying processed dairy products to consumers, would help to modernize the milk production and marketing system.

Access to market information: It significantly influenced milk commercialization positively and significantly at 5% significance level. This might be farmers who accessed market information set prices and search for potential buyers thereby facilitating decisions on the quantity to sell. The survey result indicates smallholder producers who accessed market information increased output commercialization levels by 8.5%. This result resembles the findings of [18] and [21] who indicated that market information helps to increase utilization of yield increasing dairy farm inputs such as feed management and improved varieties of cow which eventually increase commercialization levels.

Frequency of extension contact: This variable influenced the level of milk commercialization significantly and positively at a 1% level of significance. This suggests that when experts of agriculture and researchers provided technical advice on milk production (on improved cows, artificial insemination, and feeding management), smallholder producers were encouraged to produce more milk than before. The result from **Table 5** indicated that for one additional contact of the extension agent, the level of output sales increases by 4.4%. This result is consistent with the findings of [22] who found that extension contact significantly and

positively influences the quantity of milk supply to the market.

Total milk produced: This variable influenced the level of milk output commercialization positively and significantly at 1% significance level. The possible reason could be an increase in household gross production was result in an increase in the household milk commercialization level. Thus, the survey result indicates that smallholder farmers who produced more milk had a 5.1% increase in the commercialization of their output.

4. Conclusions and Recommendations

Based on the results of this study, subsequent conclusions and recommendations are made. The Tobit model result shows that the farm households' milk commercialization was positively influenced by access to improved breed type, cooperative membership, access to market information and quantity of milk produce and it was also negatively influenced by household size and distance to the nearest market.

Households' size negatively affects the level of milk commercialization in the study area. As the number of peoples in the households increase, the need for home consumption increases rather than participating in the market to sell their output. Hence, governmental and non-governmental stakeholders should give attention to strengthening clout policies on improving rural family planning to enhance farmers' level of milk commercialization

Ownership of improved breed cows benefited smallholder milk producers' commercialization positively and significantly in the research area. This means that increased availability and better use of production inputs in the research areas could result in increased milk output. As a result, it's critical to give farmers with the enhanced breed cows they need at a fair price in order to boost productivity. It also requires strengthening the existing livestock production system through providing better health services, better livestock feed, and adopting agro-ecologically based high-yielding breeds and disseminating through artificial insemination to improve the livelihood of farmers in the area.

Distance to the market influenced commercialization level of smallholder milk producers in the study area negatively. This shows that the households located far away from the markets have poor market access which increases the final cost of acquiring farm inputs, output supply, and also purchase of food items. The improvement of transportation infrastructures and market information systems should be recommended. This will lower the rate of transaction cost, thus enabling farmers to provide more produce to market.

Farmers who have access to milk market information are very likely to supply the produce to markets. In order to improve milk farmers' regular access to information on market dynamics, efforts should be made to offer proper and adequate market information by strengthening the market information distribution network and connecting farmers' cooperatives with appropriate sources of market information. Furthermore, provision on marketing issue-based extension ser-

vices, preferably market linking focused extension services rather than to continue being dependent merely the present livestock productivity extension services and marketing incentive to smallholder livestock producers should be recommended.

In the research area, farmer cooperative involvement had a considerable positive impact on smallholder milk commercialization. Farmers' cooperatives make it easier for their members to get information about prices, profitability, new technology availability, and loans. To reduce transaction costs and maintain farmers' gains from their products, initiatives such as establishing new farmer cooperatives/groups and upgrading existing ones to collect milk products and connect them to markets are required. This entails equipping them with the knowledge and skills needed to develop and commercialize milk value additions.

Extension contact is a significant contributor to the commercialization level of milk producers. Therefore, joint efforts of development agents' agricultural experts, researchers and other stakeholders on identifying and solving problems, availing and transferring of new agricultural technology and information to farmers are compulsory to enhance commercialization. As a result, policies and strategies should place more emphasis on strengthening the existing agricultural extension service provision through short and long-term training, upgrading educational level and providing non-overlapping and congruent responsibilities to extension workers.

Generally, the households should use improved inputs and participate at the market which might increase their income to purchase consumption goods. Different stakeholders need to work together to use the livestock for socio-economic development and to support the livestock-based economy. A comprehensive, integrated and multidisciplinary research effort, and links with development and extension agents are required on the livestock production and management.

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Conflicts of Interest

The authors declare that they have no competing interests.

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