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Smallholder dairy producers' participation in dairy marketing in Southern Omo Zone, Ethiopia

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Abstract

Dairy market development has been hampered by multi-faceted problems such as low adoption of improved technologies, absence of clear policy support for the sector, marketing problems, and other institutional factors. This study was aimed at analysing determinants of smallholder dairy producers' participation decisions in dairy marketing and the intensity of participation in dairy marketing. It is also aimed at identifying the existing major constraints on dairy marketing in the study area. A total of 150 random sample households were chosen, and data were analysed using descriptive and econometric methods. A Heckman two-step selection model was used to analyse the determinants of dairy market participation decisions and levels of participation. The results indicated lower participation in dairy marketing (38.67%), despite the huge potential of livestock production in the area. Dairy producers' market participation decisions were found to be significantly affected by the education status of the household head, access to market information, distance to the nearest market, number of lactating cows, and membership in a cooperative group, while the age of the household head, education status, land holding, and number of lactating cows significantly affected the dairy product sale volume. The findings imply that market information delivery systems, market infrastructures, and vocational education should be strengthened by the government and development partners.

Keywords: Dairy market participation, Bena Tsemay, Heckman two-step selection model

Introduction

Livestock plays a crucial role in Ethiopian economic development, accounting for a quarter of the national and 40% of the agricultural gross domestic product. At more than 50 million, Ethiopia's livestock population is the largest in Africa and the eighth largest globally (IRLI, 2016). Livestock, especially cattle, has historically played multiple roles both in economic life and in the socio-cultural traditions of African people. Cattle have been valued not simply as a source of food (milk, blood, and meat) and hide, but also as a visible form of wealth and a source of social prestige (Ngigi, 2005). In Ethiopia, the livestock sub-sector is estimated to support 60–70% of the livelihoods of the Ethiopian population. The country is endowed with an estimated 12 million cows and a favourable environment for dairy production (Tegegne et al., 2013; CSA 2016).

Dairy farming is an important part of livestock production in Ethiopia (IRLI, 2016). Ethiopia has untapped dairy potential due to a large and diverse livestock population as well as a dairy-friendly agro-ecology (Tegegne et al., 2013). Despite the enormous potential, most of the country suffers from a chronic shortage of dairy products. In Ethiopia, the per capita dairy consumption is very low, far below the international standards. According to the AGP-Livestock Market Development Project (2013), annual milk consumption is 19 l per capita, which is significantly lower than the global average of 105 l and the African average of around 40 l.

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In Ethiopia, dairy development has been hampered by a multi-faceted set of problems: production system-specific constraints related to genotype or low improved breed (Kumar et al., 2013, Makoni et al., 2014), feed resources and feeding systems, access to services and inputs, low adoption of improved technologies, and absence of clear policy support to the sector are major problem hindering dairying in the rural area of Ethiopia (Tegegne et al.,2013). Problems also arise from insufficient production coupled with inhibitive cultural taboos related to consumption and the absence of proper processing and marketing (Terefe, 2016).

Market access plays an essential role in assuring better income and welfare for smallholder livestock producers through various channels (Ehui et al., 2009). Integration of a market system for smallholder farmers is an essential mechanism to secure food supply to growing urban markets in developing countries (Reardon et al., 2014). Ethiopian smallholders produce about 93% of dairy products, but a very small quantity of this production is marketed. The larger volume produced milk is processed into different local dairy products (Tadesse et al., 2016).

Several factors, including a lack of market access, a lack of market information, slow technological adoption, and inadequate infrastructure, limit smallholder dairy producers' market participation in rural areas (NDA, 2005). Low marketable output: high transaction costs arising from transportation and high opportunity costs of labour involved, a dependable marketing system, and spatial separation of producers and consumers, which creates imperfection in price setting, are some of the marketing problems affecting smallholder farmers in Ethiopia (Terefe, 2016; Tadesse et al., 2016).

Several studies conducted on smallholder dairy marketing in Ethiopia are limited to the central highland area of the country (Yigrem, 2015; Terefe, 2016; Kuma et al., 2013; Tadese et al., 2016), and those studies exclusively focus on liquid milk marketing. Furthermore, most of those studies are limited to participation decisions, but they did not incorporate the level of participation. Some studies conducted in the South Omo Zone focus on livestock production constraints, dairy production systems, and post-harvest handling (Ayele and Hidosa, 2015; Ayele et al., 2016). But there is a gap in the investigation of smallholder farmers' participation in dairy product marketing. Therefore, this study is aimed at analysing the determinants of smallholder farmers' decisions to participate in dairy marketing and the level of dairy product market participation.

Methodology

Description of the study area

Bena Tsemay district is one of the nine districts found in the South Omo Zone, which covers an area of 2923 km^2 and has a human population estimated at 67,797. The population density of the district is 20 people per square kilometre. It is bounded to the northeast by the Malle district, to the west by the Hammer district, to the east by the Konso district, and to the north by the South Ari district. The district is situated between 5.01° and 5.73° N latitude and 36.38° and 37.07° E longitude. The altitude of the district ranges between 600 and 1500 m.a.s.l. The district is divided into 29 rural and 2 urban pastoralist associations (PAs).

Dry kola (arid) (78%), woynedega (sub-humid) (19%), and semi-arid (3%) are the three major agro-ecologies. The study area has a bimodal rainfall distribution (Fig. 1); the first peak, from mid-March to the end of April, is critical for crop production, while the second peak, from mid-October to the beginning of November, is brief and only important for pasture. The average annual rainfall is between 800 and 1300 mm, and the average annual temperature is between 18 and 380 °C.

Livestock are the predominant livelihood source in the district, which is supported by opportunistic crop production. The district has animal resources with an estimate of about 459,779 cattle, 146,868 sheep, 741,237 goats, 97,205 local and improved poultry, 28,877 equines, and 32,500 bee colonies. There are two ethnic groups: Bena and Tsemay, and their farming system is a mixed crop-livestock production system (Ayele et al., 2016).

Sampling procedure and sample size determination

This study employed a cross-sectional research design. A two-stage sampling technique was employed to select sample respondents. In the first stage, five potential kebeles (PAs) in the district were selected purposively because of their potential for dairy production. From 1920 household or dairy producers having lactating cows, 150 dairy farming households were selected randomly using a probability proportional to the sample size sampling technique from the list prepared. The sample size was determined based on a simplified formula provided by Yamane (1967), at a 95% confidence level and 7% level of precision.

$$n = \frac{N}{1 + N(e^2)}$$

This study employed both primary and secondary data. The sample respondents and key informant interviews yielded qualitative and quantitative primary data. Data

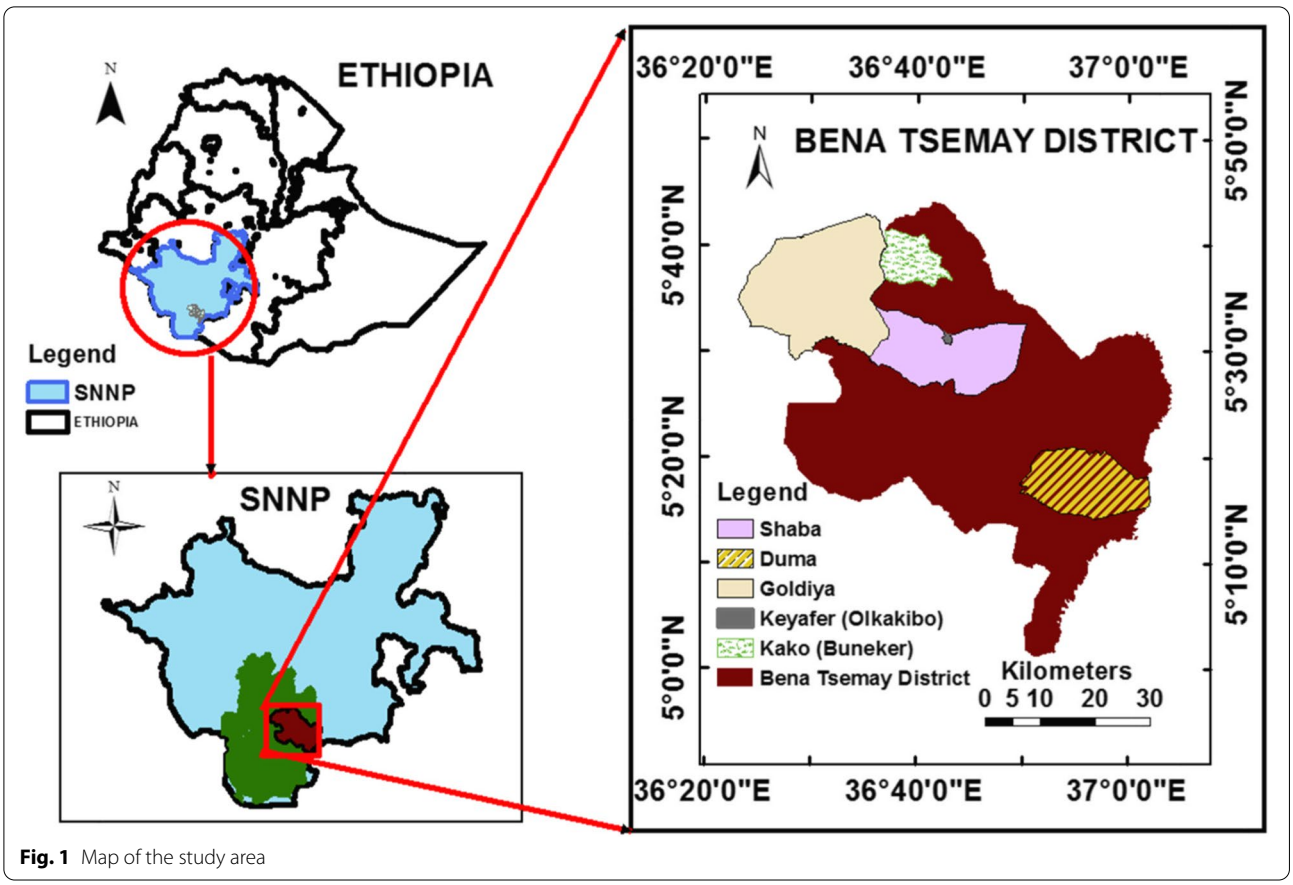

Fig. 1 Map of the study area

were collected in January and February 2021. A structured interview schedule was used to collect data from dairy producers, and a key informant interview was used to gather in-depth information on dairy marketing constraints and opportunities from livestock and dairy traders, extension agents, etc. Secondary data was collected from the district office of agriculture, CSA, and other published and unpublished documents.

Method of data analysis

Descriptive statistical analysis was carried out by employing measures of dispersion and central tendency like standard deviation and mean. Inferential statistics like the chi-square test and *T* test were used to show market participation associations with categorical and continuous explanatory variables, respectively. An econometric analysis was used to analyse the determinants of smallholders' participation decisions and the intensity of participation in dairy marketing. Different statistical tests were undertaken.

Econometric analysis

It is assumed that smallholder farmers who produce dairy products may or may not participate in dairy product marketing, i.e. may sell or not sell. There should also be variation among smallholder farmers who are participants in the level of sale. Therefore, rather than the binary model (logit or probit), which only deals with dichotomous choice (yes or no type), Heckman's two-stage model is appropriate. Heckman has developed a two-step estimation procedure model that corrects for sample selectivity bias. In some respects, the parameterization of the double-hurdle model is like that of the Heckman procedure, in that two separate sets of parameters are obtained in both cases. In the Heckman model, non-participant dichotomous or dummy variables will never participate under any circumstances. Conversely, in the double-hurdle model, non-participants are considered as a corner solution in a utility-maximizing model (Yami et al., 2013).

If two decisions are involved in the Heckman model, such as participation and level of participation, which is the value of the total sale to the market here in this study, Heckman's (1976) two-step estimation procedures are appropriate. The first stage of the Heckman two-stage model is a 'participation equation', which attempts to capture the factors affecting participation decisions. This equation is used to construct a selectivity term. The

inverse Mill's ratio is a variable for controlling bias due to sample selection (Heckman, 1976). The second stage involves including Mill's ratio to the amount of sale equation and estimating the equation using ordinary least square (OLS). If the coefficient of the 'selectivity' term is significant, then the hypothesis that an unobserved selection process governs the participation equation is confirmed. Moreover, with the inclusion of an extra term, the coefficient in the second stage 'selectivity corrected' equation is unbiased.

Specification of the Heckman two-step procedure, which is written in terms of the probability of dairy product market participation and the total value of the dairy product sale in ETB, is as follows.

Heckman's two-step procedure was used where the first step involved using a probit function (market participation). Equation (1) was used to predict the probability that a given household will sell the dairy product:

$$\Pr(zi=1|wi,\alpha) = \phi[h(wi,\alpha)] + \varepsilon i \quad (1)$$

where Zi is an indicator variable equal to unity for households that own livestock, ϕ is the standard normal cumulative distribution function, w is a vector of factors affecting the market participation, α is a vector of coefficients to be estimated, and εi is the error term assumed to be distributed normally with a mean of 0 and a variance $\sigma 2$.

The variable Zi takes the value of 1 if the marginal utility the ith household gets from participating in the market is greater than 0, and 0 otherwise. So, we have:

$$Zi^* = \alpha wi + vi \quad (2)$$

where Zi^* is the latent level of utility the household gets from market participation $vi \sim N(0,1)$ and:

$$Zi = 1, \text{if } Zi^* > 0 \quad (3)$$

$$Zi = 0, \text{if } Zi^* < 0 \quad (4)$$

The second step involved the identification of determinants of sale values (Ethiopian birr) conditional on market participation. In this step, the inverse of Mill's ratio (IMR) was added as a regressor in the sale value function regarding the level of participation to correct for potential selection bias if only the households which owned dairy cows were included in the second step. The IMR is computed according to Heckman (1976).

$$\lambda = \phi[h(wi,\alpha)]/\Phi[h(wi,\alpha)] \quad (5)$$

where $\phi(.)$ is the normal probability density function, and $\Phi(.)$ is the normal cumulative probability density function. The second stage (sales) equation is then given by:

$$E(Y/Z=1) = f(xi,\beta) + \gamma\phi[h(wi,\alpha)]/\Phi(wi,\alpha) \quad (6)$$

where E is the expectation operator, Y is the (continuous) extent of market participation or sales, x is a vector of independent variables affecting sales, and β is the vector of the corresponding coefficients to be estimated. So, Yi is expressed as:

$$Yi^* = \beta' xi + \gamma\lambda + ui \quad (7)$$

where $ui \sim N(0,\sigma u)$; $Yi^* =$ is only observed for market participants ($Zi = 1$), in which case $Yi^* = Yi$ estimated by full maximum likelihood using the Heckman procedure in STATA.

Definition of variables and working hypotheses

The dependent variable of the study

Dairy product market participation is a dummy dependent variable that represents the probability of dairy product market participation of the household. The variable takes a value of 1 for households that participate in dairy product marketing and takes 0 value if a household is not a participant in dairy product marketing.

The volume of dairy products sold (sale value) is a continuous dependent variable that is measured in birr. It represents the actual monetary value of dairy products sold.

Model evaluation and testing for regression diagnostics

The study used the variance inflation factor to check multicollinearity among continuous variables and the contingency coefficient to check multicollinearity among discrete variables. According to the test results, there are no multicollinearity problems among the continuous and discrete variables (Table 8 in Appendix).

Results and discussion

Socio-economic and demographic characteristics of the respondents

In Ethiopia, large-scale dairy producers' market participation is limited to a certain geographical area, and the most marketable dairy product is fresh milk. Market-oriented dairying is confined to the central parts of the country, and the most marketable dairy product is raw milk in the central parts of the country. The results indicated that 38.67% of respondents are participants in dairy product marketing (Table 1). The result indicated that a significant proportion (41.38%) of female-headed households were participants in dairy products when compared with the proportion of females in non-participants

Table 1 Relationship between dummy independent variables and market participation

Independent variables		Participant (%), *N* 58	Non-participant (%), *N* 92	Chi-square test
Sex of HH	Male	58.62	85.87	12.7064***
	Female	41.38	14.13	
Education status HH	Literate	56.90	18.48	23.6272***
	Illiterate	43.10	81.52	
Membership in dairy cooperative	Yes	55.17	6.52	44.5126***
	No	44.83	93.48	
Credit use	Yes	44.83	15.22	15.9491***
	No	55.17	84.78	
Access to market information	Yes	84.48	27.17	46.7418***
	No	15.52	72.83	

Source: author's computation from sample survey data (2020)

*, **, *** represent significance level at 10%, 5% and 1% respectively

(14.13%). This result is consistent with the findings of Burke et al. (2015) in Kenya and Gebremedhin et al. (2017) in Ethiopia. Key informants' findings are also in line with the survey results in that even if both males and females participate in dairy product marketing, the role of taking dairy products to the marketplace is primarily that of females, particularly in fresh milk marketing. The education status of the household head, which includes the ability to read and write, is found to have a significant difference between dairy market participants and non-participants at less than 1% level of significance. A majority (81.52%) of non-participants are illiterate, while there is a slight difference in education status among participants, with a greater proportion of literate household heads (56.9%). This indicates the relative tendency of literate household heads to participate in dairy product marketing.

Also, the results show a significant difference (p 0.01) between dairy market participants and non-participants in dairy cooperative membership, credit use, and access to market information. Dairy cooperatives and credit utilization are expected to be very important elements in dairy market development for smallholder farmers, who are handicapped financially and are in fragile market structures. However, 44.83% of the dairy market participants were not members of dairy cooperatives, and 55.17% of them had not accessed credit services. Among non-participants, 93.48% and 84.78% of sample households were not members of dairy cooperatives and had no credit access, respectively (Table 1). This indicates the presence of huge gaps in filling efficient financial services for the smallholder dairy producers. According to the key informants, pastoral households in the study area are more sceptical about accessing credit services provided by different organizations. Regarding access to market information, participants have more access to marketing information about the product prior to the market day and to whom they are selling their product. Despite the importance of dairy cooperatives, particularly for smallholder producers, milk marketing through dairy cooperatives remains low in the study area. Of the non-participants, only 27.17% had dairy product market information (Table 1). Therefore, access to market information helps dairy producers more likely to participate in dairy product marketing.

The relationship between dairy market participation and continuous variables is depicted in Table 2. The sample t-test revealed that there is a statistically significant difference in the mean age of the household head between participant and non-participant sampled households and was estimated to be significant at less than 5% significance level. Participating sampled dairy households have a mean age of 44.12 compared to non-participants (40.75) (Table 2).

The average land holding of sampled households is 1.60 and 0.89 hectares for dairy market participants and non-participants, respectively. The average land holding of the study area is greater than the national average (0.96) and that of the SNNP region (0.49) (Headey et al. 2014). According to the key informants from the district's livestock office, the land ownership pattern in the study area is changing from communal ownership to a privatized enclosure. Individual land enclosure for the purpose of crop cultivation and grass preservation for the dry season is recently common. According to key informant findings, large-sized enclosed land is primarily owned by the better-off or wealthiest communities. They further added that there is still a communal grazing area that is common for all pastoral and agro-pastoral communities in the area. Pastoralists usually flee their livestock to that pasture area during the dry season. This is what we practically observe during our field observation in Duma

Table 2 Relationship between continuous independent variables and market participation

Independent variables	Participants, mean (SD)	Non-participants, mean (SD)	*t*-value
Age of household head in years	44.12 (1.37)	40.75 (0.91)	− 2.1363**
Family size in adult equivalent	4.90 (0.20)	4.64 (0.15)	− 1.0594
Land holding in hectares	1.60 (0.11)	0.89 (0.06)	− 6.1206***
Distance nearest market in kilometres	7.10 (0. 41)	12.08 (0.71)	5.2065***
Children under 6 years in numbers	0. 95 (0.11)	1.72 (0.12)	4.7592***
Lactating dairy cows owned in numbers	5.10 (0.37)	1.51 (0.15)	− 10.3172***
On-farm income in ETB	28,403.45 (2748.88)	15,786.2 (1194.85)	− 4.7637***
Non-farm income in ETB	5455.17 (1282.45)	3366.74 (718.20)	− 1.5342

Source: author's computation from sample survey data (2020)

*, **, *** represent significance level at 10%, 5% and 1% respectively

kebeles. Due to pasture and water shortages in the area at the time, pastoralists relocated the majority of their cattle to that communal grazing area from their permanent settlement.

Distance to the nearest market and children under 6 years have a higher mean with non-participants when compared with participants. Dairy market participants are relatively closer to the market, with an average distance of 7.10 km, implying a lower cost of transportation. Another very important variable is the number of lactating dairy cows owned. The average lactating dairy cow owned by dairy market participants is 3.38 times greater than non-participants. Family size and non-farm income are found to be statistically insignificant among dairy market participants and non-participants. The mean family size of participants is higher (4.90) than that of non-participants (4.64) (Table 2).

Dairy market actors and marketing channels

The primary actors of the milk supply chain identified in the study area were milk producers, collectors, retailers (cafés and restaurants), and consumers. According to the results shown in Table 3, a greater proportion of producers sell milk directly to consumers, while others sell milk to collectors (32.26%) who then resell it to consumers. But in the case of the butter market, the majority of producers sell their product to collectors (56%) followed by those who sell it directly to consumers (29.41). In butter marketing, producers, collectors, wholesalers, restaurants, and consumers are the key participants in the butter market.

Dairy product marketing constraints in the South Omo Zone

In output markets, smallholder farmers are often faced with difficulties in enforcing contracts and meeting stringent food safety norms and lack skills; they are in remote areas and mostly rely on middlemen (Goodwin and Gouldthorpe, 2013). Both the results of key informant interviews and the survey indicated that smallholder dairy producers in the study area find it difficult to participate in a market-oriented dairying system due to several constraints. Table 4 indicates that various constraints like poor infrastructure, lack of transport facilities, dearth of market information, frequently fluctuating prices of dairy products, poor market linkage, and low productivities of livestock are among the major bottlenecks to dairy product marketing. Low dairy product prices were ranked first among major constraints to dairy product marketing, followed by poor infrastructure (68%), low dairy cow productivities (61.33%), and a lack of marketing information (51.33%).

Pricing systems prevailing in the country are biassed towards satisfying consumers rather than producers,

Table 3 Market participants and marketing channels in the dairy sector

Milk marketing (31 producers)			Butter marketing (51 producers)		
Agent	Per cent	Frequency	Agent	Per cent	Frequency
Collectors	10	32.26	Consumers	15	29.41
Hotels and restaurants	3	9.68	Collectors	29	56.86
Consumers	18	58.06	Wholesalers	3	5.88
			Restaurants	4	7.84

Source: author's computation from sample survey data (2020)

Table 4 Major marketing constraints for dairy products

Major constraints of dairy marketing	Frequency (%)	Rank
Poor infrastructure	102 (68.00)	2nd
Lack of transport facilities	58 (38.68)	6th
Lack of market information	77 (51.33)	4th
Lower price of dairy products	120 (80.00)	1st
Low productivities of dairy cows	92 (61.33)	3rd
Poor market linkage	63 (42.00)	5th

Source: author's computation from sample survey data (2020)

particularly in the agricultural sector. Accordingly, the results of key informants from both producers and traders indicate that the price of dairy products, particularly that of butter, had the highest fluctuation from the wet season to the dry season and different holidays. Furthermore, the fasting season in Orthodox Christianity had a significant effect on the price of dairy products in the market. Key informants from traders observed that the price of butter ranged from 250 birr per gallon to 600 birr per gallon (peak price, especially during holidays and the dry season). Findings by Woldemichael (2008) confirmed that the increased milk production was found to coincide with periods of weak seasonal demand. This combination pushed farm dairy product prices down significantly.

Dairy production and smallholder dairy producers' market participation

The Ethiopian dairy sector is highly heterogeneous, comprising both the traditional pastoral/agro-pastoral and mixed crop-livestock production systems and the market-oriented, intensive, specialized producers. The study area is found under traditional pastoral/agro-pastoral production systems. Milk is usually produced in excess during the wet season and is either sold fresh to nearby urban centres or processed into butter to be traded with the highlanders in the peripheral markets. Excess milk is produced for home consumption, but excess milk or milk products are sold to nearby towns or highlanders. The average milk production in the area is 1.5 l per cow (FAO, 2018). The most marketable product both in rural and urban areas of Ethiopia is butter (Tegegne et al. 2013). The results of this study also show that about 31 dairy producers brought fresh milk to the market, while most market participants sell their dairy products in the form of butter (Table 4). The results of key informant interviews and market observation indicated that fresh milk is not widely marketed in the marketplace, but rather dairy producers sell milk to urban dwellers by going from home to home through a contract system.

The results in Table 5 show that the average milk production per day per household is 6.8 l. Mengstu et al. (2015) discovered that the average milk produced per day per household in the Raya Azebo district was 5.135 l, which included 6.92 and 3.35 l of milk for participants and non-participants, respectively. Furthermore, Kuma et al. (2013) reported that the average milk produced per day per household was 6.55 l. Hence, when compared with other areas, the production is almost like those areas. But the number of livestock resources in the study area is greater than the holding size of the area mentioned above.

The data in Table 5 shows that the average daily sale of milk per household is 57.68 birr with a 38.58-birr standard deviation. The average monthly sale of butter per household is around 726.13 birr. The consumption pattern and marketing of dairy products produced at home varied depending upon the amount of milk produced per household, dairy production system, market access, season of the year, fasting period, and culture of the society. Rural dairy farmers have very little access to marketable fluid milk, and milk is often processed into butter (Tegegne et al. 2013).

Determinants of dairy product market participation

Participation in the dairy market was defined as a variable taking the value of 1 for dairy market participants and 0 for non-participants and used as a dependent variable. Market participation here is the sale of dairy products either liquid milk or butter or both from their own production. Likelihood ratio statistics which are indicated by chi-square statistics are highly significant ($P < 0.0000$), suggesting the model has a strong explanatory power.

Table 5 Dairy production and amount of dairy products marketed

Dairy products	Obs	Mean	Std
Volume of milk produced in litres per day	150	6.8	3.4
Value of milk sold in birr per day	31	57.68	38.58
Value of butter sold in birr per month	51	726.13	641.64
Average dairy product sale in birr per month	58	2456.47	1799.14
Average daily sale of dairy products in birr	58	81.88	59.97

Source: author's computation from sample survey data (2020). 1 USD = 39.5 Ethiopia birr

Out of the thirteen hypothesized explanatory variables, five variables (education status of household head, number of lactating cows, distance to the nearest market, access to market information, and membership to dairy cooperative) were found to affect market participation decisions significantly (Table 6). The data were analysed, and post-estimation of the selection equation results was done to obtain the marginal effects. The marginal effects were used for interpretation since the coefficients of the selection equation have no direct interpretation. The reason is that they are just values that maximize the likelihood function. The discussion and interpretation of the significant explanatory variables in the probit model estimation are presented in Table 6.

The educational status of the household head had a positive effect on dairy market participation decisions significantly and at less than 5% level of significance (Table 6). In the study area, there is a huge gap in education. The result of the model is consistent with the finding of Megarsa et al. (2016) suggesting the increments of market participation with education and training.

The number of lactating cows owned had a positive and significant effect on dairy market participation at less than 1% significance level. Milk production increases with the number of lactating dairy cows owned, thus increasing the share of marketable surplus by smallholder dairy producers, which could generate more money. In the study area, there are a few exotic or improved breeds, and almost all the sampled households own just local dairy cows. The marginal effect of the model indicates that other things remaining constant, as the number of lactating dairy cows increases by one, the probability of market participation increases by 18.9% (Table 6). The findings of Kuma et al. (2013) and Tadesse et al. (2016) also reported a positive and significant effect of both lactating improved cows and local dairy cows.

Access to market information was found to have a positive and significant effect on smallholder dairy producer decision to sell their product at the less than 1% probability level. This is probably because the dairy producers are aware of what they can get from dairy product marketing and probably the cost that they might incur in the marketing process. This in turn inspires them to fetch an anticipated profit from the sale of their products. The marginal effect shows that access to market information increases the probability of smallholder dairy producers' participation in dairy product marketing by 44.5% (Table 6). This result is in line with the findings of Kiwanuka and Machethe (2016), who argued that access to dairy marketing information about distribution channels, prices, product quantities, and quality creates awareness of the available market opportunities and the extent of risks involved.

Table 6 Probit result of the Heckman two-step selection model

Variables	Coefficient	Std. Err.	$P > \|z\|$	Marginal effect
Sex of the household head	0.786	0.607	0.195	0.283
Age of the household head	0.045	0.031	0.151	0.015
Family size in adult equivalent	0.074	0.192	0.699	0.025
Children under 6 years in number	−0.189	0.298	0.526	−0.063
Education status of the household head	1.117[b]	0.517	0.031	0.392
Land holding in hectares	0.336	0.371	0.364	0.112
Lactating dairy cows owned in numbers	0.569[c]	0.150	0.000	0.189
Distance to nearest market in kilometres	−0.192[c]	0.069	0.005	−0.064
On-farm income in Ethiopian birr	9.98e−07	1.98 e−05	0.960	3.32e−07
Non-farm income in Ethiopian birr	1.7e−05	3.97e−05	0.668	5.66e−06
Access to market information	1.400[c]	0.526	0.008	0.445
Access to credit service	0.872	0.533	0.102	0.313
Membership in dairy cooperative	1.022[a]	0.541	0.059	0.369
Constant	−4.515	1.880	0.016	
Number of obs = 150 LR chi^2 (13) = 158.44 Prob > chi^2 = 0.0000 Log likelihood = −20.86588 Pseudo R^2 = 0.7915				

Source: author's computation from sample survey data (2020). 1 USD = 39.5 Ethiopian birr

[a], [b], and [c] significant at 10%, 5%, and 1%, respectively

The distance to the nearest market is measured in distance from the respondent's home to the market centre in kilometres. It had a negative and significant effect on the participation decision of the sampled households. The possible reasons are reduction of transportation costs, improved quality dairy products, and reduction of other costs of information within closer distance and vice versa. The marginal effect estimates show that, as the distance to the market increase by a small number, the probability of participating in the dairy product market decreased by 6.4%. Several studies reported the opposite relationship between farmers' participation in milk marketing and distances from the market centres (Kidanu, 2010; Kuma et al., 2013; Tadesse et al., 2016; Gebremedhin et al., 2014).

Dairy cooperative in the study area is a more likely informal collection of dairy producers that help members bring their product to the market on a rotational basis and helps them to sell their product at reasonable prices. Membership in dairy cooperative significantly affects market participation at less than 10% significance level. Dairy cooperative membership helps smallholder farmers to pull a small amount of their product which would not allow them to market on their own due to different marketing costs. The study made by Montoeli et al. (2020) also find a positive effect of the dairy cooperative on dairy market participation justifying that cooperative enables farmers to attain bargaining power, economies of scale, and reduced transaction costs.

Determinants of level of dairy product market participation

The second stage estimation is summarized in Table 7, and it indicates what factors affect the sale value of dairy products in birr. The inverse Mill's ratio, which is calculated from a probit estimation of the decision to sell dairy products, is included in the second step of the Heckman model. Including inverse Mill's ratio (LAMBDA), 13 explanatory variables were estimated in this stage, and here, the distance to the nearest market was excluded from the model. Out of 13 explanatory variables, five variables (age of the household head, education status of the household head, land holding size, number of lactating dairy cows owned, and LAMDA) had significant effects on the sale value (in birr) of dairy products.

The result of this model indicates that the rho value was 1.000, and the positive sign indicated that is unobservable between the dairy market participation decision and the sale value of dairy products sold by households

Table 7 OLS result of the Heckman two-step selection model

Variables	Coefficient	Std. Err.	$P > \|z\|$
Sex of the household head	− 21.581	15.322	0.159
Age of the household head	− 1.239[a]	0.695	0.074
Family size in adult equivalent	1.653	5.448	0.762
Children under 6 years in number	− 6.163	9.169	0.502
Education status of the household head	21.007[a]	12.231	0.086
Land holding in hectares	26.124[c]	7.797	0.001
Lactating dairy cows owned in number	15.756[c]	2.961	0.000
On-farm income in Ethiopian birr	− 4.141	3.576	0.247
Non-farm income in Ethiopian birr	− 5.392	7.091	0.447
Access to market information	17.318	17.662	0.327
Access to credit service	18.270	11.710	0.119
Membership in dairy cooperative	2.899	12.744	0.820
Constant	− 9.220	47.605	0.846
Lamda	44.397[b]	18.932	0.019
Rho	1.000		
Sigma	44.397		
Number of obs	150		
Censored obs	92		
Uncensored obs	58		
Wald chi^2 (12)	66.36		
Prob > chi^2 (2)	0.0000		

Source: author's computation from sample survey data (2020). 1 USD = 39.5 Ethiopia birr

[a], [b], and [c] significant at 10%, 5%, and 1%, respectively

were positively correlated. This implied that in the determinants of the second step of the model, there was an unobserved variable that was positively related to the dairy product market participation decision. The chi-square value of rho was statistically significant, which means correction to biassed estimation.

According to the model output, the lambda (inverse Mill's ratio) or selectivity bias correction factor has a positive and statistically significant impact on dairy product sales. These findings imply that there are no unobserved factors that could influence both the likelihood of dairy household market entry decision and dairy sale value. The positive sign of the inverse Mill's ratio indicates a positive effect of unobservable factors both on participation decisions and dairy sales.

The age of the household head had a negative significant effect on the level of participation, which is the sale value of dairy products at less than 10% level of significance. The results show that an additional year of the household head would lead to a 1.24-birr (0.03 US dollar) reduction in dairy product sales, other variables in the model held constant. The findings by Woldemikael (2008) reported the negative effect of age on dairy market participation. But this result is contrary to the finding of Emukule et al. (2018), which reported an increase in dairy sales with the age of the household head.

The education status of the household head had a positive and significant effect on dairy product sales at less than 10% level of significance. The results show that an additional literacy of the household head leads to a 21.01 birr or 0.53 US dollar increment in dairy product sales; other things remained unchanged (Table 7). It is expected that household heads that are educated can easily understand the cost and benefit encountered in undertaking any sort of activity and can access various information sources needed to enhance and sustain their levels of participation (Kiwanuka and Machethe, 2016; Emukule et al. 2018). Educated individuals may also be better at understanding the possible gains from bulk sales and where to sell their products than others. Ehui et al. (2009) also reported that households with better education and more cows are associated with greater sales of dairy products.

The results further reveal that the land holding had ad positive and significant effect on the sale of dairy products at less than 1% probability level. The model result indicated that 1-hectare increments of land increased dairy sales by 26.12 birr or 0.66 US dollar. Other variables in the model were held constant. This finding is also consistent with the findings of Emukule et al. (2018) and Ehui et al.(2009), which stated that the volume of dairy products sold was positively associated with the land size owned by households.

The household's number of lactating dairy cows had a positive effect on dairy product sales with less than 1% significance. The results imply that with an increasing number of lactating women in the household, there could be surplus milk in the household, which in turn increases marketing offtake by the dairy producers. As the number of lactating cows increases by one, the monthly dairy product sale increases by 15.76 birr (0.40 US dollar), and other factors remain constant (Table 7). In the study area, although milk productivity is generally low, this low productivity is compensated for by the relatively large number of livestock in the study area. In line with this finding, many studies have found the positive effect of the number of lactating cows owned on the volume or intensity of dairy product sales (Emukule et al., 2018).

Conclusions and policy implication

The study's findings indicated that the household head's education level, membership in a dairy cooperative, and access to market information all had positive and significant effects on dairy market participation decisions. The findings also revealed the likelihood and level of market participation are greater with a number of lactating cows. Another important variable that influences participation decisions is the distance to the nearest market, which raises transaction costs. The age of the household head has a negative impact on the value of dairy product sales, whereas education and land ownership have a positive impact on the level of dairy product sales.

The study suggests important policy implications that will increase both smallholder dairy market participation and the value of dairy product sales. This study suggests that proper information delivery mechanisms be promoted through the integrated use of more appropriate information and communication technologies, the development of market infrastructures, and training for society's elderly. Pastoralists and agro-pastoralists in the study area should obtain vocational education that will improve their literacy level. Because of increased encroachment on pastureland, this study also calls for policy implications that intensify commercial-oriented dairy production. Finally, this study concludes that dairy product marketing among South Omo Zone pastoralists and agro-pastoralists is low, necessitating appropriate interventions.

Appendix (Tables 8, 9, 10 and 11)

Table 8 Test for multicollinearity

Variable	VIF	1/VIF
Family size in adult equivalent	1.89	0.529144
Lactating cows owned	1.83	0.545909
Age of the household head	1.49	0.669352
Land holding size in hectares	1.35	0.739217
Non-farm income in birr	1.35	0.741735
Farm income in birr	1.34	0.746078
Number of children under the age of 7 years	1.24	0.803841
Distance to the nearest market	1.04	0.960593
Mean VIF	1.44	

Table 9 Contingency coefficient among dummy variables

	Sex of the HH	Education status of HH	Membership in dairy cooperatives	Access to market information	Credit use
Sex of the HH	1.000				
Education status of HH	0.2187	1.000			
Membership in dairy cooperatives	0.2001	0.2059	1.000		
Access to market information	0.1778	0.2074	0.4370	1.000	
Credit use	0.1096	0.1812	0.1687	0.3096	1.000

Table 10 Heteroscedastic test

Breusch-Pagan/Cook-Weisberg test for heteroskedasticity
Ho: constant variance
Variables: fitted values of dairy products sale value in birr
chi^2 (1) = 6.05
Prob > chi^2 = 0.1139

Table 11 Test for omitted variables

Ramsey RESET test using powers of the fitted values of dairy products sale value in birr
Ho: model has no omitted variables
$F(3, 42) = 3.03$
Prob > $F = 0.1393$

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Authors' contributions
DK contributed to the whole preparation of the paper from developing proposal to report writing. DG and EJ contributed to the statistical analysis of the data, review of the literature, and preparation of the draft report, while BK and GG contributed to the review of the literature, preparation of the map of the study area, and revision of the reports. The authors read and approved the final manuscript.

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Availability of data and materials
Data used for this research is available if needed.

Declarations

Ethics approval and consent to participate
There are ethical protocols that will be followed by the researchers. Consent of every household was taken into account before conducting the interview. This ensured that their participation in the study is not out of their own volition.

Consent for publication
Here, the authors declare that they are interested in publishing this article on pastoralism because they believe that this journal is the right place to publish this paper.

Competing interests
The author declares that they have no competing interests.

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