Impacts of Dairy Cooperatives on the Livelihoods and Quality of Milk from Smallholders in Selected Areas of Central Ethiopia

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ABSTRACT

The objective of this study was to evaluate the influence of dairy cooperatives on the livelihoods of smallholder farmers and assess milk quality in selected areas of Ethiopia's central highlands. Drawing on data from 205 farmers (156 cooperative members and 49 non-members), the research employed t-tests to analyze microbiological and physicochemical properties of raw milk, alongside descriptive statistics and propensity score matching to assess outcomes such as milk yield, selling price, household income, consumption, and employment. Results revealed that cooperative membership significantly boosts milk production and household income, attributed to members' enhanced access to crossbred cows, veterinary services, inputs, and market information. While non-members achieve marginally higher prices through direct sales, cooperative members benefit from stable pricing, consistent market access, and dividend earnings, resulting in greater overall financial gains. Membership also correlates with expanded employment opportunities due to increased herd sizes. Key challenges for cooperatives include informal milk markets, fluctuating demand, and quality concerns, though growth opportunities exist through urbanization, population trends, government support, and proximity to dairy industries. Result of Laboratory analysis of 45 milk samples (30 from members, 15 from non-members) revealed significant quality differences between the groups. Milk samples collected from non-members exhibited lower specific gravity values (1.024 to 1.023) compared to members (1.027 to 1.028). Milk sample from members also had significantly ($P < 0.01$) higher average total solids (TS) and fat composition. Overall, the study highlighted significant differences in milk quality between cooperative members and non-members, leading to recommendations for improved milk handling practices.

KEYWORDS
Livelihoods;
Quality;
Smallholders;
Cooperatives.

1. Introduction

Agriculture remains the backbone of Ethiopia's economy engaging approximately 84% of the population and serving as the primary source of income for household consumption to sustain their livelihoods The sector contributes significantly to the country's economic development, accounting for 42% of the national Gross Domestic Product (GDP) and serving as a vital source of foreign currency through the export of agricultural products. Furthermore, agriculture is considered as a critical driver of future industrialization and sustainable economic development in Ethiopia (CSA, 2022). Dairy farming accounts for half of the livestock output, is particularly significant. Ethiopia is home to over 70 million cattle, with cows producing 92% of the total milk (Metaferia et al., 2011). The country produces approximately 4.96 billion litres of milk annually from 7.5 million milking cows (CSA, 2021).

Despite the potential benefits in reducing poverty and improving income, many Ethiopian smallholder farmers remain hesitant to join dairy cooperatives. Membership is low, with cooperatives concentrated in regions of high dairy potential (Molla et al., 2024). In addition, subsistence-oriented rural dairy systems, which contribute 98% of the country's milk supply, lack the technological, organizational, and institutional capacity to transition to market-oriented production. Challenges such as inefficient marketing systems, facilities, and inadequate extension services hinder sustainable dairy development (Gebreyohanes et al., 2021).

1.1.Statement of the Problem

In the central highlands of Ethiopia, milk and milk products play a critical role in the economic well-being of smallholder farmers. Women farmers, in particular, rely on income from the sale of milk and milk products to cover household expenses, with fresh milk sold at collection centres or farm gates (Gojam et al., 2017). However, smallholder farmers face considerable challenges, including limited access to markets, inadequate infrastructure, and fluctuating milk prices. Dairy cooperatives have emerged as a potential solution by fostering collective action, improving access to resources, and enhancing milk quality through better practices and technologies.

Despite the potential of dairy cooperatives, there is limited empirical evidence on their actual impact on the livelihoods of smallholder farmers and milk quality in the study area. Questions remain about how cooperative membership influences income stability, market access, and overall livelihood improvements for smallholders. Furthermore, the link between cooperative participation and milk quality, essential for both local consumption and market competitiveness remains inadequately explored. This study seeks to address these gaps by investigating the effects of dairy cooperatives on the livelihoods of smallholder farmers and the quality of milk produced in selected areas of Ethiopia's Central Highlands. By examining these issues, the research aim to provide insights into how cooperative participation can make dairy farm more sustainable and profitable for smallholders.

1.2. Research Objectives

The specific objectives of the study were:

- To assess the impact of dairy cooperatives on the livelihoods of smallholder farmers.
- To assess the microbial and physicochemical quality of milk among both cooperative members and non-members.

- To identify the challenges and opportunities faced by dairy cooperatives to bring the small holder farmers in to formal market.

2. Materials and Methods

2.1.Study Design

A cross-sectional research design combined with laboratory analysis was employed in this study. Initially, the a semi structured questionnaire was developed to gather the required information and milk sample collected for laboratory analysis of the physicochemical and microbial quality of milk at household level from smallholder farmers, both members and non-members of cooperatives.

2.2. Sampling Techniques and Sample Size Determination

A multistage sampling technique was employed to select cooperatives members and, non-members. Firstly, one active dairy cooperative was chosen purposively from each of the three-study areas namely Holeta, Bishoftu and Fitche Selale based on accessibility and ease for transportation besides their better success stories.(Yemane (1967) formula provides for calculating the study's sample size. $n = \frac{N}{1+N(e)2}$

The total active number of members of the dairy cooperatives was 322 (70 in Holeta, 110 in Fitche Selale and 142 in Bishoftu), and 100 total non-members (20 from Holeta, 30 from Fitche Selale and 50 from Bishoftu). A total of 156 representative sample members from the three targeted primary cooperatives and 49 non-members where the sampled primary dairy cooperatives are situated were selected randomly from the study areas. The total sample size for this study was 205 smallholder farmers.

From previously surveyed cooperative members and non-members a total of 45 cow milk samples (15 from non-members farmers and 30 from cooperative members) were randomly collected from the study areas and 200 mL of morning milk samples was collected for microbial and physicochemical analysis of milk from non-members and members of the cooperatives. Morning milk samples were collected aseptically and sealed in sterile containers. The samples were then stored in an icebox with ice packs and transported to Addis Ababa, where the laboratory analyses were carried out.

2.3. Data collection methods and sources

Both primary and secondary data sources were used to collect the required information for the study. The primary data was collected from dairy cooperative members and non-members by using a semi-structured questionnaire. The data was further complemented by conducting 12 focus group discussion (6 respondents with in each groups and 4 group per each study area), with a total 72 respondents of which 35 of them were female. Besides six (two per each study area) key informant interviews (KII) were conducted with senior cooperative government experts.

2.4. Impact Analysis

The methodological evaluation on the impact of dairy cooperative membership on dairy farm performance indicators, addresses the empirical challenge of creating a counterfactual to mitigate selection bias inherent in observational studies. To establish a valid counterfactual, propensity score matching (PSM) was utilized as a primary analytical tool. PSM allows us to pair each member household with one or more non-member households that share similar observed characteristics, adhering to the conditional independence assumption (CIA). This approach effectively simulates experimental conditions where households were randomly assigned to either membership or non-membership. The PSM methodology relies on two critical assumptions: the overlap or common support assumption and the balancing property. The common support assumption ensures that the propensity scores of both members and non-members fall within the same range, indicating a positive probability of being classified as either group with similar propensity scores.

The balancing property must also be met, meaning that covariate means for members and non-members should be similar after matching (Chagwiza *et al.,* 2016; Mojo *et al.,* 2017).Once these assumptions are verified, were calculate the average treatment effect on the treated (ATT), which quantifies the impact of cooperative membership on dairy farm performance indicators. The ATT is defined mathematically as follows:

$$ATT = E [Y_1 \mid C_i = 1] - E [Y_0 \mid C_i = 1]$$

Where Y_1 represents outcomes for member households, Y_0 for non-member households, and C_i indicates the presence performance indicator of cooperative membership. The analysis proceeds in two main steps. First, we estimate the conditional probability of a household becoming a member of the dairy cooperative society using a Probit model. Independent variables in this model include the age, education level of the household head, family size, herd size, ownership of crossbreed cows, distance to market, access to institutional credit, and dairy farming experience. In the second step, various matching algorithms were implemented to estimate the ATT. These include nearest neighbour matching (NNM), Epanechnikov kernel-based matching (KBM) with a bandwidth of 0.06, and radius matching (RM) with a caliper of 0.1. To ensure the validity of our PSM approach, it was assess the balancing property by comparing the distribution of observed covariates between members and non-members. A two-sample t-test was conducted to compare pseudo R^2 values and p-values from the likelihood ratio test for the joint significance of all covariates before and after matching. Sianesi (2004), recommend that p-values should be insignificant after-matching.

Additionally, the common support assumption can be visually inspected using a common support graph, and the mean absolute standardized bias (MASB) between members and non-members, as recommended by (Kassie, 2011) This study was the specific outcome variables to assess dairy farm performance, including milk production/yield, selling price, household income, household consumption, and household employment. This comprehensive methodology aims to provide a clear understanding of how dairy cooperative membership influences various performance metrics within dairy farmer households.

2.5. Statistical Analysis

All the collected data were coded and entered in to MS-Excel and the data were imported to Statistical Package for Social Science (SPSS) software version 24.0 and both descriptive and econometric tools were used to analyse the empirical data collecting for study. Descriptive statistics such as mean, standard deviation, range, frequency, percentage and t-test were applied to describe the characteristics of the respondents and for physicochemical and microbiological quality of milk samples collected from members of dairy cooperatives and non-members household farmers. Differences were considered to be significant at $p \leq 0.05$. Possible interactions were computed between different factors considered. With regard to impact assessment, the evaluation of impact was used propensity score matching and nearest neighbour matching (NNM) to match treatment and control groups, kernel-based matching (KBM) and radius matching (RM) was used to estimate the average treatment effect on the treated (ATT).

3.Results and Discussions

3.1.Milk Production, Consumption and Marketing

Table 1 presents results indicating that cooperative members owned more crossbred and milking cows than non-members, leading to higher milk production. Consequently, cooperative membership positively impacts milk yield, as well as the number of crossbred and milking cows owned and significant difference in milk yield and selling price was found between members and non-members, consistent with findings from Bayan (2018) and Hundera (2015).

Table 1: Milk production and marketing

Variables	**Member (n=156)**		**Non-member (n=49)**		**Total (n=205)**		P-value
	Mean	SD	Mean	SD	Mean	SD	
Average milk yield (lit/day)	41.15	23.63	24.87	17.03	33.05	20.33	0.021**
Milk yield (l/cow/day)	7.46	1.22	5.42	1.48	6.47	1.42	0.000***
Milk consumption (l/d/household)	1.37	0.79	0.44	0.66	0.91	0.62	0.201
Selling price (birr/litre)	46	1.5	42.5	1.16	44.32	1.5	0.084
Average daily income from consumed milk (birr)	1,695.56	1.56	903.2	2.94	1299.4	2.28	0.095

3.1. Determinants of participation in dairy cooperatives

Table 2 presented result for the regression on covariates. The results reveal that the size of the family in the labour force and for those who are more experienced in dairying profession, providing extension services, more milking and crossbreed had a significant positive influence on the probability of a household being associated with dairy cooperatives. Household size (man equivalent) is a good indicator of the available labour force for dairy production. Dairy production and membership in dairy cooperatives require more labour for rearing and managing dairy cows and frequently supplying milk to dairy cooperatives. This result is consistence with the finding of (Eshetu & Assefa, 2015).

Table 2: Probit model estimates and marginal effect

Variables	Coefficient	Standard errors	t-test	p-value	Marginal effect
Age	-0.045	0.034	-1.32	0.188	-0.0019
Sex	0.211	0.625	0.34	0.736	0.0151
Education	-0.319	0.247	-1.29	0.197	-0.007
Family size	0.041**	0.121	0.34	0.033	0.0364
Dairying experience	0.168**	0.105	1.60	0.021	0.0232
Number of dairy cows	0.310***	0.309	1.00	0.000	0.0511
Number of milking cow	0.414***	0.322	1.28	0.000	0.0486
Number of crossbreed dairy cows	0.257***	0.604	0.43	0.000	0.1040
Credit service	1.462	0.812	1.57	0.316	0.0712
Extension service	0.722**	1.436	0.50	0.029	0.0018
Training service	1.884**	0.588	0.60	0.043	0.1470
Market distance	-11.275	30.345	-0.37	0.710	0.6240
Market information	6.952***	1.328	-5.23	0.000	0.1528
Cons	7.074				
Number of observations 205					
Log likelihood -58.421					
LR Chi2 (16)					108.64***
Probit > Chi2					0.000
Pseudo R2 0.482					

3.2.Impact analysis of dairy cooperatives

Table 3 presents the results of balancing tests for individual covariates using Nearest Neighbour Matching (NNM), Kernel-Based Matching (KBM), and Radius Matching (RM). The results show that the bias for all covariates is less than 20% after matching, which is considered desirable. Table 4 also presents the overall appropriateness of the matching model. The Pseudo R2 drops significantly to 4.5% for NNM, KBM and CM after matching, from 48% before matching. The p-value is also not significant after matching. The mean standardized bias decreases from 34.6% before matching to 11.8% after matching for NNM, KBM, and CM. The low Pseudo R2, insignificant p-values of the likelihood ratio test, low standardized biases and high reduction in the total bias after matching suggest that the specification of propensity is successful in terms of balancing the distribution of covariates between members and non-members of farmer households.

Table 3: Balancing test of individual covariates

Variable	**Sample**	**Mean**		**% bias**			
		Treated	Control	Nearest neighbour	Kernel	Radius	t
Age	Unmatched	40.87	38.62	8.2	8.2	8.2	
	Matched	40.40	41.45	-12.1	-12.1	-12.1	-0.60
Sex	Unmatched	1.36	1.18	3.6	3.6	3.6	
	Matched	1.31	1.22	18.8	18.8	18.8	0.94
Education	Unmatched	2.3	1.01	1.6	1.6	1.6	
	Matched	1.77	1.65	11.5	11.5	11.5	0.55
Family size	Unmatched	4.87	3.45	12.7	12.7	12.7	
	Matched	4.71	4.69	0.6	0.6	0.6	0.03
Dairying experience	Unmatched	8.03	6.49	13.0	13.0	13.0	
	Matched	7.54	7.33	7.8	7.8	7.8	0.40
Number of dairy cow	Unmatched	10.56	6.24	22.4	22.4	22.4	
	Matched	10.61	10.49	3.3	3.3	3.3	0.18
Number of milking cow	Unmatched	8.36	4.89	13.2	13.2	13.2	
	Matched	8.44	8.24	6.8	6.8	6.8	0.36
Number of crossbreed Cow	Unmatched	1.84	1.02	16.7	16.7	16.7	
	Matched	1.7	1.78	-17.3	-17.3	-17.3	-0.87
Credit service	Unmatched	1.02	0.17	22.1	22.1	22.1	
	Matched	0.26	0.24	4.3	4.3	4.3	0.23
Extension service	Unmatched	5.2	2.7	12.5	12.5	12.5	
	Matched	1.29	1.28	1.6	1.6	1.6	0.08
Training service	Unmatched	1.01	0.18	16.8	16.8	16.8	
	Matched	0.74	0.27	10.2	10.2	10.2	5.51
Market distance	Unmatched	2.5	3.11	-10.9	-10.9	-10.9	
	Matched	2.49	2.50	-14.1	-14.1	-14.1	-1.68
Market information	Unmatched	1.08	1.01	-13.1	-13.1	-13.1	
	Matched	1.06	1.22	-16.7	-16.7	-16.7	-3.11

Table 4: Balancing test of the propensity score matching model

Test	**Before matching**	**After matching**		
		Nearest neighbour	Kernel	Radius
Pseudo R2	0.482	0.045	0.045	0.045
LR2 (p-value)	108.64 (0.000)**	9.32(0.390)	9.32 (0.390)	9.32 (0.390)
Mean standardized bias	34.6	11.8	11.8	11.8
Total bias reduction (%)	-	82.47	82.47	82.47

The impact of dairy cooperative membership on five performance indicators, milk production/yield, selling price, household income, household consumption, and household employment was assessed using three estimation techniques: nearest neighbour matching, kernel matching, and radius matching, the propensity scores, calculated through a logit model, were used to determine the common support region, and unmatched units were excluded from the analysis. The econometric results confirm that cooperative membership leads to significantly higher milk yield compared to non-members .Members have better access to crossbred dairy cows, feed, veterinary services, artificial insemination, and continuous support from livestock extension experts, all of which contribute to increased milk production and higher productivity. Consequently, the model indicates that cooperative membership increases household income from milk compared to non-members. The ATT values for milk yield varied across the different matching techniques, reinforcing the significant influence of cooperative membership on dairy productivity. This finding aligns with those of Chagwiza et al (2016) and Bayan (2018), who similarly reported positive impacts of cooperatives on milk yield.

Cooperative members also saw greater involvement in dairying, reflected in significantly higher employment. This could be due to members having larger herds of crossbred cattle, which require more care. These results are consistent with findings by Abate et al (2014), who observed that cooperative members are more likely to benefit from increased employment opportunities. Similar conclusions were drawn by Balirwa et al (2016) and Waiswa and Günlü (2023).

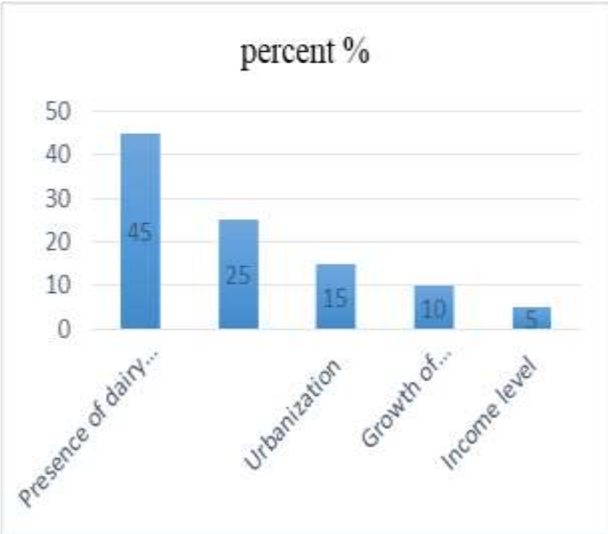
Table 5: Impact of dairy cooperatives on smallholder dairy producers

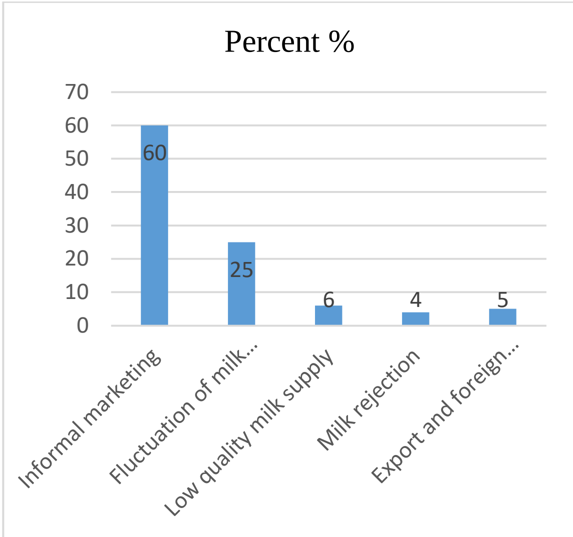
Outcome variables	**Members**	**Non-members**	**P-value**	**ATT**		
				NN	Kernel	Radius
Dairy milk yield per cow (lit)	7.46 (0.403)	5.42 (0.409)	0.000***	1.259 (0.84) ***	0.824 (0.90) ***	0.769 (0.81) ***
Selling price (birr/lit)	46.20 (0.127)	47.04 (0.084)	0.000***	-0.85 (0.116)***	-0.756 (0.124)***	-0.4469 (0.23)***
Net dairy income (birr/household)	51,675.42 (2549.66)	34,419.17 (2297.61)	0.00***	7579.98 (5938.02)***	6244.16 (5736.23)***	8246.15 (7125.17)***
Consumption(lit/household/day)	1.34 (0.04)	1.04 (0.06)	0.09	0.293 (0.186)	0.228 (0.152)	-0.072 (0.192)
Employment (man-days/ household)	160.8 (6.284)	138.59 (7.672)	0.00**	19.20 (9.16) **	17.64 (6.89) **	22.28 (8.64) **

3.3.Challenges and Opportunities of dairy cooperatives

The graph below illustrates the key challenges facing dairy cooperatives in integrating smallholder dairy farmers into formal markets. The results indicate that 60% of respondents identified informal milk marketing as the most significant challenge in the milk market. Other challenges include fluctuations in milk demand (25%), low-quality milk supplementation (6%), milk rejections due to poor hygiene and lack of freshness (4%), and market difficulties such as foreign currency shortages, out-dated technology, and inadequate milk processing facilities

(5%). On the other hand, opportunities for integrating smallholders into formal markets include the presence of dairy industries (45%), investment prospects in other sectors, population growth (10%), urbanization (15%), and increasing income levels (5%). Additionally, the government's focus on boosting agricultural productivity to support GDP growth accounts for 25% of the identified opportunities. These findings are consistent with the study by Girma (2012), who reported that 98% of milk produced by smallholder farmers was sold through informal channels.





3.4.Physicochemical characteristics of fresh milk

Specific gravity

The results presented in Table 5 indicated that significant differences ($P < 0.05$) in specific gravity values between non-members and members across the study sites of Selale, Holeta, and Bishoftu. In addition, Ghoryar and Ebner (2022) highlighted that a higher specific gravity, such as 1.035, might suggest fat removal (skimming), while lower values like 1.020 could point to the addition of water. Consistent with these findings, this study found that milk samples from cooperative members adhered to the established specific gravity ranges, while non-member samples were lower.

Total solids

The t-test analysis revealed a significant difference ($P < 0.01$) in total solid content across milk samples from three distinct study areas, comparing cooperative members to non-members. In Holeta, the average total solid content for cooperative members and non-members was 12.498 ± 0.397 and 10.258 ± 0.478, respectively. The total solid content of milk typically ranges from 10% to 17%, which includes both fat and non-fat components (Hassan, 2015).

Milk Fat

A significant difference ($P < 0.01$) in fat content was observed among the three study areas for both cooperative members and non-members. The average fat content of milk from cooperative members and non-members in the three areas was as follows: 3.56 ± 0.097 and 2.62 ± 0.130 in

Holeta; 3.54 ± 0.107 and 2.60 ± 0.122 in Fitche Selale; and 3.57 ± 0.095 and 2.58 ± 0.084 in Bishoftu town. These results were lower than those reported by Teklemichael (2012), who found fat contents of 4.3%, 3.79 ± 0.18%, and 3.86 ± 0.412%.

Milk Protein

The mean protein levels in milk differed significantly between cooperative members and non-members in Fitche Selale and Bishoftu. The average protein content of raw milk in Holeta, Selale, and Bishoftu was found to be lower than the 3.48% reported by (Abd Elrahman et al., 2009) in dairy farm milk. In contrast, Addo et al. (2011) and Fikrineh Negash (2012) reported higher protein levels (3.46 ± 0.04%) in milk from households with local and crossbred cows.

Titratable Acidity (TA)

Table 5 shows that milk samples from non-members had titratable acidity values exceeding 0.16%, suggesting prolonged exposure to room temperature and poor handling before sale or consumption. Fresh milk typically has a titratable acidity of 0.16% to 0.18% as lactic acid (Ghoryar & Ebner, 2022).In particular, the titratable acidity of milk from members in Bishoftu town was significantly higher ($P < 0.01$) compared to those in Fitche, Selale, and Holeta. Hailu (2016) reported even higher acidity levels—0.23 ± 0.01% lactic acid—in samples from individual farmers in the Harar milk shed, whereas the current study found lower values. This study highlights the variations in titratable acidity across membership categories and underscores the importance of proper milk handling and storage to preserve dairy product quality.

3.5.Microbiological quality of raw milk

The results presented in Table 6 showed that milk from non-members consistently showed higher AMBC levels than that from cooperative members across all study sites, with Bishoftu non-members having the highest AMBC values. Statistical analysis using t-tests indicated significant differences ($P < 0.01$) between members and non-members. The Total Bacterial Count (TBC) of raw milk samples exceeded 5 log cfu/ml, which is above the minimum acceptable standards for milk as set by the International Farm Comparison Network (IFCN, 2006).There were significant differences in total coliform counts between dairy cooperative members and non-members across the three study areas.. In Holeta, Selale, and Bishoftu towns, the mean total coliform counts for non-members were 3.053 ± 0.061 log cfu/ml, 3.012 ± 0.122 log cfu/ml, and 3.001 ± 0.136 log cfu/ml, respectively. In contrast, dairy cooperative members exhibited lower mean coliform counts of 2.012 ± 1.718 log cfu/ml, 2.457 ± 1.886 log cfu/ml, and 2.187 ± 0.89 log cfu/ml in these areas. The differences in mean values were statistically significant ($P < 0.01$), with non-members consistently showing higher coliform counts across all study areas.

Table 5: Physicochemical result of raw milk samples collected from the study area

Parameters	Sample sources	Study area								
		Fitche Selale			Holeta			Bishoftu		
		Mean±SD	t-value	p-value	Mean±SD	t-value	p-value	Mean±SD	t-value	p-value
Specific gravity (SG)	Members	1.027±0.002			1.028±0.003			1.028±0.002		
	Non-members	1.024±0.001	-2.776	0.016**	1.024±0.002	-3.251	0.006***	1.023±0.002	-4.497	0.001***
Total solid (TS) (%)	Members	12.47±0.510			12.498±0.397			12.748±0.37		
	Non-members	10.00±0.001	-10.627	0.000***	10.258±0.478	-9.656	0.000***	10.00±0.003	-16.287	0.000***
Fat (%)	Members	3.54±0.107			3.560±0.097			3.570±0.095		
	Non-members	2.60±0.122	-15.280	0.000***	2.620±0.130	-15.871	0.000***	2.580±0.084	-19.739	0.000***
Solid non-fat (SNF) (%)	Members	8.95±0.460			8.936±0.357			9.157±0.305		
	Non-members	8.84±0.343	-0.470	0.646	8.120±0.694	-3.064	0.009***	8.856±0.547	-1.390	0.188
Protein (%)	Members	2.89±0.144			2.920±0.162			2.980±0.175		
	Non-members	3.18±0.249	2.888	0.013**	3.020±0.349	0.774	0.453	3.200±0.292	1.845	0.088
Lactose (%)	Members	4.76±0.117			4.730±0.116			4.790±0.074		
	Non-members	4.82±0.083	1.013	0.330	4.740±0.134	0.150	0.883	4.778±0.134	-0.227	0.824
Ash (%)	Members	0.770±0.065			0.764±0.087			0.748±0.088		
	Non-members	0.812±0.057	1.212	0.247	0.693±0.052	-1.670	0.119	0.773±0.077	0.541	0.598
Titratable acidity (TA) (%)	Members	0.159+0.03			0.158+0.040			0.160+0.091		
	Non-members	0.163+0.01	1.140	0.074	0.161+0.013	1.471	0.051*	0.165+0.01	1.405	0.000***

Compared to previous studies, the coliform counts in this study were lower. For instance, Tassew and Seifu (2011) reported a mean coliform count of 4.49 log cfu/ml in Bahir Dar Zuria. Similarly, Worku et al. (2012) found counts of 6.88 ± 0.040 and 7.78 ± 0.040 log cfu/ml for cow udders and storage containers, respectively, in the Borana pastoral community. Tesfaye et al. (2013) reported 4.13 ± 0.757 log10 cfu/ml in milk samples from Dire Dawa, while Zelalem and Faye (2006) recorded a higher count of 6.57 log cfu/ml in milk from the central highlands of Ethiopia.

Additionally, Table 6 presents the mean Yeast and Mould Count (YMC) for each milk sample source. The results show that milk samples from non-members consistently had higher YMC levels compared to those from members, the t-test analysis confirmed that these differences were statistically significant ($P < 0.01$). The values of yeast and mold in this study were lower than those found by (Ahmed, 2011) in the Mieso district (6.1 and 7.4 log cfu/ml), but higher than the results reported by Karmen and Slavica (2008) and Fadda et al (2004).

4.Conclusions

This paper evaluated the impact of dairy cooperatives on the livelihoods of smallholder dairy producers, the physicochemical and microbial quality of milk from cooperative members and non-members, and analyzed the challenges and opportunities that dairy cooperatives face in integrating smallholder farmers into formal markets in Holeta, Fitche Selale, and Bishoftu towns. Descriptive statistics revealed significant differences between cooperative members and non-members in various factors such as dairy farming experience, livestock numbers, milk production, pricing, access to extension services, availability of credit, participation in training programs, and access to market information.

The propensity score matching model was used to evaluate the impact of dairy cooperative members and non-members on the outcome variables, including milk production, pricing, annual net income, and employment opportunities, These findings indicated that a substantial positive correlation between cooperative membership and several key outcomes. The analysis of raw milk samples revealed that physical and chemical properties generally adhered to EU and FAO quality standards, with the exception of titratable acidity in milk from non-members, which may have resulted from bacterial growth due to extended storage. Bacteriological and physicochemical quality was significance differences between cooperative members and non-members in this study

5. Recommendations

The following conclusions were made based on the findings of the study:

- Continuous and regular market related linkages updated to the producers.
- Improve agricultural extension services, focusing on dairy production training and raising awareness of cooperatives.

- Enhance access to essential inputs and services, such as credit facilities, breeding support, quality feed, and animal healthcare.
- Empower small-scale milk producers within the value chain through cooperative initiatives to offer training, improve market information sharing, and mitigate marketing risks.

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