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FDRE TECHNICAL & VOCATIONAL TRAINING INSTITUTE

**FEDERAL TECHNICAL AND VOCATIONAL TRAINING INSTITUTE**

**SCHOOL OF GRADUATE STUDIES**

**FACULTY OF AGRO-PROCESSING TECHNOLOGY**

**DEPARTMENT OF DAIRY PROCESSING TECHNOLOGY**

# IMPACTS OF DAIRY COOPERATIVES ON THE LIVELIHOODS AND QUALITY OF MILK FROM SMALLHOLDERS IN SELECTED AREAS OF CENTRAL ETHIOPIA

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**MARCH, 2025**

**ADDIS ABABA, ETHIOPIA**

# IMPACTS OF DAIRY COOPERATIVES ON THE LIVELIHOODS AND QUALITY OF MILK FROM SMALLHOLDERS IN SELECTED AREAS OF CENTRAL ETHIOPIA

A THESIS SUBMITTED TO FEDERAL TECHNICAL VOCATIONAL TRAINING INSTITUTE

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MARCH, 2025

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# DECLARATION

I hereby declare that the thesis entitled “Impacts of dairy cooperatives on the livelihoods and quality of milk from smallholders in selected areas of central Ethiopia’’ is my original work and has not been presented in any university /institute for examination process . All source of materials that have used for this thesis have been indicated and acknowledged by means of complete references.

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This is to certify that the research thesis entitled “Impacts of dairy cooperatives on the livelihoods and quality of milk from smallholders in selected areas of central Ethiopia submitted in partial fulfilment for the Master of Science in dairy processing technology, in the graduate program of the department of dairy processing technology which has been conducted by Genet Shumi Dugo was done under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence here can submit the thesis to the department.

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FEDERAL TECHNICAL AND VOCATIONAL TRAINING INSTITUTE (TVTI)
SCHOOL OF GRADUATE STUDIES

# IMPACTS OF DAIRY COOPERATIVES ON THE LIVELIHOODS AND QUALITY OF MILK FROM SMALLHOLDERS IN SELECTED AREAS OF CENTRAL ETHIOPIA

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# ACRYNOMYS AND ABBREVIATIONS

| | |
|---|---|
| AMBC | Aerobic Mesophilic Bacterial Count |
| ATT | Average Treatment Effect on the Treated |
| CSA | Central Statistical Agency |
| DCS | Dairy Cooperative Society |
| FAO | Food and Agricultural Organization for the United Nation |
| KBM | Kernel Based Matching |
| MDC | Members of Dairy Cooperative |
| NNM | Nearest Neighbor Matching |
| PSM | Propensity Score Matching |
| TCC | Total Coliform Count |

# ABSTRACT

*This study was conducted to evaluate the impacts of dairy cooperatives on the livelihoods of smallholder farmers and analyses milk quality in the selected areas of central highlands of Ethiopia with total sample of 205 farmers of 156 members and 49 non-members respondents, the research employs t-test to analyze the microbiological and physicochemical quality of raw milk, descriptive statistics and propensity score matching techniques to analyze key outcomes variables of milk yield, selling price, household income, consumption, and employment and the results demonstrate that cooperative membership significantly enhances milk yield and household income. Members benefited from increased access to resources, on crossbred cows, inputs, veterinary services, and market information, while non-members receive slightly higher milk prices through direct sales. The consistent market access, stable pricing, and dividends offered by cooperatives provide members with greater overall income. Furthermore, cooperative membership increases employment opportunities for members due to the increased workload associated with larger herds. Several challenges facing dairy cooperatives, on informal milk marketing, fluctuations in milk demand, and milk quality issues. However, opportunities for growth through leveraging the presence of dairy industries, capitalizing on urbanization, population growth, and increasing government support for the sector. These findings also highlight the crucial role of dairy cooperatives in improving the livelihoods of smallholder farmers in Ethiopia. For the laboratory analysis a total of 45 milk samples were collected 15 from non-members and 30 from members of dairy cooperatives based on the number of sample respondents surveyed for the physicochemical and microbiological quality. The result of physicochemical analysis of specific gravity value in the study areas of Holeta, Fitche selale and Debreziet for non-members were lower value ranging from 1.024 ± 0.001 to 1.023 ± 0.002 while for those of members higher value ranging from 1.027 ± 0.002 to 1.028 ± 0.003, respectively .The average total solid (TS) of milk for members and non-members were 12.498 ± 0.397 and 10.258 ± 0.478, 12.47 ± 0.510 and 10.00 ± 0.001, 12.748 ± 0.37 and 10.00 ± 0.003 and Fat composition shows significant difference ($P < 0.01$) 3.56 ± 0.097 and 2.62 ± 0.130 3.54 ± 0.107 and 2.60 ± 0.122, and 3.57 ± 0.095 and 2.58 ± 0.084 respectively. The titrable acidity for non-members in across all study area was exceeding 0.16%, while for members in Debrezeit town shows significant higher ($P < 0.01$) compared to members in Fitche Selale, and Holeta towns. On the other hand the microbiological quality result shows that non-members consistently higher level of Aerobic mesophilic bacterial count 5.309 ± 2.846 log cfu/ml and 5.406 ± 0.038 log cfu/m, 4.655 ± 2.137 log cfu/ml, 5.218 ± 0.044 log cfu/ml and 4.408 ± 2.027,5.253 ± 0.064, total coliform counts 2.012 ± 1.718 log cfu/ml, 2.457 ± 2.886 log cfu/ml, and 2.187 ± 2.879 and 3.053 ± 0.061 log cfu/ml, 3.012 ± 0.122 log cfu/ml, and 3.001 ± 0.136 log cfu/ml and yeast and mold count 4.146 ± 2.129 cfu/ml, compared to 5.038 ± 0.063 cfu/ml , 4.008 ± 2.137 cfu/ml and 5.055 ± 0.052 cfu/m and 4.247 ± 1.666, whereas non-members had 5.927 ± 0.090. Members and non-members in Holeta ,Fitche selale and Debrezeit respectively. The study indicate that significant differences between dairy cooperative members and non-members across the study areas. Finally the best practice of milk handling was proposed.*



***Keywords:*** *Microbiological quality, physicochemical characteristics, propensity score matching, Outcome variables.*

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# 1. INTRODUCTION

## 1.1. Background

Agriculture remains the backbone of Ethiopia's economy engaging approximately 84% of the population and serving as the primary sources 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). Within agriculture sector, the livestock subsector has an enormous contribution to Ethiopia's national economy and livelihoods of many Ethiopians. The subsector contributes 16.5% to the national GDP, 35.6% of the agricultural GDP, 15% to export earnings and 30% to agricultural employment. The livestock subsector currently support the livelihoods of about 80% of all rural population, highlighting their importance to Ethiopia's socio-economic structure (Leta & Mesele, 2014).

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 liters of milk annually from 7.5 million milking cows (CSA, 2021). Ethiopia possesses significant potential for dairy development driven by a large cattle population, favorable climate, emerging market and polices encouraging private sector involvement, and a relatively low incidence of diseases further supports dairy farming prospects ( Ulfina *et al.*, 2013).

The Ethiopia dairy sub-sector is predominantly composed of smallholder farmers who rely on limited numbers of cows for their livelihoods. These farmers face significant challenges such as low productivity, limited access to markets, and inadequate infrastructure and high transportation costs Dairy cooperatives have emerged as a crucial mechanism to address these challenges by providing smallholder farmers with access to markets, essential inputs, and support services. In this regard worth to mention, Ada'a and Selale Dairy Cooperatives in the Oromia region, which

have successfully improved the livelihoods of its members through effective management and strong market linkages (Yilma *et al.,* 2011).

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). However, the growing demands for milk and milk products driven by population growth, urbanization, and rising incomes presents an opportunity for market-oriented dairy production. Transforming subsistence-based dairy systems into productive, market-oriented ventures through organized services and sustainable market linkages holds promise for improving food security and smallholder livelihoods in Ethiopia (Eshetu & Assefa, 2015).

### 1.2. Statements of the Problems

The dairy sector is a significant contributor to economic development, particularly in developing countries, serving as an engine of growth. It fosters increased income, employment, food security, foreign exchange earnings, and improved nutrition (Yilma *et al.,* 2011). 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 farming more sustainable and profitable for smallholders.

## 1.3. Objective

### 1.3.1. General Objective

To assess the impacts of dairy cooperatives on the livelihoods of small holders and analyse the quality milk in the selected areas of central highlands of Ethiopia.

### 1.3.2. Specific Objectives

- To assess the impact of dairy cooperatives on the livelihood of smallholders farmers.
- To assess the microbial and physicochemical quality of milk among both cooperative members and non-members.
- To identify the challenges and opportunities facing by dairy cooperatives to bring the small holders farmers in to formal market.

## 1.4. Research questions

The study was guided by the following questions:

1. What is the impact of dairy cooperatives on the livelihoods of smallholders?
2. What is the microbial and physicochemical quality of milk for cooperative members compared to non-members?
3. What are the challenges and opportunities of dairy cooperatives to bring small holders farmers to formal market?

## 1.5. Significance of the research

This study aimed to evaluate the impact of dairy cooperatives on the livelihoods of smallholder farmers and to assess milk quality in the study area. The thesis contributed to understanding the differences in milk production between dairy cooperative members and non-member

smallholders, as well as identifying the factors influencing milk quality. Additionally, it proposed best practices for milk handling.

### 1.6. Delimitation/scope of the research

The study was limited in terms of coverage and depth owing to time and financial resource availability. Hence, it is limited to address the objectives mentioned in this thesis which is to assess the impact of dairy cooperatives on the livelihoods of small holders and ensure that dairy products meet food safety and quality standards set by regulatory authorities and industry certifications. The study was focused only on the dairy cooperative found in the central highland of Ethiopia which is Holeta, Fitche Selale and Debre-Zeit. In this study, were determine the impact of dairy cooperatives on the livelihood of smallholders and milk quality. Milk quality is viewed in terms of technological, institutional, and organizational aspects.

### 1.7. Definition of Terms

**Cooperative:** cooperative is defined as a private business organization that is owned and controlled by the people who use its products, supplies or services.

**Milk:** Milk is the lacteal secretion, practically free from colostrum, obtained by the complete milking of one or more healthy cows.

**Producer:** a person, company, or country that makes, grows, or supplies goods or commodities for sale. Example milk producer

**Impact:** having an effect, benefit, or contribution to economic, social, cultural, and other aspects of the lives.

**Smallholders: S**ubsistence smallholders and small commercial dairy farmers produce milk as part of mixed farming systems.

**Quality:-**The degree of excellent of something, often a high degree of it.

# 2. LITERATURE REVIEW

## 2.1. Dairy sector in Ethiopia

Dairy production in Ethiopia primarily operates as a smallholder subsistence activity, with limited commercial engagement. While small and medium-sized commercial farms exist, the sector remains dominated by rural smallholders. In 2019, the country produced an estimated 3.6 billion liters of milk, generated by approximately 6.7 million dairy cows, with over 95% of these animals being indigenous breeds (CSA, 2019). Feed scarcity is one of the primary limitations in Ethiopian dairy production. Native pastures, crop residues, and agricultural by products form the bulk of livestock feed, yet they fail to meet the nutritional requirements for optimal milk production. Seasonal variability further exacerbates feed shortages, particularly during the dry season when natural pasture availability is at its lowest (Ahmed et al., 2021). Improved forage cultivation, such as the introduction of drought-tolerant grass species, and innovations like silage and hay-making practices remain underutilized but are essential for increasing dairy productivity (Yilma et al., 2011).

Animal health issues significantly impact the Ethiopian dairy sector, with poor disease control being a persistent challenge. Many smallholder farmers lack access to adequate veterinary services and knowledge of disease prevention. Common diseases, including mastitis, brucellosis, foot-and-mouth disease, and parasitic infections, contribute to reduced milk yields and high livestock mortality (FAO, 2019). The inadequate availability of veterinary drugs and trained personnel, coupled with insufficient disease surveillance systems, hampers efforts to maintain animal health. Expansion of veterinary service delivery and training programs for farmers in disease management is essential to mitigate these losses (Yilma *et al.*, 2011).

The predominance of indigenous cattle, which account for more than 95% of Ethiopia's dairy herd, presents challenges for improving milk productivity. Indigenous breeds, though well-adapted to local environments, produce significantly less milk than crossbred or exotic breeds. Milk yields from native cows typically range from 1 to 2 liters per day, compared to 10 to 15 liters from crossbreeds under optimal management (CSA, 2019). Attempts to increase

productivity through crossbreeding programs using Holstein-Friesian or Jersey cattle have yielded some success. However, these efforts are limited by low adoption rates, weak artificial insemination (AI) service infrastructure, and challenges in maintaining crossbreed management (Gizaw *et al*., 2016).

Milk consumption per capita in Ethiopia remains low compared to other countries in the region. Between 2003 and 2012, the average annual consumption was between 32.8 and 36.5 liters per person, significantly less than the 110 liters per person observed in Kenya (Yilma *et al.,* 2017; Corne *et al.,* 2016). Limited dairy production, poor market access, and high post-harvest losses contribute to this disparity. Increasing consumer access to dairy products through improved production and market linkages is key to bridging this gap (Ahmed *et al.,* 2021).

## 2.2. Concept of cooperatives

According to International Co-operative Alliance (2021), a cooperative can be defined as 'an autonomous association of persons united voluntarily to meet their common economic, social and cultural needs and aspirations through a jointly-owned and democratically controlled enterprise. Although cooperatives vary in type and membership size, all were formed to meet the specific objectives of members, and are structured to adapt to members changing needs. Cooperative as a member-controlled association for producing goods and services in which the participating members, individual farmers or households, share the risks and profits of a jointly established and owned economic enterprise. According to this definition, a cooperative is established by farmers in response to unfavorable market conditions, which is a shared problem. This could be a problem related to the marketing of produce resulting in low farm-gate prices, to the supply of good quality and reasonably priced farm inputs, such as seed and fertilizer, or to the supply of sufficient and cheap credit.

(Gobena ,2016) defined that dairy cooperative is a business, which is owned and controlled by the dairy farmers who produce the milk used by the cooperative. At Foremost Farms, we use our member-owners' milk – more than 5 billion pounds a year – to manufacture cheese, dairy ingredients, butter and fluid products for various markets and applications. The some authors also indicated, Cooperatives have been important in helping dairy smallholders to market their

milk and lower their operating costs, providing scale economies (Gobena, 2016). Analysis concluded that dairy cooperatives could reduce a farmer's transaction costs by 45%. As (Gobena, 2016) explained that, on the review a great deal of variability in cooperatives' performance and ability to effectively serve their membership. Many cooperatives lack technical, managerial and marketing skills, and are severely undercapitalized in terms of their working capital, investment capital and start up assets (which are often not properly maintained). Many cooperatives struggle to find reliable markets. Governance is weak in some cases. Membership may have stagnated or declined.

### 2.2.1. Role and importance of cooperative in society

The Ethiopian Cooperative Establishment Proclamation No. 147/98 defines a cooperative as "a society established by individuals on a voluntary basis to collectively address their economic and social challenges while being managed democratically." It is an organization that fosters self-help through mutual support, providing a framework where members collectively address individual needs, make decisions democratically, and share in both profits and losses.

According to D'Haese *et al.* (2007), milk and milk product marketing cooperatives are associations of dairy farmers who produce at least one liter of saleable milk and collectively process and market their products. These cooperatives are found in areas such as Salale, Holetta, Sheno, Debre Zeit, Sebeta, Shashemane, Hawassa, Debre Berhan, and Dilla, among others, to add value to milk production. In the Arsi Zone, there are 24 milk marketing cooperatives, of which 67% are legally licensed, with an average operational span of four years (Matawork *et al.*, 2016).

The primary roles of dairy cooperatives, as highlighted by Matawork Milkias Gobena (2016), include collecting raw milk from members and non-members, processing it, and marketing processed products. To expand the success of dairy cooperatives, it has been suggested that Ethiopia emulate the dairy development model of India, particularly around significant milk-producing areas such as Adama, Dire Dawa, Harar, Bahir Dar, Gondar, Awassa, Jimma, and Assela. By strengthening existing cooperatives and fostering the creation of new ones, dairy cooperatives can drive substantial improvements in the sector.

The motivation for farmers to market through cooperatives, as noted in MO Dairy Cooperatives and RBS Research Reports, includes guaranteed market outlets, favorable pricing terms, efficient marketing systems, and effective representation in policy and public relations. These cooperatives balance supply and demand, ensure high-quality milk reaches the market, and assist members in adapting to regulatory and market changes.

Globally, cooperatives emerge in response to limited social and economic opportunities, particularly in developing nations. They play a crucial role in improving members' financial situations by providing credit and financial assistance at affordable rates, often filling the gap left by traditional banks reluctant to serve rural and low-income communities. Cooperatives protect members from exploitative financial practices and foster collective strength (Yadav, 2018).

Rooted in democratic principles, cooperatives are adaptable and participatory, making them well-suited for economic development. They promote community identity, social organization, and inclusivity while reducing poverty, creating jobs, and fostering economic growth and social development (Dogarawa, 2020). They improve members' living and working conditions, empower communities, and balance profitability with the well-being of members and their communities (Okwara & Uhuegbulem, 2017). Moreover, cooperatives enhance bargaining power, enabling members to access discounts, negotiate better terms, and customize supplies and services. Marketing collectively allows farmers to lower costs, promote products, and attract better offers, increasing income and market presence (Othieno & Shinyekwa, 2011). Additionally, cooperatives benefit entire communities by creating jobs, generating business earnings, and funding essential services through taxes (USDA, 2003).

## 2.3. Highland smallholder milk production

In Ethiopia's central highlands, smallholder milk production is an integral component of subsistence farming within mixed crop-livestock systems (Yigrem *et al.*, 2008). This system is predominantly subsistence-oriented, as noted by Belete (2006) and Gojjam (2018). Feed for livestock primarily comes from natural pastures, supplemented with crop residues and stubble grazing to meet nutritional requirements. Cattle in this system are mainly valued for their role as draft animals, with minimal emphasis placed on improving their milk production, despite

being the primary source of milk (Sintayehu, 2017). Indigenous breeds, which dominate dairy farming in Ethiopia, account for 97% of milk production, predominantly through the highland mixed farming system. This system also dominates livestock demographics, with cattle making up 72.4% of the total livestock units (TLU) in the highlands, similar to the lowland areas. However, only 28% of these are cows, and of those, 40–45% are milked annually (Ahmed *et al.,* 2015).

### 2.3.1. Milk hygienic practices and challenges in Ethiopia

Ethiopian milk production, especially in rural and urban settings, faces many obstacles related to handling, hygiene, and preservation. Because there aren't many useful cooling devices in rural locations, high ambient temperatures frequently cause raw milk to deteriorate. Significant postharvest losses are caused by a number of factors, including inadequate milk preservation technology, contamination during handling, poor hygiene procedures, and a lack of market demand (Azeze, 2016). Maintaining the quality of milk depends on following good hygiene procedures, which include cleaning the milking area, storage containers, and utensils. Some urban and peri-urban dairy farmers use conventional techniques, such as smoking utensils with aromatic plants like Woira (Olea), while others use hot water or detergents to clean their udders and utensils (Tegegne et al., 2013). The majority of milk is traditionally processed into butter, fermented milk, and other products in rural systems, where udder washing before to milking is still rare (Belete, 2006).

According to AGP-LMD (2013), traditional processing, which makes up 47.33% of Ethiopia's milk supply, includes techniques like churning sour milk into butter and buttermilk, then further processing it into whey (aguat) and cottage cheese (ayib). These techniques limit production efficiency and take a lot of time, despite their cultural significance. The establishment of milk processing facilities in recent years has improved milk access and use by pasteurizing milk and producing cheese, yogurt, and other goods for urban markets (MoA, 2020).The quality of milk is also heavily influenced by primary production practices such as animal husbandry, land management, and hygiene during milking. Microbial contamination often arises from milking animals or the surrounding environment, and poor agricultural practices further amplify these risks. For instance, it has been reported that up to 76% of milking personnel do not wash their

hands before or after milking, and washing milking equipment with detergents is not a widespread practice. Additionally, rural areas face challenges such as the lack of hot water essential for thorough cleaning of utensils, increasing the risk of milk contamination (Mulugeta, 2017; Amentie *et al*., 2016).

Milk collection centers face similar challenges, including poor drainage, unclean facilities, and exposure to dust from passing vehicles. The absence of refrigeration or artificial cooling systems, particularly in lowland regions, further aggravates the problem, leading to high spoilage rates during transport to urban markets (Mulugeta, 2017). Addressing these issues requires improving hygiene practices at every stage of milk production. This includes ensuring animal health through regular veterinary care, promoting proper milking techniques, using appropriate cleaning methods such as detergents and boiling water, and upgrading infrastructure, particularly refrigeration and milk collection facilities. Coordinated efforts from farmers, cooperatives, extension services, and regulatory bodies are essential to modernize milk production and minimize losses while preserving traditional practices where feasible.

### 2.3.2. Milk collection

Dairy cooperatives play a crucial role in the milk value chain, particularly in milk collection. Once collected, the milk is either sold to commercial dairy processors, directly to customers as raw milk, or processed by the cooperatives into dairy products. These products are then sold through the cooperatives' own shops or supplied to private shops, cafeterias, and hotels. The formation of current dairy cooperatives stems from various circumstances. Some were established during the Derg regime (1974–1991), while others were formed later by farmers or through support from donors, church organizations, or government initiatives. Additionally, many cooperatives offer services such as feed sales to their members.

Primary cooperatives often join forces to form unions, which enhance their bargaining power and enable collaboration in processing and marketing activities. These unions negotiate selling prices on behalf of member cooperatives and provide essential services such as training, financial audits, and business support. Dairy cooperatives typically range in size from 20 to 400 farmers, while unions act as umbrella organizations for 5 to 30 cooperatives. However, there are only a

small number of dairy cooperative unions in Ethiopia (approximately five). By working together, cooperatives and unions can significantly increase the value of the milk collected. However, their performance can vary due to differences in the quality of staff and management. Many cooperatives face challenges such as insufficient milk transportation capacity, poor road accessibility, and outdated processing equipment, all of which can hinder their efficiency (Zijlstra *et al*., 2015).

## 2.4. Milk Processing, Utilization and Consumption in Ethiopia

In Ethiopia, milk processing is carried out both by modern industrial plants and through traditional practices. Currently, there are 32 established milk processing factories across the country that produce pasteurized milk (83.4%), yogurt, and various types of cheese, including Provolone, Mozzarella, Gouda, and Feta. Traditional milk processing, which is prevalent throughout the country, results in naturally fermented milk, butter, buttermilk, cottage cheese, whey, and ghee. Different preservation methods are used to prevent milk from clotting, such as smoking containers and boiling fresh milk. Around 85% of the country's milk is sold within local markets, although obstacles such as cultural differences and the distance to markets often hinder the marketing and sale of milk and dairy products (Japaro, 2021).

In terms of processing by-products, peri-urban dairy farmers are more likely to turn butter-milk into cottage cheese compared to urban farmers, who typically use butter-milk to feed calves due to a lack of firewood for cooking. Most dairy farmers in rural areas who are far from urban centers process milk into various dairy products (Yitaye *et al.*, 2016). A significant factor influencing dairy production in Ethiopia is the cultural practice of fasting, especially among Ethiopian Orthodox Christians, who abstain from animal products, including dairy, for about 200 days per year, with the longest fasting period lasting 55 days before Easter. During these fasting periods, farmers often process milk to extend the shelf life of dairy products. Additionally, fluctuations in milk supply during the dry season, due to feed shortages and increased demand with no formal milk marketing system in place, contribute to these challenges (Duguma & G.P.J. Jansessens, 2014).

Regarding milk utilization, according to the 2014/2015 Annual Agricultural Sample Survey, Ethiopian households consume approximately 46.36% of the total milk produced annually. Around 47.33% is processed into butter (35.49% of which is sold), local cheeses (15.22% of which is sold), and other products, while only 5.98% is sold as fluid milk (CSA, 2015). While Ethiopia's total milk production has been increasing, per capita consumption has been decreasing, falling from 26 kg in 1980 to just 16 kg by 2009. This decline is due to population growth outpacing milk production. As a result, Ethiopia consumes the least amount of milk annually on average (17 kg), far below the global average of 100 kg and Africa's average of 25 kg. Liquid milk is typically viewed as food for infants or the elderly, and in the highlands, it is not commonly part of household diets, with products such as butter, cottage cheese, and soured milk being more frequently consumed (Dadi, 2017; Hussen et al., 2008; Yilma *et al.,* 2011). Consumption patterns of milk and dairy products vary based on household milk production, dairy systems, market access, season, and fasting periods, especially among Orthodox Christian communities (Tegegne *et al*., 2013).

## 2.5. Dairy products marketing in Ethiopia

Smallholder dairy products marketing in Ethiopia operates through a system where buyers and sellers engage to set prices. While there is a market, the presence of a functioning marketing channel is essential for transactions to occur. In pastoral areas, milk production is seasonal, but consumption remains year-round (Fissha & Deng, 2021). Farmers are encouraged to increase milk production through market incentives, which help improve their income, living standards, and generate jobs in rural areas (Andualem *et al.,* 2015).

Milk and milk products such as butter, fermented or soured milk (ergo), cottage cheese (ayib), and buttermilk (arera) are sold through both formal and informal markets. Informally, producers sell their products directly to consumers or to unlicensed traders and retailers, typically through price negotiation. This informal system, which accounts for 95% of milk marketing in the country, lacks regulation and quality control (Yilma *et al*., 2011). In contrast, peri-urban and urban areas tend to rely more heavily on formal marketing systems, where private collecting and processing facilities or cooperatives collect milk from producers. The products are then

purchased by merchants, supermarkets, and consumers (Gebremedhin *et al.*, 2012). The formal system includes quality checks at the time of delivery (Yilma et al., 2011), but in certain regions without cooperatives or processing plants—such as Bako and Nekemte in Oromia milk marketing remains informal (Geleti *et al*., 2014).

Dairy cooperatives are essential for consolidating smallholder efforts, offering large-scale processing and transport services. Co-operatives can significantly enhance market access, reduce marketing costs, and increase access to technology, extension services, and other resources, all of which improve production and marketing efficiency. Furthermore, cooperatives can reduce transaction costs, minimize price risks, and increase the bargaining power of producers. This, in turn, leads to higher returns and fosters innovation within the sector (Eshetu & Assefa, 2015).

The marketing channels for milk and milk products are diverse, involving stakeholders such as farmers, cooperatives, regional assembly centers, distributors, retailers, and consumers. These channels vary based on the type of livestock production system and local factors. For instance, in urban dairy production systems like Yirgalem, Shashemene, and Hawassa, the milk marketing system involves two to four channels. In Shashemene, cooperatives play a more significant role in the marketing process, compared to Hawassa, where most milk is sold directly to consumers and private wholesalers or retailers (Woldemichael, 2008). Similar systems are seen in Fogera, where butter produced in rural areas is marketed locally and distributed through informal traders in external markets such as Addis Ababa (Tegegne *et al*., 2013). In rural highlands like Bure, butter marketing is typically brief and includes direct sales to consumers or sales through retailers (Kadebe, 2009).

Fluid milk sales in urban and peri-urban systems are predominantly sourced from unofficial channels, although studies indicate that around 40% of milk produced by urban and peri-urban farmers is marketed through cooperatives (Woldemichael, 2008). In rural areas, producers may sell their milk to cooperatives or assemblers, who then distribute the products to wholesalers and retailers for final sale to consumers (Tegegne et al., 2013; Geleti *et al.*, 2014). In the Metema rural lowland dairy system, butter is marketed through various channels, including sales to

agents in Gondar town and the Tigray Region, which are 160 and 240 km away, respectively, and also to Sudan, via border crossings (Tesfaye, 2007).

## 2.6. Opportunity and constraints of smallholder milk production and marketing

### 2.6.1. Opportunity of dairy production and marketing

Ethiopia offers significant opportunities for dairy development due to its vast and diverse genetic resources of dairy animals, which are well adapted to the country's varied agro-ecologies. The establishment of veterinary health and artificial insemination (AI) centers, extensive agricultural extension services, and a high demand for dairy products further bolster its potential for growth. In addition, the country's large and growing population, coupled with urbanization, income growth, a well-trained workforce, research institutions, and an expanding milk processing industry, positions Ethiopia favourable for dairy industry development (Tegegne *et al.*, 2013).

### 2.6.2. Constraints in Dairy Production and Marketing

Despite these opportunities, dairy production and marketing in Ethiopia face several significant challenges. Some of the key issues identified include limited access to improved dairy production technologies, underdeveloped dairy markets, and the absence of private or government-run dairy processing plants. The seasonality of both supply and demand for dairy products, often influenced by extended fasting periods of over 200 days per year, poses additional challenges. Milk's perishable nature and spoilage, alongside a shortage of working capital for butter and milk traders, further hinder the sector. Furthermore, butter traders report problems such as adulteration with filth, low-quality vegetable butter ('sheno-lega'), banana, and 'kocho' (a byproduct of enset). There is also a lack of consumer knowledge on how to test butter quality and the absence of grading and standardization for butter products. The proliferation of unlicensed local traders and the lack of government licensing and inspection to ensure minimum hygiene and quality standards complicate the situation. Additionally, limited access to credit, inadequate storage facilities, and inadequate market infrastructure further contribute to the struggles faced by dairy producers and marketers (Beyene *et al.*, 2016).

Challenges in dairy production vary depending on location and production systems. Overall, the marketing and trade of livestock and dairy products, both for domestic consumption and export, is perceived as underdeveloped. Several factors contribute to this poor performance, including a lack of market-oriented production, inadequate information about livestock resources, and limited trade routes. Other issues include inadequate transport and storage facilities, ineffective infrastructure, diseases, illegal trade, and a lack of access to market information (both domestic and international) (Yigrem et al., 2008). Dairy farmers also struggle with land shortages, limited access to improved dairy animals, and inadequate artificial insemination services. Additional issues include inadequate extension services, diseases, and limited access to credit (Duguma *et al.*, 2011).

### 2.7. Milk and Milk Product Quality in Ethiopia

Milk quality refers to the combination of chemical, physical, bacteriological, and aesthetic characteristics that enhance the acceptability of dairy products. Ensuring milk safety and quality has become a top priority for consumers, retailers, manufacturers, and regulatory bodies. Globally, foodborne diseases are on the rise, and international food trade is often disrupted by recurring disputes over food safety and quality standards (Merwan *et al*., 2018). Milk and dairy products intended for export must meet the highest quality standards.

Achieving these standards requires consistent monitoring and control of milk quality, beginning at the grassroots level. Milk quality control involves the use of internationally approved tests to confirm that milk and its products meet the necessary standards for chemical composition, purity, and microbial content (Merwan *et al*., 2018). Establishing an effective quality control system ensures that milk collectors, processors, and marketing agencies adhere to correct methods. Though implementing such a system requires substantial investment, it is essential for ensuring that all stakeholders in the dairy industry benefit. A robust system for quality testing and assurance is critical to complying with national and international standards (Tessema & Tibbo, 2009).

Quality control must begin at the farm level, where the milk is produced. Farmers should follow proper milk production practices, adhere to government regulations regarding milk adulteration,

and comply with veterinary drug use guidelines for lactating animals (Tessema & Tibbo, 2009). All milk collected from various farms or bulked at collection centers must be checked for wholesomeness, bacteriological quality, and chemical standards (Felleke *et al.,* 2010).

In the marketing of processed dairy products, public health authorities enforce quality checks based on laws to ensure that only safe, uncontaminated food products are available for public consumption. Substandard or contaminated goods may be rejected, with offenders subject to prosecution. This process safeguards public health and supports consumer confidence in dairy products (Felleke *et al.,* 2010). Quality milk is defined by a normal chemical composition, absence of disease-causing bacteria and toxic substances, free from sediment and extraneous materials, low acidity, good flavor, preserving quality, and low bacterial counts (Hemme & Otte, 2010). According to the Statistical Standard (1999), quality milk is also a lacteal secretion from healthy cows, free from colostrum, collected five days after calving and before 15 days prior to parturition.

### 2.7.1. Physicochemical Quality of Milk

Milk is a rich source of macro and micronutrients, containing various active compounds essential for nutrition and health protection. The composition of milk can vary due to several factors such as breed, age, diet, diseases, lactation stage, and milking practices (Merwan *et al.,* 2018). The typical compositional measures of milk are: water content 87.1%, with a range of 85.3-88.7%; lactose 4.6%, ranging from 3.8-5.3%; fat 4.0%, with a range of 2.5-5.5%; protein 3.3%, within the range of 2.3-4.4%; casein 2.6%, ranging from 1.7-3.5%; mineral substances 0.7%, varying between 0.57-0.83%; organic acids 0.17%, with an average of 0.12-0.21%; and miscellaneous substances 0.15% (Merwan *et al.,* 2018).

Milk density, a key indicator for milk quality, is commonly used to check for the addition of water or removal of cream. Adding water to milk reduces its density, while removal of cream increases it (Merwan *et al.,* 2018). Fresh milk densities are 1.028-1.032 g/cm³ for cow milk, 1.034-1.042 g/cm³ for ewe milk, and 1.024-1.040 g/cm³ for goat milk. The pH values typically range from 6.5 to 6.7 for cow milk, 6.5 to 6.8 for ewe milk, and 6.4 to 6.7 for goat milk, with freezing points of ≤-0.517°C, ≤-0.560°C, and ≤-0.540°C, respectively (Official Journal No.

102/2000). Sensory testing is often used to evaluate the organoleptic properties taste, smell, and appearance to determine overall milk quality.

The clot-on-boiling test is a traditional method to detect milk that is overly acidic (pH < 5.8) or colostrum-contaminated, which changes to curd upon heating, indicating high levels of acids, rennet-producing microorganisms, or colostrum (Merwan *et al.*, 2018). The alcohol test is used to assess the instability of milk proteins at higher acidity levels, often resulting from mastitis or colostrum. Elevated albumen levels from colostrum or salt concentrates from mastitis may lead to curd formation when alcohol is added (Merwan *et al.,* 2018). Titratable acidity measures the freshness and bacterial activity of milk. Bacteria ferment lactose into lactic acid over time, increasing milk acidity and lowering its pH (Merwan *et al.,* 2018).

### 2.7.2. Microbial Quality of Milk

Milk, being nutrient-dense, offers a fertile ground for microbiological growth. However, fresh milk is highly perishable and quickly becomes unsuitable for processing or consumption. High bacterial counts in milk can indicate poor hygiene practices or insufficient pasteurization (Bastola, 2016). Raw milk from infected animals may introduce pathogens into milk, contributing to sanitary quality concerns (Murphy *et al.*, 2016). Milk's nutrient content and exposure to contamination can also introduce foodborne viruses (El Zubeir & Ahmed, 2007). Antimicrobial compounds in raw milk, if present, can cause toxicological and processing issues (Kang *et al.,* 2005). Before processing into liquid milk or cheese, raw milk can contain over 2 million cfu/ml of bacteria (ElLeboudy *et al.,* 2017). In Sudan, raw milk does not meet necessary quality control standards, compromising its safety for consumption (El Zubeir & Ahmed, 2007).

The standard plate count (SPC) tests raw milk to determine the total number of aerobic bacteria at the time of collection. Cleaner milk will have lower bacterial counts, while milk collected under unsanitary conditions will have higher counts. SPC is commonly used to assess milk bacteriological quality before pasteurization, though it does not distinguish between pathogens and non-pathogens (Teklehaymanot & Yemane, 2016). Milk is graded based on SPC, with counts not exceeding 200,000 cfu/ml considered of very good quality, 200,000-1,000,000 cfu/ml

good, 1,000,000-5,000,000 cfu/ml fair, and ≥5,000,000 cfu/ml poor (Teklehaymanot & Yemane, 2016).

Somatic cell count (SCC) is a crucial indicator of milk quality, particularly regarding udder health. In developed countries, low SCC is rewarded in the market as it indicates good quality milk. A high SCC reflects mastitis, which negatively impacts milk composition and overall quality (Graaf *et al.*, 1997). The methylene blue dye-reduction test, though less precise than SPC, is used to assess microbial contamination in raw milk by measuring how long it takes for the blue color to disappear. The time for decolorization is linked to the bacterial load in the milk. Milk is classified as very good, good, fair, or poor based on this test (ElLeboudy *et al.,* 2017).

# 3. MATERIALS AND METHODS

## 3.1. Description of the Study Area

The study was conducted from March to January, 2025 in the selected areas of the central highlands of Ethiopia namely Holeta, Debre Zeit and Fitche Selale. Holeta is located in the Oromia National Regional State, West Showa zone, at a distance of 29 km far away from Addis Ababa. Holeta was situated at latitude of 9° 00'N and, 38° 30'E longitude. The town is situated at an altitude of 2400 m above sea level. Holeta experience a bimodal rainfall pattern with the main rainy season from June to September and a short rainy season from March to May. The average annual rainfall is 1144 mm with the average annual temperature of 6 $^0$C and a maximum temperature of 22 $^0$C (Mekibib *et al.,* 2010).

Fitche Selale is located at an altitude ranging from 2500 to over 3000 meters above sea level. The area receives an annual rainfall of 1200mm with an average minimum temperature of 6 $^0$C and maximum temperature of 21 $^0$C. It is situated at a latitude of 9.68333000 North and a longitude of 38, 6500000 East. Fitche Selale is found in the Oromia region, approximately 85 kilometers to the north of Addis Ababa (Hassen and Mohammed, 2015).

Debre Zeit is a capital of Ada'a district and located at 45 km south east of Addis Ababa and is very close proximity to other major urban centres namely Adama and Mojo. The town is found in East showa Zone of Oromia Regional State, between longitudes of 38º51' to 39º04' east and latitudes of 8º46' to 8º59' North, covering an area of 1,750 km$^2$.About 90 % of the land in Debre Zeit town is flat. The area receives annual rainfall of 866 mm with 84% occurring during the long rainy season from June to September, and the remaining during the short rainy season extending from March to May. The mean annual maximum and minimum temperatures of the area are 26°C and 14°C, respectively, with an average relatively humidity of 61.3%. Mixed farming system is commonly practiced in the area; however, livestock farming, particularly dairy and poultry, thrives significantly due to the favourable agro-ecology and relatively well-developed production facilities. These agro-ecological conditions provide a favourable environment for dairy production (Central Statistical Agency, 2007).

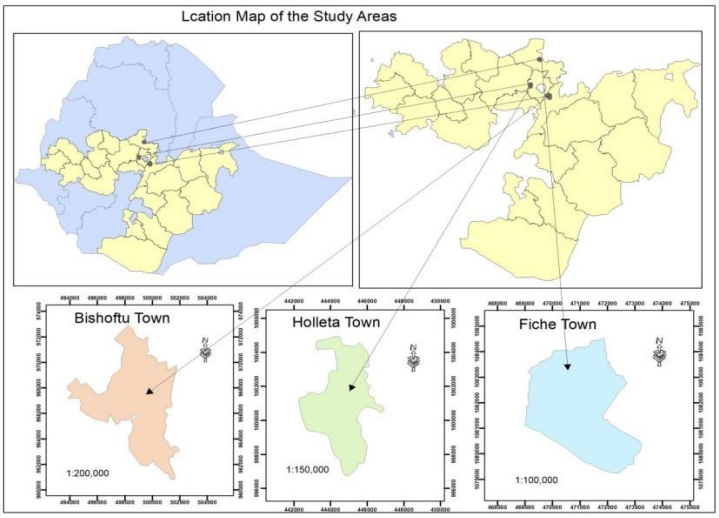



Figure 1: Map of the study area

## 3.2. Study Design

A cross-sectional research design combined with laboratory analysis was employed in this study. Initially, the survey data capturing questionnaires were developed to gather the required information from the cooperatives members and non-members of the smallholder farmers. Then, milk samples were collected from the previously surveyed non-member's farmers and members' farmers of the dairy cooperative for laboratory analysis of the physicochemical and microbial quality of milk at household level.

## 3.3.Sampling Techniques and Sample Size Determination

### 3.3.1. Survey

A multistage sampling technique was employed to select sample cooperatives, cooperatives members and, non-members. Firstly, one active dairy cooperative was chosen purposively from each of the three-study area namely Holeta, Debre Zeit and Fitche Selale based on accessibility and ease for transportation besides their better success stories. The lists of member farmers were obtained from each dairy cooperative, while the lists of non-members smallholder farmers were collected from district Livestock and Fishery Resource Development Office in *Kebeles* where the members are available. (Yemane (1967) formula provides for calculating the study's sample size, and this formula was relatively straightforward and does not require complex statistical

calculations and it helps to determine an appropriate sample size that provides reliable results without being excessively large or costly.

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

n= 322/1+322(0.05)$^2$ = 156 from dairy cooperative members

n= 100/1+100(0.05)$^2$ = 49 from non-members

The total active number of member of the dairy cooperatives was 322 (70 in Holeta, 110 in Fitche Selale and 142 in Debre Zeit), while the potential number of non-members producers which sell their milk to private sellers and compute with the members of the cooperatives across the study area was 100 (20 from Holeta, 30 from Fitche Selale and 50 from Debre Zeit). 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 the study areas. The total sample size for this study was 205 smallholder farmers (Table 1).

Table 1: Sampling layout for survey and milk quality analysis

| Milk sheds | Sample cooperatives | Total active cooperatives members | Sample members of dairy cooperative | Total non-members | Sample non-members |
|---|---|---|---|---|---|
| Holeta (robi berga | 1 | 70 | 34 | 20 | 10 |
| Fitche Selale (Egdu) | 1 | 110 | 53 | 30 | 15 |
| Debre Zeit (Adaa) | 1 | 142 | 69 | 50 | 24 |
| Total | 3 | 322 | 156 | 100 | 49 |

### 3.3.2. Milk samples

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 (Table1). Two hundred mL of morning milk samples was

collected for microbial and physicochemical analysis of milk from non-members and members of the cooperatives. The milk samples were placed in labelled sterilized sample bottles and kept in a thermos flask icebox with ice packs, and immediately delivered to the Addis Ababa University research laboratory. All the milk samples were tested for microbial and physicochemical quality in duplicates. The samples were kept in refrigerator until the time of analysis and the analysis were initiated within 24 hrs of upon the arrival of milk samples.

Table 1:1: Sampling layout for milk laboratory

| Study area | Selected sample cooperative | Active members of dairy cooperative | Milk samples | |
|---|---|---|---|---|
| | | | Non-members | Members of cooperative |
| Holeta (Robi berga) | 1 | 13 | 5 | 10 |
| Fitche Selale (Egdu) | 1 | 10 | 5 | 10 |
| Debre Zeit (Adaa) | 1 | 12 | 5 | 10 |
| Total | 3 | 35 | 15 | 30 |

### 3.4. 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 conducting12 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 that have more experienced in order to come up with good information. The impact of dairy cooperatives was assessed by analysing factors such as milk yield, milk prices, net dairy income, and the proportion of dairy income in the total household income, employment opportunities, per capita daily milk consumption and milk quality.

## 3.5. Laboratory Analysis

### 3.5.1. Chemical Composition standard procedures

**Determination of fat content**

Gerber method was used to determine the milk fat content. Milk samples were kept at 37 $^0$C for 30 minutes in a water bath to bring the milk samples to normal body temperature of the cow. Ten mL of concentrated sulphuric acid was pipetted into a butyrometer. Then 11 mL of milk was added using milk pipette into a butyrometer having the sulphuric acid and one mL of amyl alcohol was added. The butyrometer was sealed with a stopper and shaken vigorously, inverting several times until all the milk was digested by the acid. The butyrometer was then placed in a water bath at 65 $^0$ C for five minutes. The samples were centrifuged in a Gerber centrifuge at 1100 rotations per minute four minutes. Finally, the butyrometer was returned to the water bath at 65 $^0$ C for 5 minutes and fat percentage was read directly from the butyrometer. The average of duplicate readings was computed and recorded (Ghoryar & Ebner, 2022).

**Determination of protein content**

Formaldehyde titration method was used to determine the total milk protein content. Ten ml of milk was added into a beaker. Then, 0.5 mL of 0.5 percent phenolphthalein indicator and 0.4 mL of 0.4 percent Potassium Oxalate were added into the milk. The samples were titrated using digital dispenser/burette with 0.1N Sodium Hydroxide solution. The titration was continued until pink color becomes intense (Ghoryar & Ebner, 2022) . Finally, the burette reading was recorded. The reading was multiplied by a factor 1.74.

**Determination of total solids and solid not-fat**

To determine the total solids in the milk samples, three mL of milk sample was pipetted into pre-weighed and dried crucibles in duplicates. The crucibles were placed on a water bath of 35-40 $^0$C for 30 minutes. The samples were dried in an oven at 102± 2°C for 24 hours. Then, the dried samples were taken out of the oven and placed in a desiccator to cool and then weighed. The samples were dried again in the oven for an additional one hour, cooled and reweighed. The drying and weighing process was repeated until the difference in weight between two successive

weighing was not more than 1 mg (Ghoryar & Ebner, 2022) .Then the total solids were calculated using the formula:

$$TS = \frac{M_2 - M_0}{M_1 - M_o} X100$$

Where:

M0 = the mass in grams, of the crucible

M1 = the mass in grams of the test portion

M2 = the mass in grams of dried crucible and test portion

Then, the solids not fat (SNF %) of the samples were determined by subtracting the percent fat from total solids (Ghoryar & Ebner, 2022).

**Determination of ash content**

The total ash content of milk samples were determined gravimetrically by igniting the dried milk samples used for total solids determination in a muffle furnace with origin of china and model of GWL series in which the temperature was slowly raise to 550 $^0$C until five hours. The sample was ignited until carbon (black colour) disappears or until the ash residue becomes white. Finally, the ash was removed from the furnace and cooled in desiccators (Michael and Joseph, 2004). The ash content was calculated as:

$$\%Ash = \frac{\text{Weight of burnt crucible + sample} - \text{Weight of oven-dry crucible}}{\text{Sample weight}}$$

**Determination of specific gravity**

To determine the specific gravity, the density in g/mL was determined by using a lactometer. The raw milk was poured into a 100 mL measuring cylinder and the lactometer was placed gently into the milk filled cylinder, allowing it to sink slowly until it floats freely without touching the sides of the cylinder. The lactometer reading was then taken and recorded in Lactometer degree (L°). The temperature of milk during measuring was calibrated at 20°C. Therefore, no corrections factor was made for temperature differences at 20 °C. The readings were used to calculate the milk density using the following formula:

$$\text{Milk Density} = 1 + \frac{\text{Lactometer Reading}}{1000}$$

**Titrable acidity**

Materials needed for the experiment was including milk sample, flask for mixing, 10 mL pipette, burette (0.1 mL graduations), mixing utensil (e.g., glass rod) ,Phenophtalein solution (0.5% phenophtalein in 50% ethanol) and Sodium hydroxide (NaOH; base, 0.1M) procedure 9 mL of the milk sample was added to a fask , 1 mL of the phenophtalein solution to the milk sample was added slowly and gradually, add sodium hydroxide from the burette to the milk sample. Stop the assay when the milk sample reaches a pink color. Record the amount of sodium hydroxide needed to obtain the pink color. Fill the bottom burette container with 0.1M NaOH. Squeeze the container to push liquid into the burette and fill the burette until the bottom of the meniscus is at zero then open the valve slowly to adjust the flow rate of 0.1M NaOH. Finally Record the volume (mL) of sodium hydroxide needed to develop the pink color. Divide this number by 10 to get the percentage acid of the milk sample (Ghoryar & Ebner, 2022).

### 3.5.2. Microbial quality analysis

**Aerobic Mesophilic Bacterial Count**

Homogenized milk samples were serially diluted by adding mL of milk into 9 mL of peptone water. One mL of the sample from a chosen dilution was placed on the petri dish using pour plating technique. Then, plate count agar media of 15-20 mL was poured on to the petri-dish and thoroughly mixed with the sample and allowed to solidify for 15 minutes and incubated for 48 +2 hours at 35°C. Finally, duplicate plates having 25-250 colonies were manually counted. The plate counts were calculated by multiplying the count on the dish by $10^n$ in which n stands for the number of consecutive dilutions of the original sample (Shah et al., 2016). The result of the counts were transformed to log 10 (logarithms of 10) before the statistical analysis.

**Total Coliform Count**

Samples were decimally diluted and plated with violet red bile agar media (VRBA) into petri dishes for enumeration of total coliforms bacteria as colony forming units per mL. Plates were be incubated at 32 $\pm 10^0$C for 24±2 hours. One mL of milk sample was serially diluted using peptone water and transferred into sterile petri - dishes. 10-15 mL of violet red bile agar media tempered to a temperature of $44^0$ C to 46 $^0$C was added to the milk sample and thoroughly mixed and allowed to solidify for 5-10 minutes. The mixture was overlaid with the same plating agar media of 3 to 4 mL to inhibit surface colony formation. The medium has been allowed to

solidify. The plates were inverted and incubated at 32 ±10 $^{0}$C for 24±2 hours. Counts were made manually. d= Dilution from which the first counts were obtained (H. Michael W. and Joseph F. Frank 2004)).

## Yeasts and molds counts

Yeasts and molds counts were enumerated according to the method as described by (IDF, 1990). Pre-prepared test sample (1ml) of 10-2 and 10-3 dilution was transferred into sterile petri dish through dispensing pipette with sterile plastic tips, and the yeast extract dextrose chloramphenicol agar medium (12 to 15 ml) was poured into inoculums. The mixture was mixed thoroughly and allowed to solidify than incubated at 25 ◦C for 5 days. The colonies appeared more than 10 and less than 150 after 5 days incubation were selected (Shah et al., 2016). The result was calculated using the following formula.

$$N\left(\frac{\mathrm{CFU}}{\mathrm{mL}}\right) = \frac{\sum \mathrm{C}}{[(1\mathrm{xnl})+(0.1\mathrm{xn2})]*\mathrm{d}}$$

Where:

N = number of colonies per millilitre of milk

Σ C = sum of colonies counted on all positive plates.

n1 = number of plates retained at the lower dilution.

n2 = number of plates retained in the next higher dilution.

d = the lowest dilution factor from which the first counts are obtained

### 3.6. Impact Analysis

This study was employed a robust methodology to evaluate the impact of dairy cooperative membership on dairy farm performance indicators, addressed the empirical challenge of creating a counterfactual to mitigate selection bias inherent in observational studies. To establish a valid counterfactual, it was utilized propensity score matching (PSM) 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 was 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:

$$ATT = E [Y_1 | C_i = 1] - E [Y_0 | C_i = 1]$$

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, implement various matching algorithms 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 use 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.

### 3.7. 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 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).

# 4. RESULTS AND DISCUSSION

## 4.1. Descriptive statistics of household characteristics

Data on demographic and socioeconomic of smallholder farmers who were a member and non-member of dairy cooperatives; were the summarized in descriptive statistics and statistical tests of those continuous and dummy variables are presented in Table 2 and 3. The average age of the sample households head was found to be 39.49 years with a minimum and maximum age of 38.62 non-members and 40.87 years in dairy cooperative members, respectively. This implies that the majority of the sample respondents are in the productive age group. this finding is in line with (Molla *et al.,* 2024).While no significant variations were observed between dairy cooperative members and non-members.

The family size has an important implication for a household's dairy cooperative membership decision (Chagwiza *et al.,* 2016). The mean family size of sample respondents was found to be 4.7 with a standard deviation of 2.01. For the members of the dairy cooperative, the mean family size was found 4.87 with a standard deviation of 1.05 while for the non-members it was found to be 3.45 with a standard deviation of 1.02. As indicated in Table 2, a significant mean difference was found between member and non-member smallholder farmers concerning family size. The result of the current study is in lined with who reported the average family size of household (Molla *et al.,* 2024).

The mean dairy farming experience among the sample respondents was 7.24 with a standard deviation of 2.94. Dairy cooperative members had a significantly higher average of 8.03 years of dairy farming experience compared to 6.49 years for non-members households ($P<0.05$) (Table 2)this finding is in lined with the finding of (Molla et al., 2024). According to (Leta & Mesele, 2014) report livestock particularly dairy farming plays a significant role for households worldwide and it is extensively practiced in the study areas. The average total number of dairy and milking cows owned by members were 10.56 and 8.36, respectively, which are significantly higher than those processed by non-members, who had 8.50 total dairy cows and 6.59 milking cows. The overall mean number of crossbreed cows owned by sample respondents was 1.69.

Dairy cooperatives members owned an average number of 1.84 crossbreed cows, while non-members hold an average of 1.52. The result shows that dairy cooperative members tend to own more crossbreed cows than non-members with this finding is also in lined with (Molla *et al*., 2024).

Table 2: Descriptive statistics of sample respondents for continuous variables

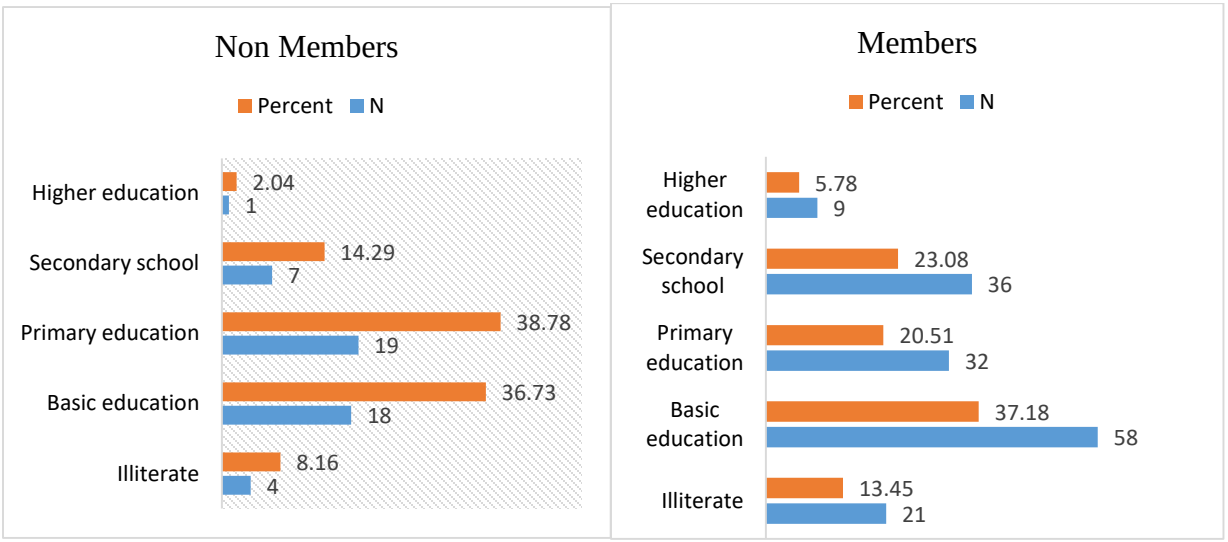
| **Variables** | **Members (N=156)** | | **Non-members (N=49)** | | **Total (N=205)** | | **P-value** |
|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | |
| Age | 40.87 | 11.51 | 38.62 | 11.43 | 39.49 | 11.54 | 0.625 |
| Family size | 4.87 | 1.05 | 3.45 | 1.02 | 4.7 | 2.01 | 0.067 |
| Dairy farming experience | 8.03 | 2.84 | 6.49 | 2.71 | 7.24 | 2.94 | 0.029** |
| Total number of dairy cows | 10.56 | 3.46 | 6.24 | 2.73 | 8.50 | 3.10 | 0.037** |
| Number of milking cows | 8.36 | 2.83 | 4.89 | 2.32 | 6.59 | 2.51 | 0.022** |
| Number of crossbreed cows | 1.84 | 0.49 | 1.02 | 0.45 | 1.69 | 0.46 | 0.059 |
| Extension service | 5.2 | 4.76 | 2.70 | 3.10 | 3.00 | 3.63 | 0.035** |

Providing adequate extension services to smallholder farmers is a key focus of the Ethiopian government to enhance productivity in the dairy sector. In this regard, development agents play vital role for farmers through improving the awareness level and technical knowledge of farming practices. The survey results revealed that dairy cooperative members had an average of 5.2 extension contacts per year, which is significantly higher than the 2.70 contacts reported by non-members (Table 2).This result is in lined with (Molla *et al.,* 2024).

The result indicated that the mean distance of the respondent's homes to the market was 2.5 km for dairy cooperative members and 3.11 km for non-members. Overall, the mean distance to the nearest market for all sample farmers was 2.805km. Market proximity plays a valuable role in selling dairy products, buying inputs, and serving as a hub for social interaction and exchange of ideas and valuable information .This finding is reveal with the report of (Bayan, 2018). Among the sample farmers, about 72.2% were male-headed, while the rest 27.8% were female-headed farmers (Table 3). With regard to credit service, about 30.8% of the sample farmers received credit service while the majority of the respondents (69.2%) did not have access

to get credit service as indicated in (Table 3). This result is consistence with finding of (Kuma, 2012).

The current finding indicate that 63.1% of the sample households have participated in training related to dairy production, marketing, and processing, while the remaining 36.9% have not. However, dairy cooperative members had significantly higher training participation rate (90.4%) compared to non-member (9.6%). This result is consistence with the finding report of ((Molla et al., 2024) training services are important for all farmers to acquire knowledge and skills required to utilize various technologies and improve dairy production. In addition to milk collection, cooperative members gain valuable information through training provided by cooperatives. This includes formulating animal feed, feeding management systems, and practicing hygienic milk handling to secure better return. The training also helps in changing attitude and practices related to milk sales, as many households did not sell raw milk before joining the cooperative. With the knowledge of market dynamics, household incomes have increased. Besides, members have acquired new technologies, such as improving animal breeds through AI service, accessing animal vaccination services and raising awareness of consumption.




Educational background of the respondents

Table 3: Descriptive statistics of sample respondents for dummy variables

| Variables | Response | **Members (N=156)** | | **Non-members (N= 49)** | | **Total (N =205)** | | P -value |
|---|---|---|---|---|---|---|---|---|
| | | N | % | N | % | N | % | |
| Sex | Male | 125 | 84.5 | 23 | 15.5 | 148 | 72.2 | 0.837 |
| | Female | 31 | 54.4 | 26 | 45.6 | 57 | 27.8 | |
| Credit service | Yes | 51 | 80.9 | 12 | 19.1 | 63 | 30.7 | 0.105 |
| | No | 105 | 73.9 | 37 | 26.01 | 142 | 69.3 | |
| Training participation | Yes | 118 | 90.8 | 12 | 9.2 | 130 | 63.4 | 0.030** |
| | No | 38 | 50.7 | 37 | 49.3 | 75 | 36.6 | |
| Market information | Yes | 156 | 80.4 | 38 | 19.6 | 194 | 94.6 | 0.047* |
| | No | 0 | 0 | 11 | 100 | 11 | 5.4 | |

The educational level of the household head plays a crucial role in influencing farmers' decision to join dairy cooperatives by enhancing their understanding of the challenges and benefits associated with cooperative membership. This study's findings align with those of Debeb & Haile (2016), who examined factors affecting farmers' cooperative membership in the Bench Maji zone, south western Ethiopia, and found that education level significantly influenced farmers' decision to join cooperatives. The majority of respondents, regardless of their cooperative membership status, had only basic education (37.18%), followed by primary school (20.51%) and secondary school (23.08%) education (Table 3).

The study also revealed significant differences in access to market information between cooperative members and non-members in the study areas. A large proportion of cooperative members (80.4%) had access to market information, compared to only 19.6% of non-members. Access to milk market information helps farmers understand market conditions and supports their decision to join dairy cooperatives (Table 2). This finding is consistent with the study by Eshetu & Assefa (2015), which examined the performance and determinants of household participation in dairy marketing cooperatives, specifically in Lemu-Arya and Bekoji dairy marketing cooperatives in the Arsi Zone of Oromiya Region, Ethiopia.

## 4.2. Milk Production, Consumption and Marketing

The overall average milk yield per animal per day for the sample respondents was 33.05 liters, with a standard deviation of 20.33. The average number of milking cows was 8.36 for cooperative members and 4.89 for non-members, with standard deviations of 2.83 and 2.32, respectively. The average milk yield per milking cow per day for members was 41.15 liters with a standard deviation of 23.63, while non-members had an average of 24.87 liters with a standard deviation of 17.03. The results indicate 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. As shown in Table 3, a significant difference in milk yield was found between members and non-members, consistent with findings from Bayan (2018) and Hundera (2015).

Smallholder dairying plays a significant role in food security and poverty alleviation by providing direct consumption benefits to smallholder farmers. The average daily milk consumption per household for cooperative members and non-members was 1.37 and 0.44 litters respectively. Statistically no significant difference between members and non-members in milk consumption (Table 3).This finding result is contradicted with the finding of Eshetu & Assefa (2015).

The suppliers of milk for the cooperatives included small, medium, and large-scale producers. Milk was transported by self-carrying or loaded onto draft animals such as horses or donkeys, from the production point to the collection centres. Payments for milk were made within 15 to 30 days or twice a month. The average selling price of milk per litter per day was 46 birr for members and 42.5 birr for non-members, with standard deviations of 1.5 and 1.16 birr, respectively. This indicates that non-members received lower prices for their milk, while cooperative members benefitted from better pricing. The study also found a significant difference in selling prices between cooperative members and non-members, showing that membership positively impacts both milk prices and marketing. This result aligns with Hundera (2015). Non-members in rural areas who sold milk directly to consumers reported prices of 60 and 55 birr per litter, which represents around 1% of respondents. For non-members, the higher

price is likely due to direct sales to consumers, rather than through intermediaries. However, the advantages provided by cooperatives, such as marketing services, may persuade farmers to participate even at a lower price.

For 64.9%, 11.2%, and 23.9% of respondents, their main sources of income were milk and milk products, livestock sales, and crop sales, respectively. The equivalent income earned from consumed dairy products was calculated by multiplying the average amount of dairy products consumed per household by the average price paid per liter or kilogram of the dairy products. The average daily income from milk for cooperative members was about 1,695.56 birr, while for non-members it was 903.2 birr. The t-test results showed a significant difference in mean daily income between cooperative members and non-members, with membership having a positive impact on income generation. These results are consistent with Bayan (2018) and Hundera (2015).

Table 4: 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 |

**Determinants of participation in dairy cooperatives**

The regression results are presented 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 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.

Table 5: 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 cow | 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 Cow | 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** | | | | | |

Those who had more milking and crossbreed cow had a positive and significant effect of the probability of being a member of dairy cooperatives. As farmers, own productive dairy cows, their likelihood of being members of the dairy cooperative increases. This is because farmers having more high-yielding crossbreed dairy cows can produce and supply a sufficient quantity of milk to the cooperative. Thus, farmers tend to be members of dairy cooperatives to obtain sustainable market outlets for their products. This result is consistence with the finding of (Eshetu & Assefa, 2015).

Providing extension services positively and significantly influenced dairy cooperative membership. The group of service providers plays with an important role for farmers through improving the awareness level and technical knowledge of farming activities. The results revealed that training service positively and significantly influenced dairy cooperative

membership, indicating that the provision of training attracts more farmers to the cooperative. This might be because training helps farmers to modernize the dairy production system, which in turn increases their milk production.

Training also raises farmers' understanding of the importance of dairy cooperatives. The present finding is consistent with (Grace, 2011)); (Nugusse *et al.* (2013); Dejen & Matthews (2016); Assefa *et al.* (2018), who reported that credit service increases farmers' membership in agricultural cooperative.

Access to milk market information access affect the likelihood of dairy cooperative membership decisions positively. The results revealed that the market information access and the probability of dairy cooperative membership were positively related and significant. This can be justified because, as households are informed about the price of milk, it motivates their decision to be a member of dairy cooperatives. Information improves farmers' knowledge about the marketing conditions of their milk. Similarly, (Dejen & Matthews (2016) concluded that access to information facilitates cooperative membership among farmers.

### 4.3. Impact analysis of dairy cooperatives

The balancing tests for the individual covariates for nearest neighbour matching (NNM), Kernel-based matching (KBM) and radius matching (RM) are shown in table 6. The tests show that bias for all covariates is less than 20% after matching, which is desirable. Additionally, table 7 tells appropriateness of the model as a whole. 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 reduces from 34.6% before matching to 11.8% for NNM, KBM and CM after matching. 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 6: 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 7: 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, as shown in Table 6. 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 (Table 8). 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. Non-members experience price fluctuations, especially during fasting periods, where milk prices are lower, while cooperative members benefit from a more stable price structure due to the cooperative's role in ensuring sustainable development through policies endorsed by its members. The ATT value for milk yield varied across matching techniques, reinforcing the significant impact of dairy cooperatives on milk yield. This finding aligns with those of Chagwiza *et al*. (2016) and Bayan (2018), who also reported a positive impact of cooperatives on milk yield.

Interestingly, non-members tended to receive higher prices for their milk than cooperative members. This may be due to the direct sales to consumers, bypassing intermediaries. However,

the cooperative offers advantages such as marketing services, which may encourage members to sell at slightly lower prices. but still there was no market fluctuation  Membership in dairy cooperatives significantly impacts annual net income. Bayan (2018) similarly found a positive and statistically significant effect of cooperative membership on farm income. While cooperatives tend to offer lower prices than the open market, they provide consistent market access, inputs, services, and higher yields, which compensate for the lower price. Additionally, members receive dividends at the end of the year, contributing to a higher annual net dairy income. However, cooperative membership did not significantly affect household consumption, a result that contradicts the findings of Debeb & Haile (2016), who reported a positive impact on consumption.

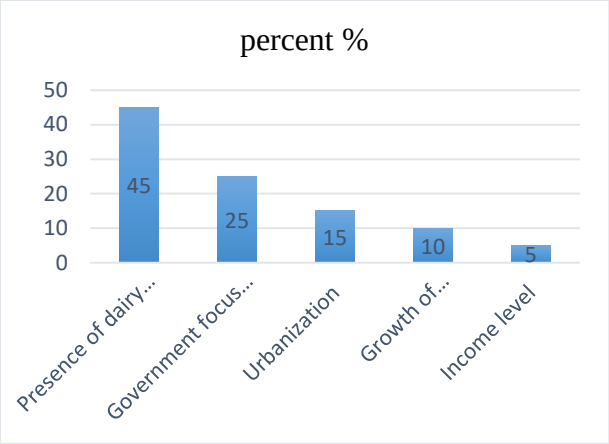
Cooperative members also saw greater involvement in dairying, reflected in significantly higher employment. This could be due to members having larger herds of crossbred cattle, which require more care. These results are consistent with findings by Abate *et al.* (2014), who noted that cooperative members are more likely to experience employment benefits, as well as with Balirwa *et al.* (2016;  Waiswa & Günlü (2023), who observed a high probability of cooperative membership among those seeking greater opportunities. Similarly, Priscilla & Chauhan (2019) also found a positive link between cooperative membership and employment. Overall, these results suggest that cooperative membership offers greater opportunities to members compared to non-members.

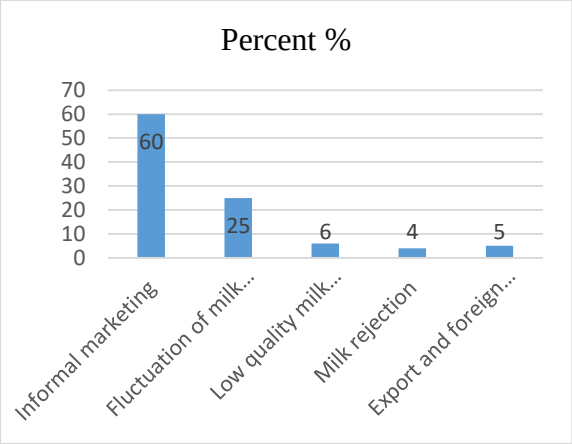
Table 8: Impact of dairy cooperative on smallholders dairy producers

| 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) ** |

## 4.4. Challenges and Opportunities of dairy cooperatives

The survey results on key challenges facing dairy cooperatives in integrating smallholder dairy farmers into formal markets. These challenges resulting in 60% of respondents indicate that informal milk marketing is the significant challenge in the market of milk, 25% of fluctuations in milk demand, 6% of respondents indicate that low-quality milk supplementation, 4% milk rejections due to lack of hygiene and freshness, export difficulties due to a foreign currency shortage, and the lack of modern technology, suitable milk processing facilities that indicate 5% of the market problem. On the other hand, opportunities for integrating smallholders into formal markets include the presence of dairy industries, that indicate 45% investment prospects in other sectors, and the growth of population10%, urbanization 15%, and income levels 5%. Furthermore, the government's focus on boosting agricultural productivity for the country's GDP enhances these prospects in 25%. These findings align with the work of (Girma Debele, 2012), who reported that 98% of milk produced in rural Ethiopia is sold through informal channels. Many dairy producers have neglected to explore formal market options, such as joining cooperatives, partly due to the socio-economic conditions of producers and the characteristics of their dairy farms, as noted by Chagwiza *et al*. (2016) and Tefera *et al*. (2017).




**Challenges and opportunities of dairy cooperatives**

## 4.5. Physicochemical characteristics of fresh milk

### 4.5.1. Specific gravity

The results of the current study, as shown in Table 9, indicate significant differences ($P < 0.05$) in specific gravity values between non-members and members across the study sites of Selale, Holeta, and Debre Zeit. Specifically, non-member samples had lower specific gravity values ranging from 1.024 ± 0.001 to 1.023 ± 0.002, while member samples displayed higher values, ranging from 1.027 ± 0.002 to 1.028 ± 0.003. These variations suggest notable differences in the specific gravity between the two groups, potentially indicating differences in milk composition across the surveyed areas.

Typical specific gravity values for milk range from 1.027 to 1.035 grams per millilitre, with an average value of 1.032 grams per millilitre (Tamime, 2009). Similarly, the reported a normal milk range of 1.028 to 1.033 grams per millilitre. In addition, (Ghoryar & 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, which could indicate fat removal or water adulteration in the non-member samples. Further research has suggested that water adulteration lowers specific gravity, while additions of solids like flour or sugar and the removal of butterfat can increase specific gravity above 1.035 grams per millilitre (Omore *et al.*, 2005).

These results highlight the significance of monitoring specific gravity as an essential tool in assessing milk quality and identifying potential adulteration practices.

### 4.5.2. 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. In Selale, the values were 12.47 ± 0.510 and 10.00 ± 0.001, while in Debrezeit, the figures were 12.748 ± 0.37 and 10.00 ± 0.003 (Table 9). According to Webb et al. (1974) ; Hassan (2005), the total solid content of milk typically ranges from 10% to 17%, which includes both fat and non-fat components. The fat content usually varies from 3% to 4%, and the non-fat portion falls between 7% and 10% (Webb et al., 1974; Hassan, 2005). These findings align with established norms and previous research. Notably, the average total solid content among cooperative members was significantly higher than that of non-members. This suggests that cooperative members are more likely to produce milk with higher total solid content, potentially due to their greater awareness of maintaining milk quality.

### 4.5.3. 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 were 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 Debre Zeit town. These results were lower than those reported by Mansson *et al.* (2003), Janštová *et al*. (2010), and Teklemichael (2012), who found fat contents of 4.3%, 3.79 ± 0.18%, and 3.86 ± 0.412%, respectively, for milk produced on dairy farms.

According to European Union quality standards for unprocessed whole milk, fat content should be not less than 3.5% (Tamime, 2009). Consequently, the average fat content of milk from cooperative members in the three areas met the European Union standards (Table 9), whereas that of non-members did not. The data further reveals that the average fat content among cooperative members was significantly higher than that of non-members. This disparity can

likely be attributed to the fact that cooperative members often receive training and education on best practices for dairy farming, including strategies to improve milk quality and increase fat content. Such knowledge equips them with the tools to enhance factors like cattle nutrition and breeding, resulting in higher fat content in their milk.

Table 9: Physicochemical result of raw milk samples collected from the study area

| Parameters | Sample sources | Study area | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Fitche Selale | | | Holeta | | | Derbrezeit | | |
| | | 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*** |

### 4.5.4. Solid non-fat (SNF)

As presented in Table 9, the average solid non-fat (SNF) content of milk from cooperative members and non-members across the three study areas was as follows: 8.936 ± 0.357 and 8.120 ± 0.694 in Holeta; 8.95 ± 0.460 and 8.84 ± 0.343 in Selale; and 9.157 ± 0.305 and 8.856 ± 0.547 in Debre Zeit town. No significant difference ($P > 0.01$) in SNF content was observed between the two groups in the Selale and Debre Zeit areas, while a significant difference was found in Holeta. Overall, milk samples from members had higher average SNF levels than those from non-members. The solid non-fat content in various milk samples ranged from 8.48% to 9.36% (Jenny *et al.,* 1989), indicating that about 90.64% to 91.52% of the milk is water, with the remaining 8.48% to 9.36% consisting of solid non-fat components. Therefore, the average SNF content observed in the study areas falls within this established range.

### 4.5.5. Milk Protein

The mean protein levels in milk from cooperative members and non-members across the three study sites were as follows: 2.92 ± 0.162 and 3.02 ± 0.349 in Holeta; 2.89 ± 0.144 and 3.18 ± 0.249 in Selale; and 2.98 ± 0.175 and 3.20 ± 0.292 in Debre Zeit town (Table 9). A significant difference was observed between members and non-members in Fitche Selale and Debre Zeit. The average protein content of raw milk in Holeta, Selale, and Debre Zeit 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) documented higher protein levels (3.46 ± 0.04%) in milk samples from households with local and crossbred cows. According to European Union standards for unprocessed whole milk, which set a minimum total protein content of 2.9% (Tamime, 2009), the average protein content in the study areas closely met these benchmarks.

### 4.5.6. Milk Lactose

No significant difference in milk lactose levels between cooperative members and non-members. The average sugar content in milk from cooperative members and non-members across three areas was 4.73±0.116 and 4.74±0.134; 4.76±0.117 and 4.82±0.083; 4.79±0.074; and 4.778±0.134 at Holeta, Selale and Debre Zeit town, respectively (Table 9). (Imran *et al.,* 2008)

reported that the lactose in the milk was from 2% to 5%. (Karim, 2008) established the standard milk sugar content at 4.75%. Therefore, the lactose content in the milk samples collected in the study closely matched the standard values reported by these researchers.

### 4.5.7. Ash

The average ash content of milk collected from cooperative members and non-members in the three areas were as follows: 0.764 ± 0.087 and 0.693 ± 0.052 in Holeta; 0.770 ± 0.065 and 0.812 ± 0.057 in Selale; and 0.748 ± 0.088 and 0.773 ± 0.077 in Debre Zeit town, respectively (see Table 9). The ash content across milk samples from these areas did not show a statistically significant difference ($P > 0.01$). Typically, the ash content of cow milk remains relatively consistent, ranging from 0.7% to 0.8%, and may vary based on factors such as the cow's breed, lactation stage, and diet (O'Connor, 1995).

### 4.5.8. Titratable Acidity (TA)

In this study, titratable acidity levels in milk samples collected from Holeta, Selale, and Debre Zeit towns exhibited significant variations (Table 9). Notably, milk samples from non-members in these regions showed titratable acidity values exceeding 0.16%, suggesting prolonged exposure to room temperature and suboptimal handling practices before consumption or sale. Fresh milk typically registers a titratable acidity of 0.16% to 0.18%as lactic acid(Ghoryar & Ebner, 2022). Particularly, the titratable acidity of milk from members in Debre Zeit town was significantly higher ($P < 0.01$) compared to members in Fitche, Selale, and Holeta towns (Table 10). Besides, the average titratable acidity values in non-member samples from Selale and Holeta were higher than those of cooperative members.

Statistical analysis using t-tests revealed significant differences in acidity levels between members and non-members. The increased titratable acidity in raw milk samples from non-members across all study sites is likely due to bacterial growth and prolonged milk storage before distribution. Hailu (2016) reported higher acidity levels in milk samples from individual farmers (0.23 ± 0.01% lactic acid) in the Harar milk shed, while the current study found lower acidity values. This study highlights the variations in titratable acidity across different membership categories and underscores the importance of proper milk handling and storage practices to ensure the maintenance of dairy product quality.

## 4.6. Microbiological quality of raw milk

The microbiological quality of milk was evaluated by collecting and analysing 45 samples from dairy cooperative members and non-members in Holeta, Selale, and DebreZeit. The samples were cultured to determine the aerobic mesophilic bacterial count (AMBC), total coliform count (TCC), and total yeast and mold count (TYMC). Table 10 provides the mean AMBC values for each sample source. In Holeta, the AMBC for cooperative members and non-members were 5.309 ± 2.846 log cfu/ml and 5.406 ± 0.038 log cfu/ml, respectively. In Selale, cooperative members had an AMBC of 4.655 ± 2.137 log cfu/ml, while non-members had 5.218 ± 0.044 log cfu/ml. In Debrezeit, the AMBC for cooperative members was 4.408 ± 2.027, compared to 5.253 ± 0.064 for non-members.

The results revealed that milk from non-members consistently showed higher AMBC levels than that from cooperative members across all study sites, with Debrezeit 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 in the study exceeded 5 log cfu/ml, surpassing the minimum acceptable bacterial count standards for milk set by the International Food and Agricultural Conference (IFCN, 2006).

Furthermore, studies from Tanzania and other African countries also reported high bacterial counts in raw milk samples. The overall microbiological quality assessment revealed that all milk samples exceeded both the international standard and the East African Community's (EAC) maximum acceptable standard of 2.0 x 10^5 CFU/ml for raw milk intended for further processing. These findings suggest that milk produced in the study areas failed to meet the quality standards for good milk, indicating poor bacteriological quality likely due to inadequate sanitation practices during milk production and handling. The t-test analysis emphasized that non-members across all areas had significantly higher AMBC levels than members, underlining the need for improved sanitation conditions and practices in milk production and handling to reduce microbial contamination and ensure the production of high quality milk.

Table 10: Microbiological count of raw milk samples (log10 cfu/ml) in the study area

| Parameters | Sample sources | Study Area | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Fitche Selale | | | Holeta | | | Derbrezeit | | |
| | | Mean+SD | t-value | p-value | Mean+SD | t-value | p-value | Mean+SD | t-value | p-value |
| AMBC | Members | 4.655±2.137 | 4.703 | 0.000*** | 5.309±2.846 | 3.279 | 0.006*** | 4.408±2.027 | 4.791 | 0.000*** |
| | Non-members | 5.218+0.044 | | | 5.406+0.038 | | | 5.253+0.064 | | |
| CC | Members | 2.457+2.886 | 6.401 | 0.000*** | 2.012+1.718 | 3.547 | 0.004*** | 2.187+2.879 | 5.737 | 0.000*** |
| | Non-members | 3.012+0.122 | | | 3.053+0.061 | | | 3.001+0.136 | | |
| YMC | Members | 4.008±2.137 | 4.882 | 0.000*** | 4.146±2.129 | 5.788 | 0.000*** | 4.247±1.666 | 4.444 | 0.001*** |
| | Non-members | 5.055+0.052 | | | 5.038+0.063 | | | 5.927+0.090 | | |

*AMBC .....CC…… YMC.....*

The t-test analysis in this study revealed significant differences in total coliform counts between dairy cooperative members and non-members across the three study areas. In Holeta, Selale, and Debre Zeit 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 ± 2.886 log cfu/ml, and 2.187 ± 2.879 log cfu/ml in these areas. The differences in mean values between members and non-members were statistically significant ($P < 0.01$), with non-members consistently showing higher coliform counts in their milk samples across all study area.

When comparing the coliform counts in this study with previous research, it was found that the current values were lower. For instance, Tassew and Seifu (2011) reported a mean coliform count of 4.49 log cfu/ml in Bahir Dar Zuria, and 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 in the Borana pastoral community. (Tesfaye et *al*., 2013) reported 4.13 ± 0.757 log10 cfu/ml for milk samples in Dire Dawa town, while Zelalem and Faye (2006) recorded a higher coliform count of 6.57 cfu/ml in milk samples from the central highlands of Ethiopia. Internationally, reports from countries such as India (5.89 log cfu/ml), Tanzania (5 cfu/ml), Kenya (4.67 log cfu/ml), and various regions in Ethiopia (6 log cfu/ml) show similar elevated coliform levels in raw milk.

Though it is challenging to entirely eliminate coliforms from milk, their presence is generally tolerated within acceptable limits. However, high coliform counts exceeding 100 organisms per millilitre raise concerns about the milk production process. Elevated coliform levels in dairy products can pose health risks to consumers, highlighting the need for improved hygiene practices. Factors such as poor hygiene, inadequate milk handling, udder infections, water quality issues, and improper handling contribute to coliform contamination. Monitoring coliform counts is essential to detect fecal contamination or improper sanitation in milk production.

Additionally, Table 10 presents the mean Yeast and Mould Count (YMC) for each milk sample source. In Holeta, milk from cooperative members had a mean YMC of 4.146 ± 2.129 cfu/ml, compared to 5.038 ± 0.063 cfu/ml for non-members. At Selale, the YMC for members and non-members was 4.008 ± 2.137 cfu/ml and 5.055 ± 0.052 cfu/ml, respectively. In DebreZeit,

cooperative members' YMC was 4.247 ± 1.666, whereas non-members had 5.927 ± 0.090. The results show that milk samples from non-members consistently had higher YMC levels compared to those from members, with DebreZeit non-members exhibiting the highest YMC. The t-test analysis confirmed that these differences were statistically significant ($P < 0.01$).

Regarding yeast and mold, the values 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) (2.3 log cfu/ml) and Fadda et al. (2004) (2.64 log cfu/ml). These discrepancies may be due to factors such as geographic location, high altitude, and humidity promoting mold growth, feeding practices that favour mold development, insufficient hygiene protocols, and improper storage practices.

# CONCLUSION AND RECOMMENDATIONS

In this study findings it was concluded that the impact of dairy cooperatives on the livelihoods of smallholder dairy producers, evaluate the physicochemical and microbial quality of milk from cooperative members and non-members, and analyse the challenges and opportunities that dairy cooperatives face in integrating smallholder farmers into formal markets in Holeta, Fitche Selale, and Debrezeit 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 findings indicated a substantial positive correlation between cooperative membership and several key outcomes, including milk production, pricing, annual net income, and employment opportunities, highlighting the advantages of cooperative membership. Strengthening services such as veterinary care, breeding assistance, feed supply, extension programs, and ensuring fair prices for members could further enhance dairy cooperative participation. 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 significance differences between cooperative members and non-members was observed the t-test analysis in this study was significant differences in Aerobic mesophilic bacterial count ,total coliform count and yeast and mold count between dairy cooperative members and non-members across the three study areas and reflected variations in hygienic practices due to support on training. Overall, the microbial quality of milk from the study areas fell below acceptable standards, indicating insufficient sanitary conditions during production and handling.

**Finally from the results obtained the following recommendations forwarded**

- 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.
- Involving the non-members farmer dairy producers in to members of dairy cooperatives
- Provide training on how to process their milk in to different product for further income generation.

# REFERENCES


Abate, G. T., Francesconi, G. N., & Getnet, K. (2014). Impact of agricultural cooperatives on smallholders' technical efficiency: Empirical evidence from Ethiopia. *Annals of Public and Cooperative Economics*, *85*(2), 257–286. https://doi.org/10.1111/apce.12035.

Abd Elrahman, S. M. A., Said Ahmad, A. M. M., El Zubeir, I. E. M., El Owni, O. A. O., & Ahmed, M. K. A. (2009). Microbiological and physicochemical properties of raw milk used for processing pasteurized milk in blue nile dairy company (Sudan). *Australian Journal of Basic and Applied Sciences*, *3*(4), 3433–3437.

Abunna, F. (2018). Assessment of major reproductive health problems, their effect on reproductive performances and association with brucellosis in dairy cows in Bishoftu town, Ethiopia. *Journal of Dairy, Veterinary & Animal Research*, *7*(1), 14–20. https://doi.org/10.15406/jdvar.2018.07.00183.

Addo, K. K., Mensah, G. I., Aning, K. G., Nartey, N., Nipah, G. K., Bonsu, C., Akyeh, M. L., & Smits, H. L. (2011). *Microbiological quality and antibiotic residues in informally marketed raw cow milk within the coastal savannah zone of Ghana*. *16*(2), 227–232. https://doi.org/10.1111/j.1365-3156.2010.02666.

Ahmed, M. A. M., Ehui, S., & Assefa, Y. (2015). *Dairy Development in Ethiopia EPTD Discussion Paper No . 123 dairy development in ethiopia Mohamed A . M . Ahmed , Simeon Ehui , and Yemesrach Assefa*. *August*.

Amentie, T., Eshetu, M., Mekasha, Y., & Kebede, A. (2016). *Milk postharvest handling practices across the supply chain in Eastern Ethiopia Milk postharvest handling practices across the supply chain in Eastern Ethiopia*. *June*. https://doi.org/10.5455/javar.2016.c139

Andualem, Tamir, B., Goshu, G., & Belete, E. (2015). *Characterization of cattle husbandry practices in Essera Woreda, Dawuro Zone, Southern Ethiopia*. *10*(34), 3421–3435. https://doi.org/10.5897/AJAR2015.9939.

Assefa Gashaw, B., & Mebratu Kibret, S. (2018). Factors Influencing Farmers' Membership Preferences in Agricultural Cooperatives in Ethiopia. *American Journal of Rural Development*, *6*(3), 94–103. https://doi.org/10.12691/ajrd-6-3-4.

Ayenew et al., 2009. (2016a). *Handling , processing and marketing of milk in the North western Ethiopian highlands Livestock Research for Rural Development , 2009 , Volume 21 , 97 .*

*Handling , processing and marketing of milk in the North western Ethiopian highlands * University of Na*. *July 2009*.

Ayenew, Y. A., Wurzinger, M., & Tegegne, A. (2016b). *Handling , processing and marketing of milk in the North western Ethiopian highlands Livestock Research for Rural Development , 2009 , Volume 21 , 97 . Handling , processing and marketing of milk in the North western Ethiopian highlands * University of Na*. *July 2009*.

Azeze, T. (2016). *Assessment of Post-Harvest Loss of Milk and Milk Products and Traditional Mitigation Systems in Southern Ethiopia*. 85–96.

Balirwa, E. K., Sserunkuuma, D., Hyuha, T., & Nalunkuuma, J. (2016). Factors Influencing Smallholder Dairy Farmers' Decision to Participate in Milk Markets in Uganda. *International Journal of Research Studies in Science, Engineering and Technology*, *3*(1),

Bastola, K. P. (2016). Quality of Raw Milk Supplied to Organized Milk Collection Centers of Western Chitwan. *ABC Research Alert*, *4*(1), USA. https://doi.org/10.18034/ra.v4i1.300

Bayan, B. (2018). Impacts of dairy cooperatives in smallholder dairy production systems: a case study in Assam. *Agricultural Economics Research Review*, *31*(1), 87. https://doi.org/10.5958/0974-0279.2018.00008.3.

Bekuma, A., Debela, D., & Science, A. (2023). *Milk Composition , Hygiene Practices and Marketing System in Wachale District , North Shewa , Ethiopia*. *February*.

Bekuma, A., Galmessa, U., & Fita, L. (2018). Dairy Products Marketing Systems and its Constraints in Gimbi District, West Wollega Zone, Oromia, Ethiopia. *Journal of Veterinary Science & Technology*, *09*(05). https://doi.org/10.4172/2157-7579.1000556.

Belete. (2006). *studies on cattle milk and meat production in fogera*.

Beyene, B., Geta, E., & Mitiku, A. (2016). Value Chain Analysis of Dairy Products in Esssera District Dawro Zone, Southern Ethiopia. *Industrial Engineering Letters*, *6*(6), 16–44.

Britz, T. J., & Robinson, R. K. (2008). Advanced Dairy Science and Technology. In *Advanced Dairy Science and Technology*. https://doi.org/10.1002/9780470697634.

CAC, 2004. (n.d.). *Milk and Milk Products Second edition Milk and Milk Products*.

Central Statistical Agency. (2007). Population and housing census 2007 –oromia statistical. *Ethiopian Statistics Service*, 158. https://www.statsethiopia.gov.et/wp-content/uploads/2019/07/Statistical_Oromiya-1.pdf.

Chagwiza, C., Muradian, R., & Ruben, R. (2016). Cooperative membership and dairy performance among smallholders in Ethiopia. *Food Policy*, *59*, 165–173. https://doi.org/10.1016/j.foodpol.2016.01.008

CSA. (2021). *federal democratic republic of ethiopia central statistical agency agricultural sample survey 2020 / 21 [ 2013 e . c .] volume ii report on*. *II*(March).

CSA. (2022). *the Federal Democratic Republic of Ethiopia Central Statistics Service*. *VIII*, 1–89.

D'Haese, M., Francesconi, G. N., & Ruben, R. (2007). Network management for dairy productivity and quality in Ethiopia. *Quality Management in Food Chains*, 185–197. https://doi.org/10.3920/978-90-8686-605-2

Dadi, T. A. (2017). *Challenges and opportunities of milk , meat and live animal marketing in Ethiopia : A review*. *8*(November), 180–186.

Debeb, D., & Haile, M. (2016). A Study on Factors Affecting Farmers' Cooperative Membership Increment in Bench Maji Zone, Southwestern Ethiopia. *Sustainable Development, 6(2).*, *6*(2), 129–138. www.iiste.org

Dejen, D., & Matthews, H. (2016). Agricultural Cooperatives, Opportunities and Challenges, the Case of Bench Maji Zone, Ethiopia. *An International Peer-Reviewed Journal*, *22*(1989), 57–70. www.iiste.org

District, E., & Gojjam, E. (2018). *Dairy Cattle Production , Processing and Handling of Milk and Milk Products in Advances in Dairy Research Dairy Cattle Production , Processing and Handling of Milk and Milk*. *October*. https://doi.org/10.4172/2329-888X.1000214

Dogarawa, A. B. (2020). Munich Personal RePEc Archive The Role of Cooperative Societies in Economic Development Ahmad Bello , Dogarawa. *Article in SSRN Electronic Journal ·*, *July*.

Duguma, B., & G.P.J. Jansessens. (2014). Smallholder Milk Processing and Marketing Characteristics at Urban Dairy Farms in Jimma Town of Oromia Regional State , Ethiopia Department of Animal Science , College of Agriculture and Veterinary Medicine , Laboratory of Animal Nutrition , Faculty of Ve. *Global Veterinaria*, *13*(3), 285–292. https://doi.org/10.5829/idosi.gv.2014.13.03.8511

Duguma, B., Kechero, Y., & Janssens, G. P. J. (2011). Analysis of Constraints Facing Urban Dairy Farmers and Gender Responsibility in Animal Management in Jimma Town. *Libyan*

*Agriculture Research Center Journal International*, *2*(4), 155–160.

El Zubeir, I. E. M., & Ahmed, M. I. A. (2007). The hygienic quality of raw milk produced by some dairy farms in Khartoum State, Sudan. *Research Journal of Microbiology*, *2*(12), 988–991. https://doi.org/10.3923/jm.2007.988.991

ElLeboudy, A., Amer, A., Alansary, M., & MSM, A. (2017). Microbial Profile of Heat-Treated Milk Sold at Local Markets. *Alexandria Journal of Veterinary Sciences*, *55*(1), 133. https://doi.org/10.5455/ajvs.281720

Eshetu, T., & Assefa, G. (2015). Performance and Determinants of Household's Participation in Dairy Marketing Cooperatives: The Case of Lemu-Arya and Bekoji Dairy Marketing Cooperatives, Arsi Zone, Oromiya Region, Ethiopia. *Global Journal of Emerging Trends in E-Business, Marketing & Consumer Psychology*, *1*(1), 240–258. https://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=116136825&site=ehost-live.

FAO: Ministry of Agriculture - Republic of Kenya. (2011). Milk testing and Quality Control. *Training Programme for Small Scale Dairy Sector and Dairy Training Institute*, *2*, 28. http://www.fao.org/AG/AGAInfo/resources/documents/MPGuide/mpguide2.htm

Felleke, G., Tachew, Woldearegay, Medhin, & Haile, G. (2010). Inventory of Dairy Policy - Ethiopia. *SNV Ethiopia*, 1–31.

Fikrineh Negash. (2012). Microbial quality and chemical composition of raw milk in the Mid-Rift Valley of Ethiopia. *African Journal of Agricultural Reseearch*, *7*(29), 4167–4170. https://doi.org/10.5897/ajar12.830.

Fissha, T., & Deng, Y. (2021). *Dairy Production System in Lowland Areas of Gambella , Ethiopia*. *1*, 1–9.

Galmessa Ulfina, Dessalegn Jiregna, Tola Alganesh, Prasad, S., & Mulugeta Kebede. (2013). Dairy Production Potential and Challenges in Western Oromia. *Journal of Agriculture and Sustainability*, *2*(1), 1–21.

Gebremedhin, B., Samson Jemaneh, Hoekstra, D., & Anandajayasekeram, P. (2012). A guide to market-oriented extension services with special reference to Ethiopia. *IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project.*, 111.

Gebreyohanes, G., Yilma, Z., Moyo, S. and, & A., M. O. (2021). Dairy industry development in

Ethiopia : Current status , major challenges and potential interventions for improvement. *ILRI position paper Dairy*, 1–39.

Geleti, D., Hailemariam, M., Mengistu, A., & Tolera, A. (2014). Analysis of fluid milk value chains at two peri-urban sites in western Oromia, Ethiopia: Current status and suggestions on how they might evolve. *Global Veterinaria*,*12*(1), 104–120. https://doi.org/10.5829/idosi.gv.2014.12.01.81164.

George Marechera and Joseph Ndwiga. (2015). This document is discoverable and free to researchers across the globe due to the work of AgEcon Search . Help ensure our sustainability . *AgEcon Search*, 18.

Getachew, 2003. (2003). *FAO Prevention of Food Losses Programme*. *June*.

Ghoryar, M. A., & Ebner, P. D. (2022). *Milk quality & safety testing manual*. *August*.

Girma Debele, 2012. (2012). *analysis of milk value chain: the case of ada'a dairy cooperative in ada'a district, east shawa zone of oromia regional state, ethiopia*. *September*.

Gojam, Y., Hunde, D., & Shumiye, M. (2017). Improved Dairy Technology to Smallholders in the Central Highlands of Ethiopia: Experiences and Way Forward. *Journal of Science and Sustainable Development*, *2017*(2), 85–95. https://doi.org/10.20372/au.jssd.5.2.2017.075.

Gonfa et al., 2009. (2001). *Field survey and literature review on traditional fermented milk products of Ethiopia*. 173–186.

Graaf, T. de, Romero Zuniga, J. J., Caballero, M., & Dwinger, R. H. (1997). Microbiological quality aspects of cow's milk at a smallholder cooperative in Turrialba, Costa Rica. *Revue d'Elevage et de Medecine Veterinaire Des Pays Tropicaux*, *50*(1), 57–64.

Grace, G. (2011). Exploring the Determinants of joining Dairy Farmers Cooperatives in Rwanda : A Perspective of Matimba and Isangano Cooperatives. *Insititute of Social Studies*, 1–63. https://www.semanticscholar.org/paper/Exploring-the-Determinants-of-joining-Dairy-Farmers-Gasana/018956cc37a8349ca6cfd755e231d42328bc701b.

Hailu, Y. G. T. A. (2016). Physicochemical Properties and Microbial Quality of Raw Cow Milk Collected from Harar Milk-shed, Eastern Ethiopia. *Issn*, *54*, 47–54. www.sasjournals.com.

Hemme, T., & Otte, J. (2010). Pro-Poor Livestock Policy Initiative Status and Prospects for Smallholder Milk Production A Global Perspective. *Food and Agriculture Organization of the United Nations*, *January 2010*, 1–12.

Henehan, B. M., & Brandoff, R. I. (1998). *considerations for group action in marketing specialty crops produced in the new york city watershed*. *October*.

Hundera. (2015). *assessment of the role of co-operatives in small holder dairy production and marketing. (the case of biftu berga dairy cooperative union, oromiya national regional state, west showa zone, ethiopia)*. 1–146.

Hussen et al., 2008. (2008). *Cow and Camel Milk Production and Marketing in Agro-pastoral and Mixed Crop- Livestock Systems in Ethiopia Kedija*. 1–18.

Imran, M., Khan, H., Hassan, S. S., & Khan, R. (2008). Physicochemical characteristics of various milk samples available in Pakistan. *Journal of Zhejiang University: Science B*, *9*(7), 546–551. https://doi.org/10.1631/jzus.B0820052

IFCN (International Farm Comparison Network). 2006. Dairy Report 2006. For a better understanding of milk production world-wide. International Farm Comparison Network Dairy Research Centre, Kiel, Germany

International Co-operative Alliance. (2021). The ICA Statement on the Cooperative Identity Historical Context and Global Relevance for Today. *World Cooperative Congress 2021*, 1–5. https://www.ica.coop/sites/default/files/news-item-attachments/25-anniversary-concept-note-final-draft-554502669.pdf

Japaro, A. M. (2021). Dairy Product Processing and its Marketing in Ethiopia: Current Scenario and Way Forward. *Journal: Journal of Veterinary Medicine and Animal Sciences*, *4*(2), 1–9. http://meddocsonline.org/

Kadebe, A. B. (2009). Characterization of Milk Production Systems, Marketing and On- Farm Evaluation of the Effect of Feed Supplementation on Milk Yield and Milk Composition of Cows at Bure District, Ethiopia. *Department of Animal Science and Technology School of Graduate Studies*, *Thesis*(May 2009). https://doi.org/10.13140/RG.2.1.3353.7682

Kuma, B. (2012). *school of graduate studies Market Access and Value Chain Analysis of Dairy Industry in Ethiopia : The Case of Wolaita Zone A Dissertation Submitted to the School of Agricultural Economics and Agribusiness , School of Graduate Studies , In Partial Fulfillm*. *February*.

Leta, S., & Mesele, F. (2014). Spatial analysis of cattle and shoat population in Ethiopia: Growth trend, distribution and market access. *SpringerPlus*, *3*(1), 1–10.

https://doi.org/10.1186/2193-1801-3-310

MataworkMilkiasGobena. (2016). Review on the Role of Dairy Cooperative in Market Oriented Development in Ethiopia. *European Journal of Business and Management*, *8*(2008), 38–48.

Mekibib, B., Furgasa, M., Abunna, F., Megersa, B., & Regassa, A. (2010). Bovine mastitis: Prevalence, risk factors and major pathogens in dairy farms of holeta town, central Ethiopia. *Veterinary World*, *3*(9), 397–403. https://doi.org/10.5455/vetworld.2010.397-403

Merwan, A., Nezif, A., & Metekia, T. (2018). Review on milk and milk product safety, quality assurance and control. *International Journal of Livestock Production*, *9*(4), 67–78. https://doi.org/10.5897/ijlp2017.0403

Metaferia, F., Cherenet, T., Gelan, A., Abnet, F., Tesfay, A., Ali, J. A., & Gulilat, W. (2011). Ministry of Finance and Economic Development and Ministry of Agriculture: Areview to Improve Estimation of Livestock Contribution to the National GDP. *IGAD Livestock Policy Initiative, December 2011*, 0–42.

MoA, 2013. (2020). *Ethiopia livestock master plan Roadmaps for growth and transformation*.

Molla, A., Abebe, A., & Assefa, D. (2024). Determinants of dairy cooperative membership among smallholder farmers in North-Western Ethiopia. *Cogent Food and Agriculture*, *10*(1). https://doi.org/10.1080/23311932.2023.2289717

Mulugeta getu, 2017. (n.d.). *proceeding of research for enhancing pastoralists livelihood through resilience*.

Murphy, S. C., Martin, N. H., Barbano, D. M., & Wiedmann, M. (2016). Influence of raw milk quality on processed dairy products: How do raw milk quality test results relate to product quality and yield? *Journal of Dairy Science*, *99*(12), 10128–10149. https://doi.org/10.3168/jds.2016-11172.

Najim, N. H. (2017). The combined effect of bacteriocin-producing Lactobacillus rhamnosus GG-ATCC and Lactoperoxidase system activation on microbiological quality of raw milk with special emphasis against E.coli O157:H7 in milk. *The Iraqi Journal of Veterinary Medicine*, *40*(2), 66–72. https://doi.org/10.30539/iraqijvm.v40i2.114.

Nugusse, W. Z., van Huylenbroeck, G., & Buysse, J. (2013). Determinants of rural people to join cooperatives in Northern Ethiopia. *International Journal of Social Economics*, *40*(12), 1094–1107. https://doi.org/10.1108/IJSE-07-2012-0138.

Okwara, M. O., & Uhuegbulem, I. J. (2017). Roles of Cooperatives in Economic and Rural Empowerment in Imo State, Nigeria. *American Scientific Research Journal for Engineering, Vol 33 (1)*, 146–154. http://asrjetsjournal.org/

Othieno, L., & Shinyekwa, I. (2011). This document is discoverable and free to researchers across the globe due to the work of AgEcon Search . Help ensure our sustainability . *Trade, Revenue and Welfare Effects of the East African Community Customs Union Principle of Asymmetry on Uganda*.

Priscilla, L., & Chauhan, A. K. (2019). Economic impact of cooperative membership on dairy farmers in Manipur: a propensity score matching approach. *Agricultural Economics Research Review*, *32*(1), 117. https://doi.org/10.5958/0974-0279.2019.00010.7

Rata, F., & Brook, A. (2018). Urban Water Supply System Performance Assessment ( the case of Holeta Town , Ethiopia ) Thesis submited to addis ababa science and technology university. *National Acadamic Documentation Resources Ethiopia*, *September*, 176.

Sebsibe, I., Degaga, B., Feye, G., & Tekle, T. (2021). Bacteriological and physical quality of fiche drinking water from households and reservoirs, oromia, ethiopia. *Water Practice and Technology*, *16*(3), 924–934. https://doi.org/10.2166/wpt.2021.043

Shah, J. M., Arain, M. A., Saeed, M., Sciences, A., & Siyal, F. (2016). *Microbiological Quality of Raw Milk and Associated Health Risk in the Hyderabad Region of Pakistan*. *May*.

Sintayehu Shibru. (2017). A Review of Challenges and Opportunity of Livestock Marketing in Southern Part of Ethiopia. *Journal of Marketing and Consumer Research*, *34*, 1–4.

Statistics, N. C. for H. (1999). *Technical Appendix from Vital Statistics of the United States, 1995, Mortality*. *April*.

Tamime, A. Y. (2009). Milk Processing and Quality Management. *Milk Processing and Quality Management*, 1–324. https://doi.org/10.1002/9781444301649

Tefera, D. A., Bijman, J., & Slingerland, M. A. (2017). Agricultural Co-Operatives in Ethiopia: Evolution, Functions and Impact. *Journal of International Development*, *29*(4), 431–453. https://doi.org/10.1002/jid.3240

Tegegne et al. 2013. (n.d.). *Working Paper No. 31*. *31*.

Teklehaymanot, A., & Yemane, H. (2016). Cow Milk Handling Practices and Factors Contributing to Quality Deterioration in Ethiopia Cow Milk Handling Practices and Factors

Contributing to Quality Deterioration in Ethiopia. *Food Science and Quality Management*, *48*(September 2016), 14–17.

Tesfaye, 2007. (2007). characterization of cattle milk and meat production, processing and marketing system in metema district, ethiopia.

Tessema, A., & Tibbo, M. (2009). Milk Quality Control. *Technical Bulletin*, *2*, 1–12. https://doi.org/10.13140/RG.2.1.2400.9200

U.S. Department of Agriculture (USDA). (2003). Measuring the Economic Impact of Cooperatives in Minnesota. *Rural Business Cooperative Services*.

Waiswa, D., & Günlü, A. (2023). Analysis of Challenges Facing and Factors Influencing the Profitability of Dairy Cattle Enterprises in Southwestern Uganda. *Turkish Journal of Agriculture-Food Science and Technology*, *11*(2), 207–214. https://doi.org/10.24925/turjaf.v11i2.207-214.5126

Woldemichael, 2008. (2008). dairy marketing chains analysis: the case of shashemane, hawassa and dale district's milk shed, souhern ethiopia. *Peraturan Menteri Pekerjaan Umum Tentang Pedoman Penyediaan Dan Pemanfaatan Ruang Terbuka Hijau Di Kawasan Perkotaan.*, *June*, 3.

Worku, T., Negera, E., Nurfeta, A., & Welearegay, H. (2012). *Microbiological quality and safety of raw milk collected from Borana pastoral community , Oromia Regional State*. *3*(November), 213–222.

Yadav, G. (2018). a Study on the Impact of Cooperatives on Economical Development. *International Journal of Research -granthaalayah*, *6*(5), 238–243. https://doi.org/10.29121/granthaalayah.v6.i5.2018.1444.

Yigrem, S., Beyene, F., Tegegne, A., & Gebremedhin, B. (2008). Dairy production, processing and marketing systems of Shashemene–Dilla area, South Ethiopia. *IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper*, *9*.

Yilma, Z., Guernbableich, E., & Sebsibe, A. (2011). *A Review of the Ethiopian Dairy Sector*. http://www.fao.org/docrep/017/aq291e/aq291e00.pdf.

Yilma, Z., and Faye, B. (2006) Handling and Microbial Load of Cow's Milk and Irgo-Fermented Milk Collected from Different Shops and Producers in Central Highlands of Ethiopia. Ethiopian Journal of Animal Production, 6, 67-82.

Yitaye et al., 2016. (2016). *Handling , processing and marketing of milk in the North western*

*Ethiopian highlands Livestock Research for Rural Development , 2009 , Volume 21 , 97 . Handling , processing and marketing of milk in the North western Ethiopian highlands * University of Na. July 2009.*

Zelalem ,Yilma, and Faye, B. 2006 Handling and Microbial Load of Cow's Milk and Irgo-Fermented Milk Collected from Different Shops and Producers in Central Highlands of Ethiopia. Ethiopian Journal of Animal Production, 6, 67-82.

Zijlstra, J., Berhanu, T., Vernooij, A., Boere, A., & Lee, J. van der. (2015). Investment opportunities in the Ethiopian Dairy sector:Business Opportunities Report Dairy #2 in the series written for the "Ethiopian Netherlands business event 5–6 November 2015, Rijswijk, The Netherlands. *"Ethiopian Netherlands Business Event 5–6 November 2015, Rijswijk, The Netherlands"*, 19.

# APPENDIX

**<u>Part one</u>: Survey questionnaire for Dairy producers**

General information's

Name of the respondent _____

1. Age of respondent ___ 1. <30 2. 30-40 3.41-50 4.51-60 5. >60
2. Sex _____ 1. Male 2. Female
3. Marital status _____1= Single 2= Married 3= Divorced 4=Widowed
4. Religion _____ 1. Orthodox 2. Muslim 3. Protestant 4. Others/ specify _____
5. Education level 1= illiterate 2= basic education 3 =primary school (grade 1-8) 4= secondary school (grade 9-12) = Higher education
6. Total number of household members (family size) ----------
7. Are you the member of dairy cooperative found in your area? 1 = Yes 2= dairy No
8. If yes, for how many years? 1. One year's 2. Two years 3. Three years 4.more than four years
9. How many years' experience do you have on dairy production? 1. For less than 5years 2. More than 5 years 3. More than 10 years
10. What is the main source of your income? 1. Selling of Milk and milk product 2. Selling of crop 3. Selling of livestock 4. Others (specify)
11. Do you use family labour to run your dairy business? 1= Yes 2=No
12. Dairy herd Production, Consumption, marketing and division of labor in dairy related activities

| Cows | No of dairy cows | No of milking cows | Average yield per day ( in liter) | Average liter of milk consumed ( per day) | Average liters of milk sold ( per day) | Amount of milk used for processing |
|---|---|---|---|---|---|---|
| Local cows | | | | | | |
| Crossbred cows | | | | | | |
| Total | | | | | | |

13. Do you get extension services from dairy cooperative? 1=Yes = 2=No=
14. Who mostly provides you with information about dairy production and marketing?

Code= 1=Livestock extension service 2=Dairy cooperative 3=Trader 4=From media

**Milk marketing activities**

15. Did you sell milk currently? 1. Yes 2. No
16. If yes to 14 what motivated you to sell milk?

    1. The existence of dairy cooperative in the area
    2. The need for additional income in the family
    3. The presence of many milk buyers in the area
    4. Because of my neighbors' are selling milk
    5. Others (specify) _____

17. Where do you sell your dairy product (raw milk)?
    1.Dairy cooperatives 2. Private milk collectors 3. Direct to consumers
18. What is the price of your milk_____
19. What are the means of transportation to sell your milk?
    1.Using draft animals 2. Using truck 3. Self-carrying
20. Distance travelled to market (KM)
    1. <5 □ 2. 5-10 □ 3. 10-15 □ 4. >15 □
21. What are the major milk marketing constraints you have observed?

    1. Fluctuation in the quantity of milk obtained from cows
    2. Distance of milk collection centers from my home
    3. Lack of getting adequate market especially during fasting time
    4. Inadequacy of labor in the household to transport milk
    5. Spoilage of milk during transportation
    6. Unable to get market information
    7. Others (specify) _____

22. Did you process your milk like to change it to butter and cheese after you join the dairy cooperative? 1=Yes 2= No
23. If yes to 23 what is the main reason of processing?

    1. For home consumption
    2. To get better market price than selling milk
    3. There is high demand of milk products than selling the milk
    4. Others ( specify)_____

**Membership of the dairy marketing cooperatives and benefits obtained**

24. Initially where did you get information to be member of the cooperative?

    1. From the district cooperative office
    2. From friends/ relatives
    3. From NGOs working in the area
    4. From the executive committees of the dairy cooperative in my place

5. Others ( Specify) _____

25. What were the requirements you had to fulfil to be member of the cooperative?

1. Paying registration fee
2. Paying share
3. Respecting the by-laws of the cooperative
4. having dairy cows
5. Others (specify) _____

26. What were the main reasons that motivated you to be member of the dairy cooperative?

1. To get secured market for the milk that I have
2. To get dairy inputs (feed, dairy breeds, veterinary service, advisory service, etc) timely and with fair price.
3. To get dividend from the cooperative
4. To get education, training & extension advisory services from the cooperative
5. To get credit from the cooperative
6. Others (specify) _____

**Technological, organizational, institutional and marketing innovations that members have tried to get from the dairy cooperative**

27. As a member of the dairy cooperative do you have access to the following services from your cooperative?

| No | Services/ technologies | Frequency of getting the services | | | Remark |
|---|---|---|---|---|---|
| | | Whenever needed | Sometimes | Never | |
| 1 | Marketing ( Buying & Selling) | | | | |
| 2 | AI services | | | | |
| 3 | Provision of feed | | | | |
| 4 | Veterinary service | | | | |
| 5 | Improved breeds / crossbreed cows | | | | |
| 6 | Credit services | | | | |
| 7 | Extension Advisory services | | | | |
| 8 | Training and education services | | | | |
| 9 | Dividend payment | | | | |
| 10 | Employment opportunity | | | | |

*Frequency of getting the services: 1= Never 2= Sometimes 3= whenever needed (Mark (√)

28. Perceived Benefits of members from the dairy cooperative

| | ***Benefits to members (actual/potential)*** | | | |
|---|---|---|---|---|
| | Strongly disagree | disagree | Agree | Strongly agree |
| Better access to outside support services | | | | |
| Better access to improved technology | | | | |
| Better access to inputs at reasonable price | | | | |
| Better access to market | | | | |
| Better access to social support services during time of crisis | | | | |
| Acquired knowledge & skills in improved dairy management | | | | |
| More income since joining co-op | | | | |
| More savings since joining co-op | | | | |
| More consumption since joining co-op | | | | |

1=strongly disagree, 2= disagree, 3= Agree, 4= strongly agree

29. What will be your outcome level

| **Outcome variable** | **Measurement** | **Remark** |
|---|---|---|
| Milk yield | Liter /day____ | |
| Net dairy income | Birr/day_____ | |
| Proportion of dairy income | Ratio | |
| Employment | Person/day/month___ | |
| Price of milk | Birr/liter_____ | |
| Milk quality | Microbial and chemical composition fulfil regulatory standard ___ | |
| Per capita milk consumption | Daily milk consumption if gram/liter___ | |
| Proportion of calf born with AI | Ratio proportion of calves born using AI | |

**KNOWLEDGE AND INFORMATION**

**Training**

30. Have you ever participated on dairy production training for the past three years?

    1=Yes  2= No

31. If yes do you think that the training was helpful to gain knowledge and skill to solve your practical problems related to dairy production and marketing? 1) Yes 2) No.

    If no, why? _____

**Advice**

32. Do you get dairy advisory service on dairy production and marketing? 1. Yes 2. No
33. Who provides the advisory service?
    1. The dairy cooperative
    2. NGOs (specify) _____
    3. Private dairy farms (specify) _____
    4. Development agents in the area
34. How do you get the advisory service?
    1. Farm to farm visit by the development agent
    2. from member to member through the cooperative (like through innovative members of the cooperative)
    3. Going to the service providers (eg. When supplying milk)
    4. Others (specify) _____
35. How do you evaluate the different advisory service providers?

| **Service providers** | **Evaluation*** | | | | |
|---|---|---|---|---|---|
| | Timeliness | Relevance | Costliness | Feed back | Targeting |
| Dairy cooperative | | | | | |
| NGOs | | | | | |
| WOARD/DA | | | | | |
| Private dairy farm | | | | | |

* 1. Excellent 2. Very good  3. Good  4. Poor

**Part two Focus group discussion**

36. As a member of the dairy cooperative what are the new knowledge and information that you get from your cooperative as compared to joining the cooperative?

    With related to access to technology: _____

    With related to marketing: _____

    With related to changing in attitudes and culture: _____

    With related to getting new knowledge and information:_____

37. In your opinion what are some of the changes you observed in your life after getting such knowledge and information from your cooperative?

38. If the advice you are getting from your cooperative and other actors is not as per your information and knowledge need, could you please mention relevant information and knowledge that you need to enhance market oriented dairy production.

1. _____

**Other issues on the long-term success of the dairy cooperative**

39. Did you believe that the dairy cooperative is doing a good job in solving the problems the farmers are facing these days? 1. Yes 2. No

40. If No, for Q 40 what is/are the major commonly felt problems that isn't/aren't solved by the cooperative in your area?

1. Lack of having enough milk collection centers near to my home
2. Lack of providing adequate dairy inputs for members
3. Lack of having enough materials like chilling plant and refrigerators to preserve milk .
4. Lack of commitments by the management committees for the long term success.
5. Others (specify) _____

41. In general, do you believe that farmers will overcome their commonly felt problems by working together such as establishing cooperative in the future? 1. Yes 2. No

42. If No, for Q 39 what is/ are the possible reasons?

1. Lack of responsibility for common work
2. Misuse of the cooperative by some individuals
3. Lack of commitment by the members
4. Political influence/ intervention
5. Others specify_____

43. Do you want to continue your membership of the cooperative? 1. Yes 2.No

44. If yes, Q 43, what is/are the possible reason(s)

1. I get goods and services which are not available elsewhere
2. It purchases (assures a market for) our products
3. I don't want to isolate from other farmers
4. There is external pressure
5. Others/ specify_____

45. If no, Q 43, why? _____

**<u>Part three</u>: Checklist for key informant interviewing of dairy cooperative management members**

1.From how many producers did you buy milk last year?

2.From where do you commonly collect milk?

| Type of producer | Number of producer sells to you? | Average volume of milk collected/day (lit.) | Number of times a day milk collected | Type of vehicle used for transportation | Mode of payment |
|---|---|---|---|---|---|
| Small scale producer (<3 animal) | | | | | |
| Medium scale producer (<3 animal) | | | | | |
| Large scale producer (>10 animal) | | | | | |
| Type of vehicle used:1= head load 2= by-cycle 3= van 4=truck 5=other (specify)<br>Mode of payment: 1=**cash** , 2= **paid in 7 days** ,3= **paid in 7-15 days**, 4=**paid in 15-30 days**; 5=**more than one month**; 6= **other (specify)** | | | | | |

3. Apart from milk collection, do you provide other services to producer? ----------
4. Month wise per day average milk collection last year by dairy cooperative _____
5. Registered number of milk suppliers _____
6. No of workers involve in cooperative_____
7. Service provided by cooperative to the members_____
8. Active numbers of milk suppliers_____
9. Number of collection centers_____
10. Average distance of collection centers from cooperative_____
11. What tests do you use for screening milk? _____
12. What problems do you commonly find with the milk? _____
13. Principal buyer(s) of milk from producers/farmers_____

| No. | Type of milk and milk products | Type of buyers (Code) | Price /liter/ kg | Total volume buy per day | Place of purchase (code) |
|---|---|---|---|---|---|
| 1 | Raw milk | | | | |
| 2 | Butter | | | | |
| 3 | Soft cheese | | | | |
| 4 | Yoghurt | | | | |
| 5 | Others (specify)_____ | | | | |

14. Is there a difference in price setting between the dry and rainy seasons?
    1=Yes 2= No, give your explanation----------
15. Is there a difference in price setting during fasting periods? 1=yes 2=No, give your Explanation----------
16. What type of dairy products do you sell and who are your main customers (market Segmentation)?
17. Who are the competitors and supporters of your dairy activities? ----------
18. What are the main problems with purchase and sale of dairy products (Raw milk)
19. Quantity of milk rejected per day---------- or per month----------
20. What contribution has your dairy cooperative towards improving the position of small scale farmers in milk value chain? ----------
21. What are the main problems faced by milk buyer (dairy processer)?
22. Suggestion to improve present collection and processing capacities ----------
23. Who are the supporters of your dairy cooperative?
24. Who are the competitors of your dairy cooperative?
25. Who are the influencers of your business activities?
26. What is your basis to pay the price of the milk
    1=. Quantity, 2=. Quality, 3= Others, specify:
27. What is the criterion of your milk quality control/measure?
28. What are the challenges and opportunities to bring the small dairy holders to formal marketing systems? Explain----------

Challenges_____

1. Informal marketing
2. Fluctuation of milk demand
3. Low quality of milk supply
4. Milk rejection
5. export and foreign currency shortage
6. shortage and Lack of modern technology for processing -

Opportunity _____

1. Presence of dairy industries
2. Government focus on the sectors
3. Urbanization
4. Growth of population
5. Income level