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Identification of Climate-Smart Practices in the Downstream Dairy Value Chain in Ziway-Hawassa Milk Shed, Ethiopia

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Velp
The Netherlands

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A Research Project Submitted to Van Hall Larenstein University of Applied Sciences in partial fulfilment of the requirements for the degree of Masters in Agricultural Production Chain Management: Specialization, Livestock Chains

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"This research has been carried out as part of the project "Climate Smart Dairy in Ethiopia and Kenya" of the professorships "Dairy value chain" and "Sustainable Agribusiness in Metropolitan Areas".

DEDICATION

This work is dedicated to the Almighty God who was always there for me, and I couldn't achieve anything without him.

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ABSTRACT

The study was carried out in the Southern part of Ethiopia within Ziway-Hawassa milk shed. The study was aimed to identify climate-smart practices in the downstream dairy value chain in order to design efficient and climate-smart business models for milk collectors. Purposive and random sampling techniques were alternatively employed to collect data. A total of 32 collection points, four processing units and six milk retailers were targeted, and one respondent per unit was selected. A survey by using semi-structured questionnaire was held to generate data from the respondents. At the start and end of data collection, two FGD (Focus Group Discussion) that had a minimum of six participants in each session was conducted. Moreover, observations on milk collection points and processing units were held. For qualitative data, chain map, PESTEC and CANVAS business model was used to analyse and present the result. Quantitative data were analysed using Excel and SPSS and, presented by using different tables and graphs. Among milk collectors, clusters have been established between large- and small-scale collectors, and independent sample t-test was employed to know the difference between the means carbon footprint per litre of milk. The downstream part of the dairy value chain was controlled and monopolised by a few large-scale collectors and processors. They involved in the production, directly collecting milk from producers, process and or retailed it through their retailing outlets. At the collection points, females were dominant in the reception and quality control activities whereas males in the transportation of milk. The Producers→Collectors→Consumers channel was the main route of milk distribution to the consumers in the shed. Simple contract agreement and trust were the main milk procurement strategies of milk collectors and processors practised in all study districts. 55% of milk collectors implemented lactometer-based milk quality testing and, most of them (83%) rejected if the milk has inferior quality. On average 375 ± 418 litres of milk was lost due to spoilage per collection centre per year. The mean purchasing price per of litre milk for large scale collectors was 17.78 ± 2.0 Ethiopian Birr (ETB) and 19.23 ± 2.1 ETB for small-scale collectors ($P>0.05$). Milk collectors took the highest gross margin in fresh milk, but the value share was higher for producers. In butter, Producers had the highest gross margin and value share than processors and retailers. Small-scale collectors contribute a higher carbon footprint per litre of milk than large scale collectors ($P<0.05$). The average utilisation efficiency of milk cooling refrigerators for large- and small-scale collectors was 46 and 9% respectively. In general, milk collectors released a total of 167,727 kg of carbon footprint per year from collection, cooling and distribution activities. Similarly, milk processors contributed a total of 227,648 kg of carbon footprint per year from processing activities. There were many factors stated as a reason for the spoilage of milk in the shed. Poor hygienic practices during milking, transportation and storage, and the inaccessible market were indicated as the major causes of spoilage. Therefore, providing regular and practical based training on milk handling, efficient utilisation of transportation and cooling machines, and quality testing techniques is highly recommended. For milk procurement, updating and using formal contract agreement that has quality and quantity specification would be advisable for milk collectors to secure milk quality as well quantity.

Keyword: Climate smart practice, carbon footprint, business model

CHAPTER 1. INTRODUCTION

1.1. Background

Climate change has become a worldwide challenge, caused by Greenhouse gas (GHG) emissions which poses a risk to the living environment, health, and safety of human beings (Mantyka-Pringle et al., 2015; IPCC, 2013). Agricultural production is one of the main sources of GHG-emissions, accounting up to 25% of the total anthropogenic global GHG-emissions, of which the livestock sector contributes 14.5% (Hawkins et al., 2015; Laratte et al., 2014; Gerber et al., 2013). Dairy creates 2.7% of global GHG-emissions or 4.0% including meat from dairy animals (Hil, 2017). On the other hand, climate change affects livestock production and consequently food security. Especially in arid and semi-arid regions, livestock production is highly negatively impacted by climate change (Rojas-Downing et al., 2017).

The demand of milk in Ethiopia is projected to grow by 47%, and the Country's Livestock Master Plan envisions a 93% increase in national cow milk production over the period 2015-2020 (LMP; ILRI, GTPII, 2015). Given the expected vast increases in Ethiopian cow milk consumption and production, the Ethiopian dairy value chains are facing tremendous challenges of limiting accompanied increases in greenhouse gas (GHG) emissions as well as enhancing resilience to climate change. In 2013, the dairy cattle sector in Ethiopia emitted 116.3 million tonnes carbon dioxide equivalent (FAO and NZAGRC, 2017). Thus, Ethiopia has the ambition to shift towards green economy development and growth by limiting net GHG-emissions and improving resilience to climate change towards 2030/greening dairy (FDRE, 2011).

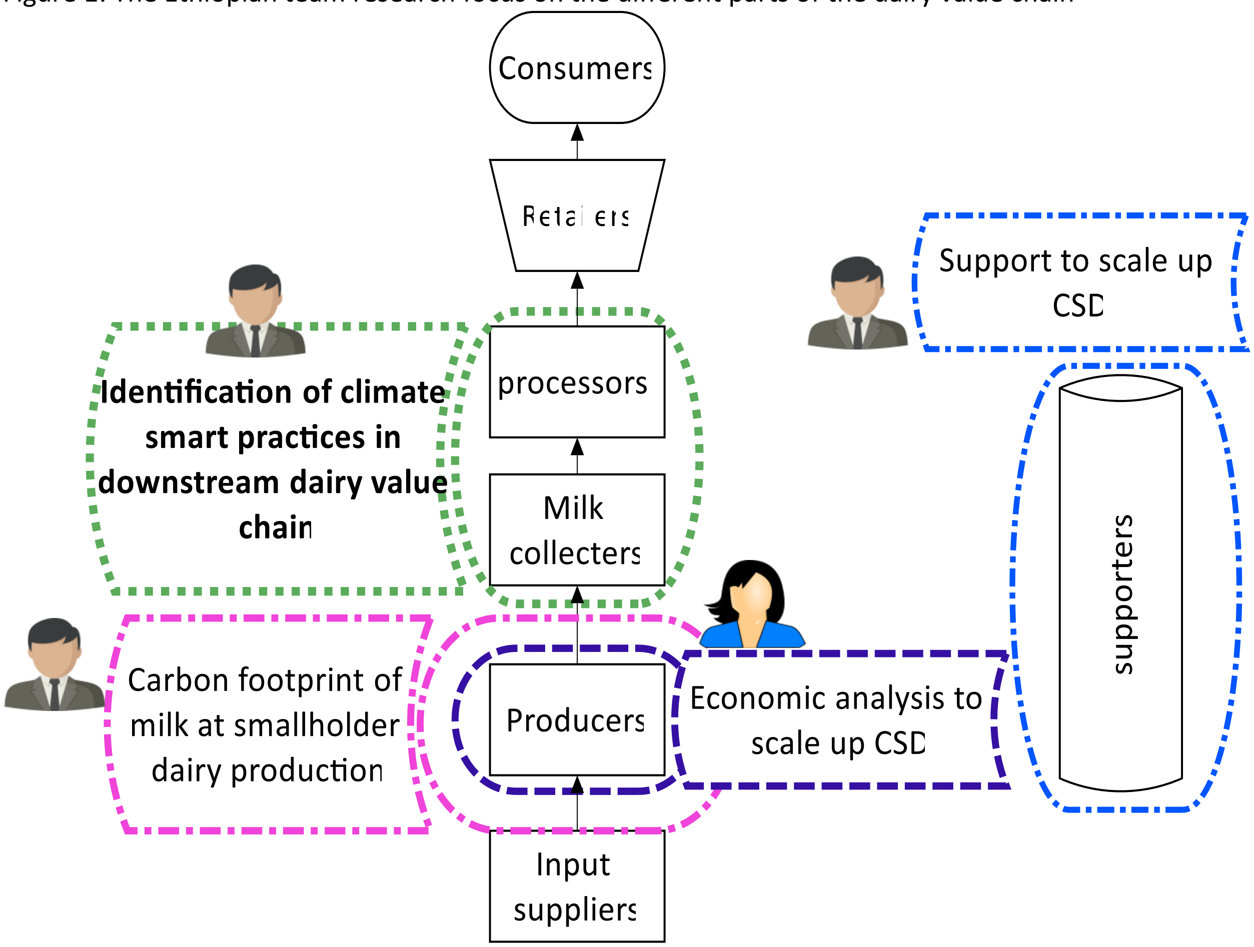
Therefore, reduction of losses in milk supply chain will lead to increased efficiency and is one of the strategies to limit GHG-emissions from dairy value chains. FAO (2011) estimated that food loss (post-harvest and distribution losses) in the dairy value chain in Sub-Saharan Africa is about 20%. Post-harvest and distribution losses in well-developed commodity chains in Europe and North America are on average 1%. According to Azeze and Haji, 2016, post-harvest loss of milk in Hawassa district was estimated up to 40% from milking to consumption phases. The high percentage of loss such as poor handling practices, the presence of an informal market, unavailability of the cooling facility, including adulteration, were reported as the main reasons for milk spoilage that are resulting in the rise of post-harvest loss of Hawassa district (Azeze and Haji, 2016).

Even though the production of raw milk is the main contributor (more than 80%) for GHG-emissions; the subsequent process (from raw milk collection through the product processing to the end of life) have also non-negligible impact on climate change (Guercia et al., 2016). Among the non-farming phases, those of most importance for GHG-emissions are dairy processing (6%) and packaging production (5%), followed by distribution (4.5%), end-of-life (4%) (Guinard et al., 2009). Therefore, analysis of the dairy supply chain from production through the ultimate disposal of packaging is necessary to provide dairy industry with a documented baseline of the carbon footprint of fluid milk for one's country (Thomas et al., 2013). Life Cycle Assessments (LCAs) is an internationally accepted mean to analyse the environmental impact of milk, considering all phases of its "life cycle" (Nutter et al., 2013; FAO, 2010).

1.2. Project description

The research project "Inclusive and climate-smart business models in Ethiopian and Kenyan dairy value chains" is connected to the Climate Change, Agriculture and Food Security (CCAFS) program of CGIAR through the "Nationally Appropriate Mitigation Actions" (NAMA) for Dairy Development in Kenya. NAMA supports stakeholders in Kenya to design/pilot activities to reduce GHG-emissions from dairy production (NWO, 2018). The research project aims to describe business models of chain actors and supporters to identify opportunities for scaling up good climate-smart practices. Since the research project leader is affiliated with Van Hall Larenstein (VHL) University of Applied Sciences, it gives a chance for interested students of the university to link their thesis research to the project. Consequently, four VHL students as a research team participated in the Ethiopian part of the project by taking a different part of the dairy value chain. My research is a part of this project that focuses on the chain actors, particularly on analysing the downstream part of the dairy value chain. As indicated in Figure 1 my research aim is to develop climate-smart and efficient business models for milk collectors and processors.

Figure 1: The Ethiopian team research focus on the different parts of the dairy value chain



Source: Ethiopian research team sketch (2018)

1.3. Research problem

It is known that post-farm GHG-emissions amounts to approximately 20% of dairy sector emissions. According to Sevenster and De Jong (2008), product losses are responsible for 57% of the post-farm emissions and 41% is due to milk processing. In the other way, De Vries et al., (2016) reported that improvement of the post-farm-gate chain was the second-most effective intervention for lowering GHG emission. In Ziway-Hawassa milk shed, the main problem is high milk spoilage/loss due to the dominance of informal chain that leads to the inconsistent supply of milk to the formal chain. As evidence, Brandsma et al., (2013) reported that in Shashemene-Hawassa areas only limited volumes of milk could be collected, processed, and marketed by small private and cooperative processing facilities. The effect of the problem is severely affecting the profitability of chain actors and leads to inefficient utilisation of energy throughout the channel. Because milk transporting trucks, cooling tanks and processing units have a high probability to work under capacity when supply is not consistent. Therefore, VHL University of Applied Sciences in collaboration with *Climate Change, Agriculture and Food Security* (CCAFS) and Adami-Tulu agricultural research institute analysed the situation and recommended a solution for the issues by developing climate-smart business models for milk collectors, which will lead to support sustainability of the chain.

1.4. Research objective

To identify climate smart practices in the downstream dairy value chain in order to design efficient and climate-smart business models for milk collectors

1.5. Research questions

a. What is the level of organisation of dairy value chain in Ziway-Hawassa milk shed?

i. What are the functions and existing relationships among downstream chain actors?
ii. What is the role of gender in collecting and processing functions?
iii. What is the distribution of gross margins and value share in downstream milk chain actors?
iv. What is the suitable and profitable business model for milk collectors?

b. What is the level of carbon footprint produced by milk collectors and processors?

i. What are the practices of milk collectors and processors to reduce carbon footprint of milk?
ii. What is the amount of energy utilised in chilling and processing units?
iii. What is the carbon footprint (CF) of milk in transportation and collection level?
iv. What is the CF of processed milk products in the processing units?

CHAPTER 2: LITERATURE REVIEW

2.1. Dairy value chain in Ethiopia

The Ethiopian dairy sector is characterised by smallholder farmers, weak milk cooperatives and very few private small and large-scale processors. The dairy value chain starts with input supply for producing raw milk at the farm level and ends with consumers who make a choice to buy, or not to buy, the finished product. The dairy value chain has several links between the farm (production) and the consumer (consumption) operated by actors which involve in activities like procurement (collection), transportation, processing and packaging, storage and distribution, retailing, and food services (Yilma et al., 2011).

The dairy farmer has three market-outlets apart from their consumption. The milk producers can sell surplus milk to neighbours in the informal marketing channel or to dealers or to milk co-operative that may deliver to a milk-collecting centre (Feleke et al., 2010). According to CSA (2010), only 6.8% of the total milk produced is marketed, and milk and milk products are distributed both informally and formally.

2.1.1. Formal chain

I. Distribution system/supply

In the formal system, milk is distributed by licensed milk cooperatives and unions and the private sector. Milk collected at milk collection centres is supplied directly to consumers in the urban towns and transported by bulk tankers to the respective processing plants. These dairy enterprises process and pack the fresh milk collected for distribution to consumers in urban areas through agents and retailers. Homogenized, pasteurised and standardised (2.7–2.8% milk fat) milk is packaged and distributed (Yilma et al., 2011).

II. Performance/effectiveness

When milk is collected at the cooperative or private milk collection centres and transported to processing plants; milk quality tests (principally acidity using alcohol and clot-on-boiling test, and density) are performed on delivery, thereby assuring the quality of milk. This quality measurement has encouraged the producers to improve the hygiene conditions, storage and transportation of the milk to avoid rejection of the product on delivery to the collection centre (Yilma et al., 2011 and Ruben et al., 2017). Therefore, in the formal chain, loss of milk due to spoilage is minimal.

2.1.2. Informal chain

In Ethiopia, raw milk dominates fluid milk consumption and mostly reaches to consumers through informal marketing channel (Ruben et al., 2017). Out of marketable milk, a few proportions of milk are processed (into pasteurised milk, reduced fat milk, butter, cheese, and yoghurt), whereas another significant share of milk is directly sold and consumed in its raw state (Ruben et al., 2017).

I. Distribution system/supply

In the informal system, milk is distributed from producers to consumers (neighbours and in local markets) and milk products mainly in local markets (Yilma et al. 2011). The informal market involves direct-delivery of raw, fresh milk to consumers in the immediate neighbourhood and sale to itinerant traders and nearby institutions. The milk producers can sell to dealers. The dealers also collect milk from farmers and transport it to nearby urban centres for direct sale to consumers (in some cases to retailers).

Milk transportation is usually done by hand-carrying or packing on donkey/horses or using public transport. The type and cleanliness of container used, distance to market, the ambient temperature, the way the equipment is carried and movement of the carrier cause changes in the milk composition and affects the contamination level. The absence of bulk transport in smallholder milk marketing system has a significant effect on the overall milk supply. This risk is minimised in areas where the formal milk marketing is operational; small-scale processing unit is functional in the vicinity and consumers are located nearby.

II. Performance/effectiveness

In Ethiopia, milk and milk products are channelled to consumers through both formal and informal marketing system. In national level, about 95% of the marketed milk is channelled through the informal system. Unlike formal marketing system, the informal system is characterised by the absence of operation license, low cost of operation, high producer prices and no instruction of operation (SNV, 2008). The informal marketing channels are of low cost and use short-cut marketing routes between the producer and consumers and are thus believed to be more efficient than the formal marketing systems (Feleke et al., 2010). The hygienic condition of milk and milk products channelled through this system is also poor. This is mainly due to the prevailing situation where producers have limited knowledge of dairy product handling coupled with the inadequacy of dairy infrastructure such as cooling facilities and unavailability of clean water in the production areas (Yilma et al., 2011). Informal retail outlets rely on embedded local quality standards.

2.2. Gross margin and value share

An efficient marketing system is an essential tool for achieving higher economic efficiency of any enterprise, like the dairy sector. Management of marketing activities like procurement of quality raw milk from milk producers, milk processing and delivering safe and healthy milk on affordable prices to consumers in some cost minimisation manners create an economic efficient marketing system (Ishaq et al., 2016).

Costs are incurred by each chain actors such as producers, collectors, wholesalers, processors and retailers for different activities of milk trading. The costs belonging to the milk trade intermediaries include costs that are used for transportation, processing, tax, market information such as telephone, material cost, labour and cost of loss from perishable nature of milk.

A study conducted in South Region of Punjab, Pakistan showed that the distribution of gross margin among the whole chain of the dairy processing plant, distributors/wholesaler/retailer's and milk collection centres was 10.18%, 4.22%, 1.81% respectively. The estimated value share for milk producers in final consumer price in the four district markets varied from 42% to 44%. The level of profit efficiency was much higher for middlemen in the informal marketing channels (between 0.61 and 0.79) in comparison to the formal marketing channels (between 0.24 and 0.44). That means the middlemen present within informal marketing channels absorb more per litre profit as compared to formal milk marketing channels (Ishaq et al., 2016).

In Northern Ethiopia, Dessie Zuria district, a study showed that the producer--collectors --hotels/cafes --consumers channel was an important milk marketing channel that conveyed the highest volume of milk to end users. In this channel, cafes/hotels were the highest benefited market actor (63.3%) for the share of gross market margins in this channel followed by producers (28%) and collectors (8.67%). Optimizing the benefit share and minimising unbalanced share of benefit among the chain actors recalls urgent action to make the chain sustainable and more efficient (Tegegne et al., 2017).

2.3. Milk marketing channels in Shashemene-Hawassa area

The market channels of milk and milk products vary based on production system and type of the dairy product produced. Milk marketing channels in the urban dairy production system of Hawassa and Shashemene involved 2–4 channels (Table 1). It is noticed that the role of cooperatives in the marketing channels is higher in Shashemene, as compared to Hawassa city, where the bulk of the milk is sold directly to consumers and private milk wholesalers and retailers (Tadesse, 2016). But, information's about gross margin, and value share for each chain actors in the Ziway-Hawassa milk shed is lacking.

Table 1: Major milk marketing channels in urban dairy system of Shashemene- Hawassa area

S. No.	Milk marketing channels	Urban dairy system	
		Shashemene (%)	**Hawassa (%)**
1	Producers → Consumer	4.7	21
2	Producer → Wholesaler → Retailer → Consumer	-	60
3	Producer → Cooperative → Retailer → Consumer	46.9	2.2
4	Producer → Retailer → Consumer	38	16
5	Producer → Cooperative → Consumer	10.4	0.8

Sources, Tadesse, 2016 and Woldemichael, 2008

Milk wholesalers were playing the role of balancing supply and demand by transporting milk from surplus production areas such as Shashemene and Arsi-Negele to milk deficient areas (Hawassa). About 97% of milk supplied to Hawassa by wholesalers was obtained from Shashemene and Arsi-Negelle towns. In Shashemene about 71% of milk is conveyed via informal milk marketing channels, whereas in Hawassa only 27% of milk was estimated to be marketed informally. From the total milk marketed through the formal milk marketing channels of the milk shed, 70% and 30% of milk were estimated to be marketed by milk semi-wholesalers and dairy producers' cooperatives societies, respectively (Woldemichael, 2008).

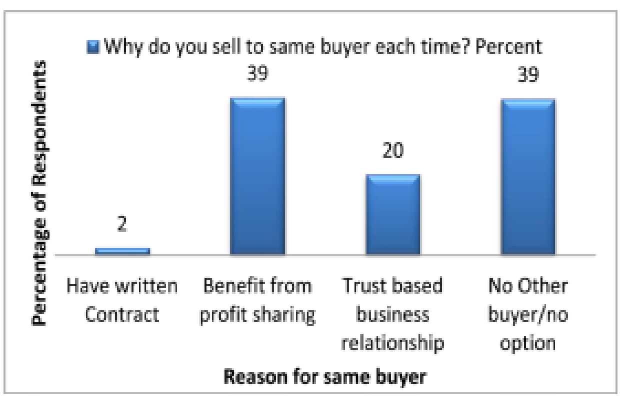
2.4. Value chain relationships (Chain governance)

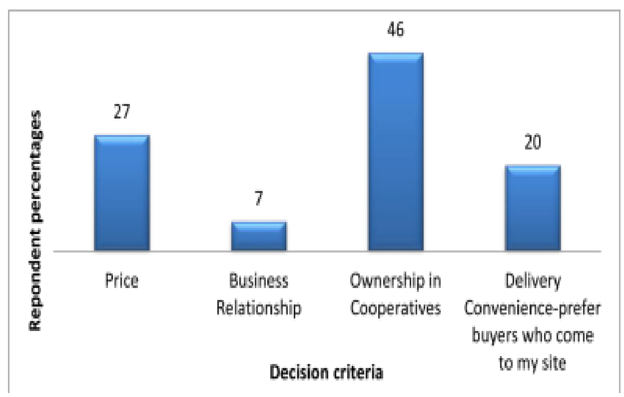
The dairy value chain in Bangladesh has been characterised as fragmented and disconnected with limited trust, which reduces cooperation, coordination, and flows of information. In underdeveloped value chains, trust and coordination are often low. This may be due to different reasons, including lack of leadership, mistrust of competitors, a zero-sum outlook, or simply an inability of actors to see the long-term benefits for cooperation (Mckague and Siddiquee, 2014).

Stronger and more trusting value chain relationships are an important element of achieving this because greater trust and coordination promotes cooperative behaviour, reduces transaction costs, enables rapid problem solving, reduces conflict, allows flexibility and adaptability, increases information flows, and reduces risk (Mckague and Siddiquee, 2014).

In the central part of Ethiopia, most dairy farmers always sell their dairy products to their cooperatives or union. The reason for selling to the same buyer is because of ultimate share in the profit of the cooperatives, trust-based relationships, and lack of alternatives to access another buyer (Figure 2). Only a few farmers reported that they had written a contract with the buyer. With regards to the primary buyer selection criteria, the majority of producers stated the ownership interest they had in cooperatives is their primary criteria. Also, price, delivery convenience, and business relationships were indicated as some criteria in buyer selection decision (Amentae et al., 2015).

Figure 2: Reasons for maintaining chain relations in Ethiopian dairy value chain





Source: Amentae et al., 2015

2.5. Consumption and post-harvest losses

Urban consumers buy milk for direct consumption mainly from the urban and peri-urban dairy farmers near settlement areas where demand for milk is high. The absence of an organised marketing network has made a significant amount of milk produced unable to reach the consumer. Together with the perishable nature of milk postharvest losses is thus high due to spillages and spoilage. In some case studies losses of up to 20-35% have been reported from milking to consumption for milk and dairy products. The inconsistency of demand and supply of milk are among the main factors which affect the dairy value chain (Feleke et al., 2010).

2.6. Involvement of gender in dairy value chain

Ethiopian government policy is intended to be gender sensitive; it has not been effective in influencing local institutions or customs. However, some dairy development programmes have taken steps to promote the participation of women and men, using approaches such as setting and monitoring gender targets, organising training activities to benefit both women and men, and encouraging husband and wife teams (FAO, 2017).

The development of formal value chains offers an opportunity for both women and men to establish businesses to supply feed and health inputs or engage in milk trading. However, this requires them to have access to knowledge, training and credit, which women and poor men find hard to access. Without such supports and better capacity-building interventions, there is a risk of excluding small-scale farmers from participation, particularly women, and from the resulting benefits in the subsector (FAO, 2017). Especially, women and girls in remote (off-road) areas have limited access to collection points and cooling facilities, hence the limited market for fresh milk.

2.7. Inclusive business models

A social business venture is a business that is set up as a for-profit from the outset, though its specific mission is to drive transformational social and environmental change (Elkington & Hartigan, 2008). Within this category, two different business models can be distinguished: the social business model (Yunus et al., 2010) and the inclusive business model (UNDP, 2008; WBCSD, 2012).

Social business model is designed and operated just like a “regular” business enterprise, but the primary aim is to serve society and improve the lot of the poor (Yunus et al., 2010). A regular business model consists of three components; value proposition, value constellation and economic profit (Yunus et al., 2010), and to make a social business model, a fourth component is included, which is the social profit equation.

Inclusive business models include the poor on the demand side as clients and customers, and the supply side includes employees, producers and business owners at various points in the value chain, and they establish bridges between business and the poor for mutual benefit (UNDP, 2008). They aim to provide affordable products and services to meet the basic needs of the poor for water, food, sanitation, housing and healthcare (WBCSD, 2012). The inclusive business model embeds its origin in the bottom of the pyramid theory (Michelini & Fiorentino, 2012), which is based on the concept of “serving the poor profitably”.

Similarly, Osterwalder and Pigneur (2010) reported triple baseline business models that have a strong ecological and social mission (Figure 3). The triple baseline model seeks to minimise negative social and environmental impacts and maximise the positive.

Figure 3: Triple baseline business model canvas

INFRASTRUCTURE MANAGEMENT		PRODUCT	CUSTOMER INTERFACE	
Key Partnerships	Key Activities	Value Proposition	Customer Relationships	Customer Segments
	Key Resources		Channels	
FINANCIAL ASPECTS				
Cost Structure			Revenue Streams	
Social and environmental costs			Social and environmental benefits	

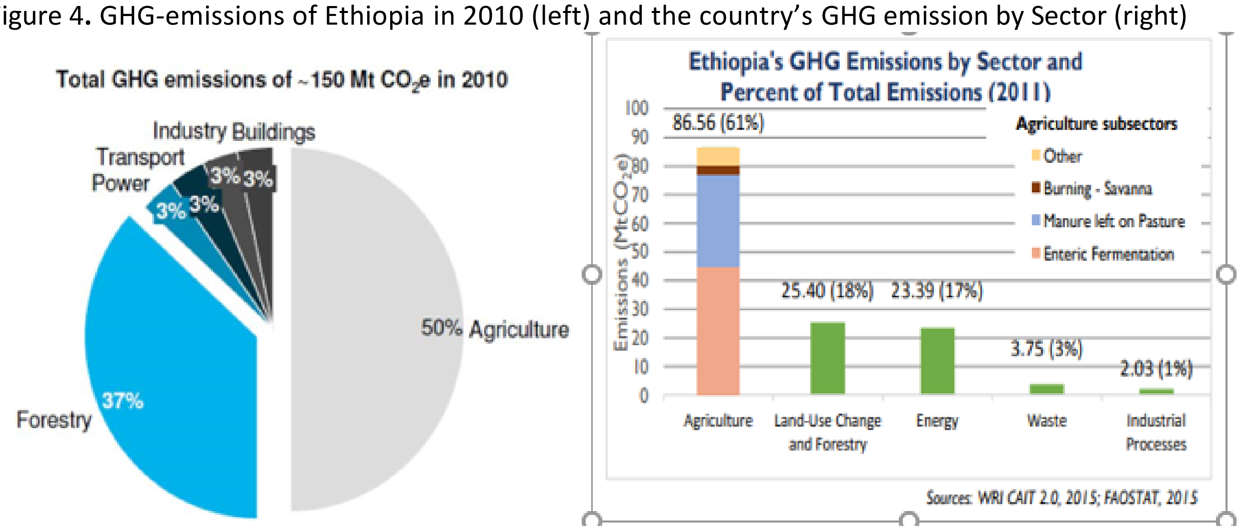
Source: Osterwalder & Pigneur, 2010

2.8. GHG-emissions in Ethiopia

The robust interfaces among agriculture, forest, and climate are very challenging for Ethiopian effort to build CRGE (climate resilient green economy) and to realise the GTP (growth and transformation plan). Because the Ethiopian economy is highly dependent on rain-fed agriculture which is highly vulnerable to the impact of climate change (Abbadiko, 2017).

In most developing countries, agriculture and forestry represent an essential part of the economy, at the same time; it represents an integral part of greenhouse gases emissions (Figure 4). The highest bases of Ethiopian economy and source of energy are agriculture and forests respectively, plus to this, both sectors are a source of more than 80% Green House Gas (GHG) emission in the country (EPA, 2011 and UNDP, 2011).

Figure 4. GHG-emissions of Ethiopia in 2010 (left) and the country's GHG emission by Sector (right)

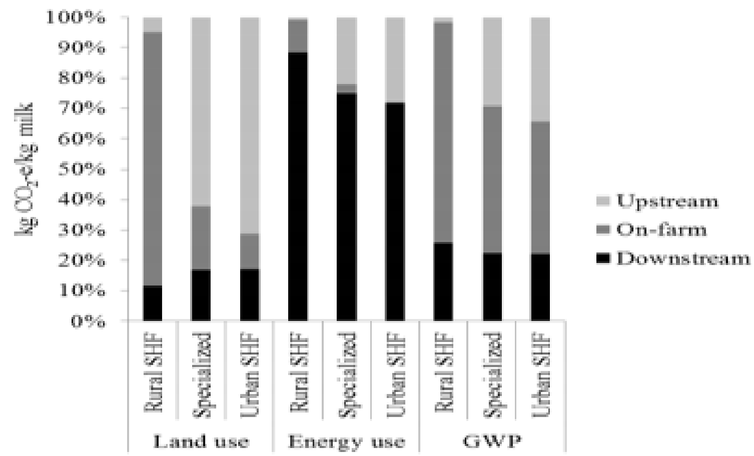


Source EPA, (2011)

2.8.1. Carbon footprint of milk

According to De Vries et al., 2016), 72-88% of energy use in Ethiopian dairy value chain was in post-farm gate stages (Figure 5). Energy is used for the transporting of milk, cooling and storing milk, heating water, lighting and ventilation in collection centres. In developing countries, cooling of milk generally accounts for most of the electrical energy consumption. For the sake of maintaining the quality, the raw milk temperature needs to be lowered quickly from 37.5 to 4 degrees Celsius. Refrigeration systems are usually energy-intensive (FAO, 2013). At upstream, specialised farms and smallholder farms consume a smaller amount of energy that is directly related to feeding production.

Figure 5: Contribution of dairy value chain environmental impacts



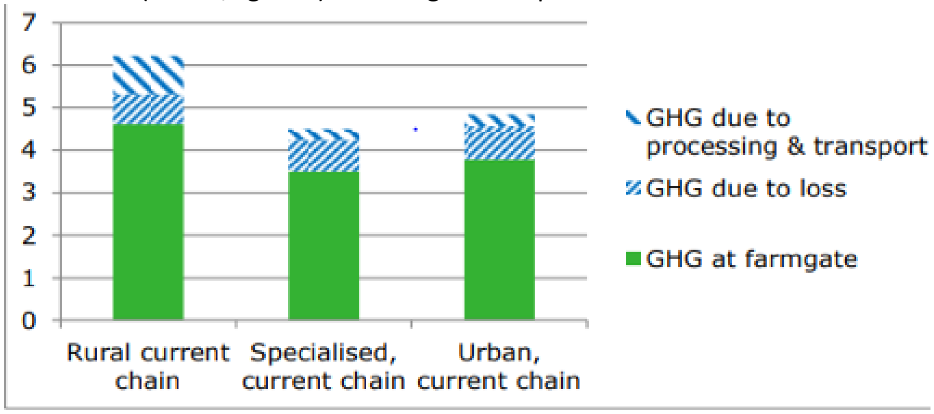
Source : De Vries et al., 2016

2.8.2. Off-farm emissions (On milk channel)

Many different sources potentially exist in the downstream part of the chain. Some important sources are product processing and packaging, product transport, and disposal of waste food by end-consumers (Figure 6). The total estimated GHG-emissions per kg of milk and milk products at the end of the observed post-farm chain without retail and consumer in Ethiopia were reported 6.2 kg CO2-e per kg of milk for the rural smallholder farms. Similarly, 4.5 and 4.8 kg CO2-e per kg of milk was also estimated for specialised farms and the urban smallholder farms, respectively (De Vries et al.,2016).

The same author also reported that milk losses in the commodity chain were 11% for rural smallholder farms and 16% for each specialised and urban smallholder farms. The significant fraction of sold fresh milk is responsible for the relatively large loss in the peri-urban and urban commodity chains. The increase in GHG between farm gate and the end of the observed processing chain can be explained by losses (0.70 to 0.78 kg CO2-e) and by processing (0.27 kg CO2-e for specialised and urban), and 0.90 kg CO2-e for rural farms. Processing emissions at rural farms are high because they are considered to use fuelwood for heating and processing.

Figure 6: GHG-emissions (CO2-e/kg milk) at farm gate and post-farm chain



Source : De Vries et al., 2016

2.9. Climate-smart supply chain

Climate-smart supply chain works to establish a 'triple win' scenario in which innovative practices that lead to keep the quality of products build resilience to climate change (reducing long-term risks) and lower carbon emissions all along the supply chain (FAO, 2013). When working effectively and efficiently modern supply chains allow goods to be produced and delivered the correct amounts of the product, to the right places, at the right time and cost-effectively.

Climate relevance and impacts are only just starting to become a consideration in standards. However, as good agricultural practices have environmental and social relevance and impacts, a number of these practices can also be used to enhance the climate-smartness of schemes. One way of doing this as a first step has been to assess the climate (or carbon footprint of farming and other processing and operations) in the agri-food chain (Verhagen et al., 2013).

As a means of energy efficiency, renewable energy and record keeping contribute to climate change mitigation by reducing emissions and providing data for monitoring these reductions. Smallholder farmer adoption of climate-smart GAPs (Good Agricultural Practices) will only be realistic when they contribute tangible economic benefits to farm economics, such as reducing input costs, enhancing yields, and improving land management (Verhagen et al.,2013).

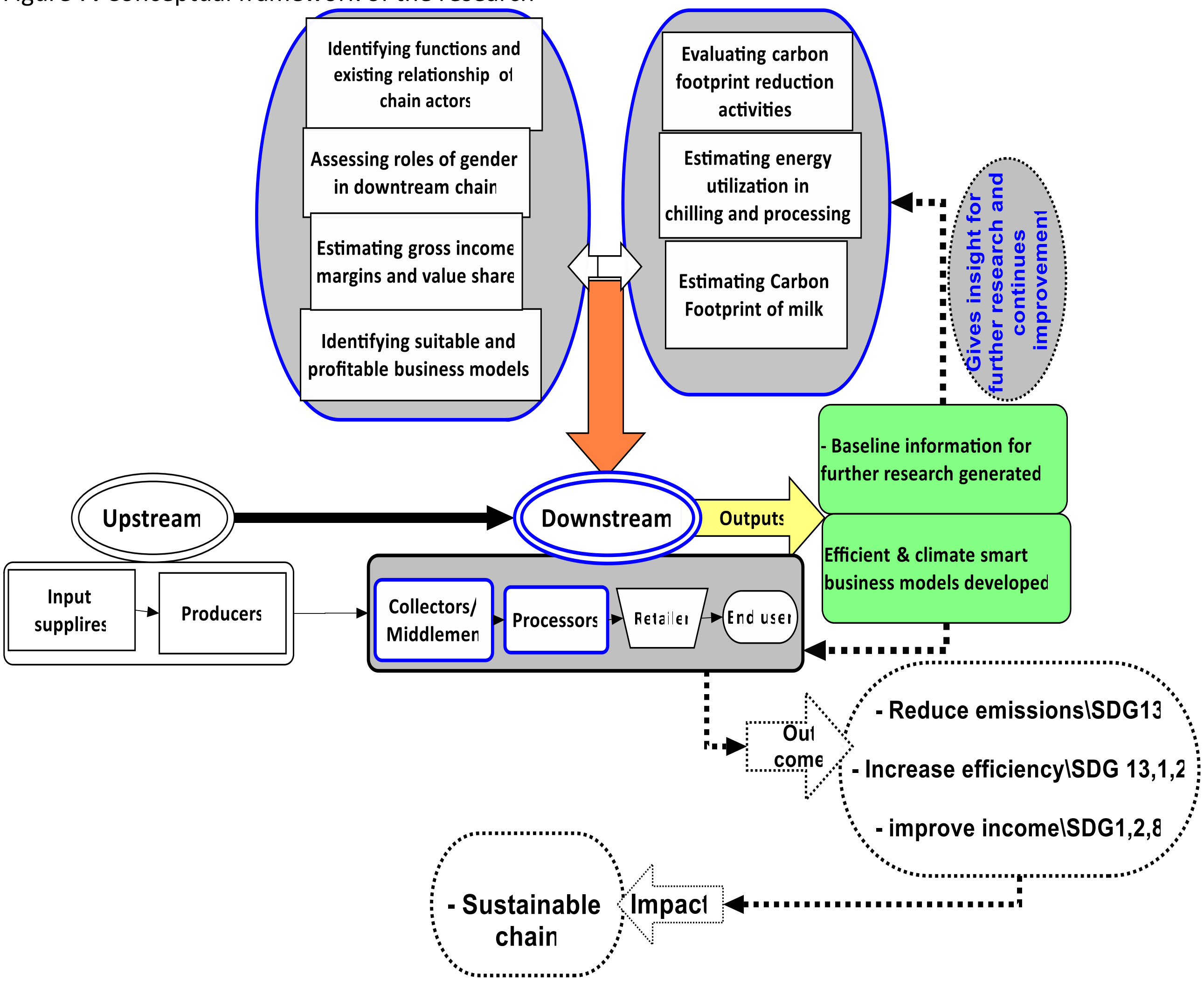
2.10. Climate-resilient green economy in Ethiopia

By 2025, Ethiopia aims to achieve middle-income status triggered by the development of green economy. The conventional development path would, among other adverse effects, result in a sharp increase in GHG-emissions and unsustainable use of natural resources. Because growing in traditional ways, GHG emission has a strong positive correlation with economic and population growth of one country. Therefore, the planned growth targets, as well as the rise of the human population, will lead to higher emissions if the conventional growth path is followed (USAID, 2015).

Therefore, Ethiopia has introduced the Climate-Resilient Green Economy (CRGE) strategy to escape from the negative impact of climate change and to set up a green economy that will help to realise its ambition of reaching middle-income status before 2025. The government has selected four initiatives for fast-track implementation: exploiting the vast hydropower potential; large-scale promotion of advanced rural cooking technologies; efficiency improvements to the livestock value chain; and Reducing Emissions from Deforestation and Forest Degradation (FDRE, 2011).

2.11. Conceptual framework

Figure 7**:** Conceptual framework of the research

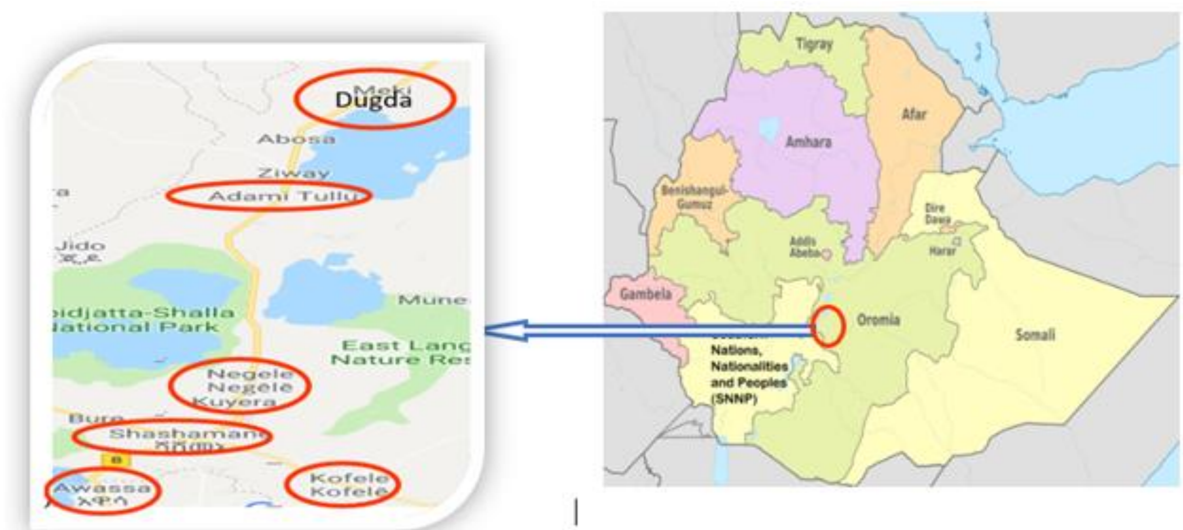


CHAPTER 3: METHODOLOGY

3.1. Description of study area

The study was conducted in the south of Ethiopia. It covered six districts such as Dugda, Adami-Tullu, Arsi-Negelle, Shashemene, Kofele and Hawassa city (Figure 8). The study area stretched 141.8 km from Dugda to Hawassa. The districts are found in the Mid-Rift Valley of Ethiopia. The altitudes of these areas range from 1500 to 2600 meter above sea level and have a semi-arid type of climate. The Mid- Rift Valley has an erratic, unreliable and low rainfall averaging between 500 and 1300 mm per annum. The temperature also varies from 12 to 27 ^{o}C (Yigerem et al., 2008, Negash et al., 2012 and Chalchissa et al., 2014). The areas are famous for milk production and are one of the major milk shed of the country (Yigerem et al., 2008).

Figure 8: Map of study areas

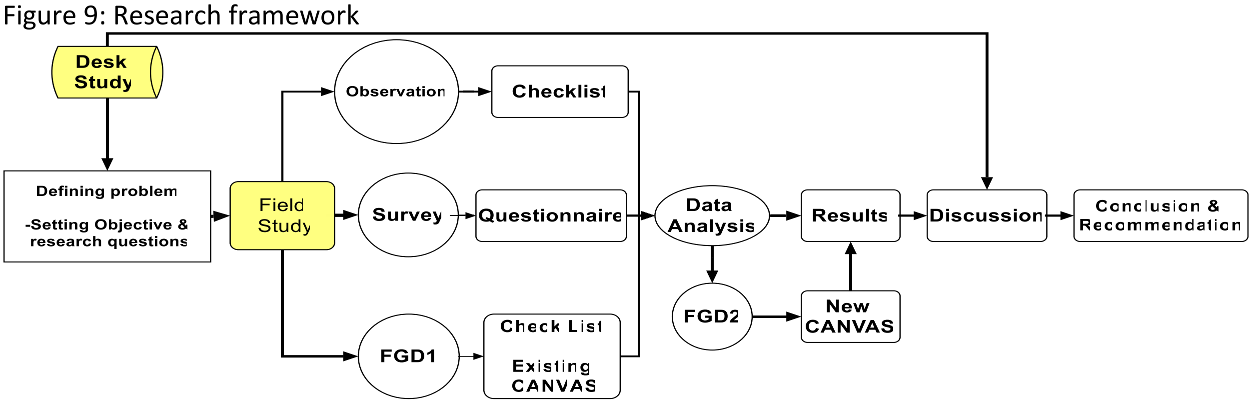


Source: Adopted from Oromia administrative region map, 2018

3.2. Research strategy and framework

3.2.1. Research framework

Figure 9: Research framework



3.2.2. Research design

Both quantitative and qualitative research was used in this study:

i. **Qualitative research was used for:** Description of the collection and distribution procedures of milk, identification of constraints to scale up climate-smart practices at collection and processing functions of the chain, gender role and sustainability matrix.
ii. **Quantitative research was used for**: Energy, volume of milk flow in the shed, quantification of the carbon footprint of milk and milk products in the collection, distribution and processing functions, and economic analysis.

3.2.3. Research units

Purposive and random sampling technique was used for the research. The Ziway-Hawassa milk shed, and study districts were selected purposively based on the interest of the commissioner of this study. Through stakeholder meeting and preliminary assessment, the available milk collection points/traders and processing units throughout the milk shed were identified and mapped. Then, 32 milk collection points were randomly selected and all processing units considered for further redefining the study unit. One respondent per collection point (32); and one respondent per processing unit (totally four) was selected for survey study. Besides, six participants were selected randomly among milk collectors and processors in the milk shed for focus group discussion. For the economic study, one milk and milk products retailers per district (6) was randomly selected within the milk shed (Table 3).

3.3. Data collection methods and tools

3.3.1. Desk study

Before the commencement of fieldwork, desk research was conducted to obtain secondary information regarding Ethiopian dairy value chain, milk collection and distribution procedures, the involvement of gender in the chain. Besides, information about the estimated carbon footprint of milk in Ethiopia and other countries, and economic aspects were gathered from the internet by studying relevant and recent scientific journals.

3.3.2. Survey

A semi-structured questionnaire was used to generate both qualitative and quantitative data (Appendix 1). The survey was held with helpt of language translator (Afan Oromo and Amharic speaker). Close-ended part of the questionnaire was prepared in a way that can help to quantify the carbon footprint of milk along with the channel and value share of the downstream chain actors. Similarly, open-ended parts of the questionnaire were used to describe the milk collection and distribution procedures, the roles of downstream chain actors, hindering constraints for milk collectors and processors to scale up climate-smart practices.

3.3.3. Observation

The unstructured observation was conducted by using a checklist (Appendix 2) to triangulate the validity of the data obtained through the questionnaire. Also, the collection points and processing units were observed about the arrangement of the operating system for product quality and energy utilisation.

3.3.4. Focus group discussion (FGD)

The Ethiopian research team conducted the general stakeholder meeting with the whole chain actors for two rounds. In the first round, the purpose and procedure of the study were presented by the research team and discussed with all stakeholders. Besides mapping of the milk shed's dairy value chain was held participatory with all stakeholders. In the second round, the preliminary outputs of the study were presented to the stakeholder by the team and feedbacks was obtained that helps to improve the research findings.

In some part of the stakeholder meeting, a specific discussion was held with a group of milk collectors and processors to collect some qualitative data. In each discussion session, about six participants from milk collectors and processors were involved. Checklist for an interview (Appendix 3) and participatory tools like mapping of milk collection and distribution procedures, and CANVAS business model (Appendix 4) was used for the discussion. The checklist was prepared and applied in a way that can help to get in-depth information about challenges and climate-smart practices of milk collectors and processors. Mapping of milk distribution channels in the shed and drawing of CANVAS business model was held participatory with participants during the discussion. In the first round of the discussion the existing business model was drawn together with participants. In the second round, newly proposed CANVAS business models were presented for stakeholders and feedback gathered.

3.4. Methods of data analysis

3.4.1. Qualitative data analysis

Different analytical tools were employed for qualitative data. Mapping and stakeholder matrix was used to visualise and describe the chain actors especially those who played a role in the collection, processing and distribution functions. PESTEC was used to analyse the challenges for scaling up climate-smart practices at the collection and processing functions of the dairy chain. And CANVAS Business Models was generated to present and recommend profitable and efficient business operations for milk collectors and processors.

3.4.2. Quantitative data analysis

Statistical Package for Social Science (SPSS) was used to process and produce frequency tables, graphs, and average values for different variables involved in the study. In this study, collectors were clustered into two groups based on the volume of milk collected per day. Those who collect a high volume of milk (greater than and or equal to150 litres per day) were grouped as large scale collectors. And those who collect a low volume of milk (less than 150 litres) grouped as small-scale collectors. Accordingly, 13 collectors were grouped in large scale collectors whereas the rest was considered as small-scale collectors. Independent samples t-test was applied to know the statistical differences of means of carbon footprint per litre of milk, cost and revenue for the two established clusters.

3.4.2.1. Life cycle analysis (LCA)

LCA is used to evaluate the possible environmental impact of a product throughout its life cycle based on the quantitative survey and assists to estimate GHG-emissions of all materials and energy, to seek opportunities to the improvement of product safety and environmental performances (Huysveld et al., 2015).

There are two main sources of GHGs at the factory level:

- Process energy consumption
- Fossil fuel consumption for transport

The post-farm-gate emissions occur at transportation, cooling and processing systems.

A. For transporting milk

The following protocol was used to estimate the carbon footprint of milk in the transportation phase which is adapted from Torquati et al., (2016):

- ⇨ The type of transport used, kilometres travelled and the quantity of milk transported was determined
- ⇨ The fuel consumption by the vehicle per kilometre and its full capacity of loading was considered
- ⇨ If the milk was carried in public transport or with other stuff/items, allocation of fuel was made to find the quantity of fuel consumed only for transporting of milk. To do that, the following procedures were used:
  - o Estimating total travelled distance, then
  - o Divide by the number of persons or weights travelled within that vehicle.
  - o The quantity of fuel consumption per person (that is for milk trader) or unit was used for further analysis. Plus, the money paid for the milk-transport was converted to person unit and added
- ⇨ Then, total estimated carbon dioxide (CO_2) emissions from milk transport is a product of the distance of milk transported, fuel consumption per kilometre and CO_2 emissions per litre of fuel.

$$Fuel = D \times L$$

Where:

- Fuel is the total litres of fuel consumed by the vehicle to transport the milk to a certain distance (litres).
- D is the distance that the milk is transported (kilometres).
- L is the litres of fuel consumed by the vehicle per kilometre to transport the milk (litres)

$$CF = Fuel \times EF$$

Where:

- CF is the total carbon footprint of milk due to transportation
- Fuel is the total litres of fuel consumed by the vehicle to transport the milk (litres).
- EF is the emission factor of CO_2 from fuel consumption estimated for Ethiopia

⇨ The emission per kg or litre of milk was obtained by dividing the total CF for the corresponding quantity of milk delivered in each step of the supply chain.

B. For milk cooling and processing

Total emission from cooling and processing systems was estimated by using the energy consumption data of the equipment. The following procedures were followed to estimate the carbon footprint of milk contributed from cooling and processing units in the milk shed:

- Electricity use for cooling, processing and packaging of milk was recorded
- Energy consumption of the cooling and processing machines per hour was collected from electricity bills or equipment specification (Energy = Power x Time); electrical energy supplied to consumers is bought by the unit known as a kilowatt-hour (kWh).
- The emissions of carbon dioxide were assessed by multiplying the total energy consumptions (Kwh) and the emission factors

$$CF = \sum_{i=n}^{n} Ei\ (Kwh) * EF$$

Where

- CF = is the total carbon footprint of milk due to cooling and processing system
- Ei (Kwh) = is the total energy used by the cooling and processing machines in Kwh
- EF = Emission factor estimated for the use of Ethiopian electric power

C. Emission factors

Energy based approach is used to estimate the emission factor because data regarding energy use of the vehicles was obtained and the standard emission factor is used to convert values to CO_2 emissions. Vehicle's emission factors are estimated based on the averaged details of vehicle numbers; annual mileage travelled; fuel specifications; road distribution by type of road; average vehicle speed; and temperature and humidity (Hao et al., 2013). Therefore, the vehicle's emission factor for any diesel and gasoline car in Ethiopia is 2.67 and 2.42 kg CO_2/liter respectively (FDRE, 2011).

Table 2: CO_2 emission factors calculated for Ethiopia in related to Energy consumption.

Activity level	Source of emission	Emission factor
Transporting of milk	Gasoline	2.42kg CO_2/liter
	Diesel	2.67kg CO_2/liter
Milk cooling & processing	Electricity	0.13Kg CO_2/kWh

Sources : Gebre, 2016, FDRE, 2011 and Brander et al., 2011

3.4.2.2. Economic analysis

An economic parameter like gross margin was used to analyse the benefit share and added value of collectors, processors and retailers along milk value chain in the shed. The gross income for each actor was estimated by subtracting the cost price of the product/unit from the sale price (revenue) of that product. Or in short: $Gross\ income = Revenue - Variable\ cost$ (KIT and IIRR, 2008). Gross margins

(GM) show the percentage of the actor's revenue that is gross profit per unit of produce and was calculated as follows:

$$GM = (\frac{Gross\ income}{Sale\ price(revenue)}) * 100$$ (KIT and IIRR, 2008)

Added value is the amount of value that each actor in the chain adds. It is the difference between the price the actor pays for the produce, and the price she or he sells it for. It was calculated as follows.

$$Added\ Value = \ Price\ received\ by\ actor - \ Price\ paid\ by\ actor$$ (KIT and IIRR, 2008)

Like gross margins, the size of the value share also reflects the number of costs and risks appear in the chain by that actor. Value share was estimated by using the following formula:

$$Value\ Share = (\frac{Added\ value}{Final\ retail\ price}) * 100$$ (KIT and IIRR, 2008)

Table 3: Summary of research methods

Research design	**Research Unit**	**Research methods**	**Tools**	**Methods of Analysis**	**Stakeholder**
Qualitative	2 (2*6)	FGD	Checklist	PESTEC, Mapping, Stakeholder matrix CANVAS	- Milk collectors, - processors
	32 (2*16)	Survey	Questionnaire		
Quantitative	**32 (2*16)** **+** **6 (2*3)**	Survey	Questionnaire	LCA	- Milk collectors **+** - Processors
	32 (2*16) **+** **6 (2*3)** **+** **6 (1*6)**			Economic analysis	- Milk collectors **+** - Processors **+** - Retailers
For triangulation purpose		**Observation**	**Checklist**		Collection points + Processing units

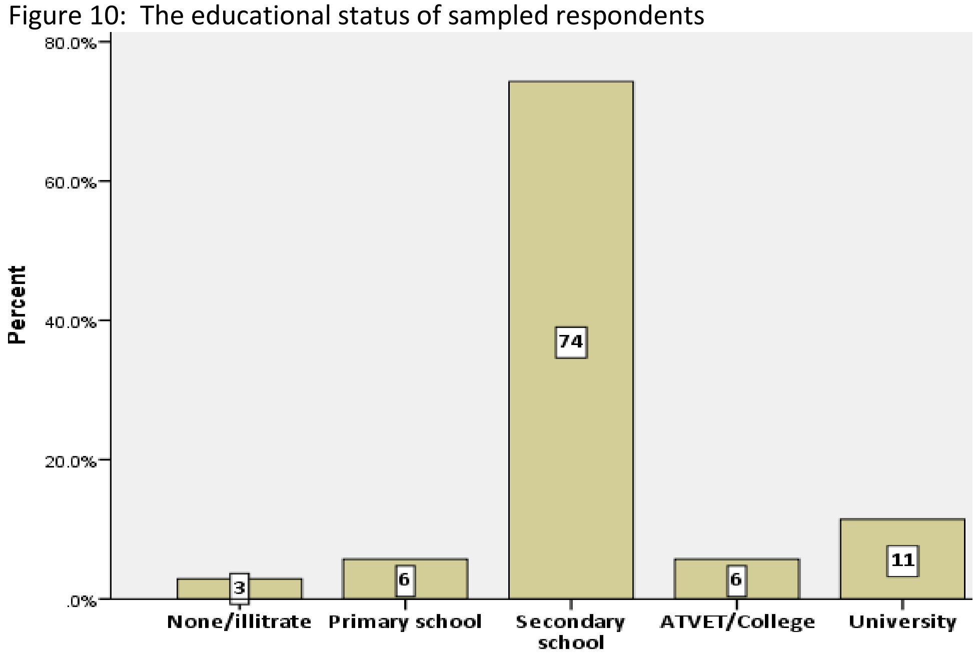
CHAPTER 4: RESULTS

4.1. Household Information

The average age of the sampled respondents (both collectors and processors) was 35 ± 2 years with a wide range of 19 to 65 years old (Appendix 5). The sex ratio of the respondents was equal which means one to one for male and female individuals. It means, in milk collection and processing functions, both males and females are active. It is because milk handling jobs are deliberately given to females that were involved in traditional and cultural milk practices.

As indicated in Figure 10, most of the respondents have attended the secondary school and some university. Besides a few illiterates that worked for a long time and captured the good experience, few college graduates were also interviewed.

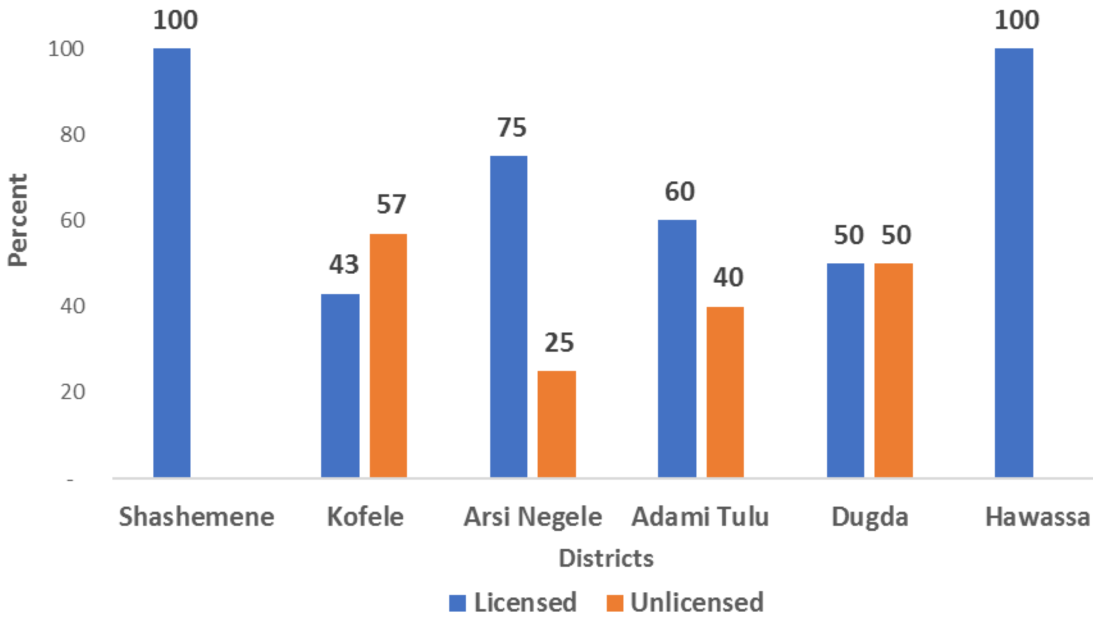
Figure 10: The educational status of sampled respondents



4.2. The proportion of licensed and unlicensed milk collectors and processors

In Ziway-Hawassa milk shed, most of the sampled respondents had a legal license to operate milk collection and processing business. However, in Kofele district unlicensed milk traders were more dominant than licensed collectors. In Dugda district, an equal number of licensed and unlicensed milk collectors were identified. But in Shashemene and Hawassa, all sampled milk collectors and processors were licensed to run their business (Figure 11).

Figure 11: The proportion of licensed and unlicensed milk collectors and processors in the shed



4.3. Reasons for engaging on milk collection and processing business

Most of the milk collectors and processors believed that milk trading is a right way of money-making business in the Ziway-Hawassa milk shed. As indicated in Table 4, 56% of the respondents stated that milk collection and processing is the only source of their income. The remaining proportion of the respondents had other income sources along with milk trading business.

Based on their report, the area has a high potential for milk production, and even the communities have a high demand and habit to purchase and consume milk and milk products. Some respondents also reported that they engaged in milk collection and processing business because of personal interest or hobby and lack of another alternative (Table 4).

Table 4: Income source and reasons for engaging on the business

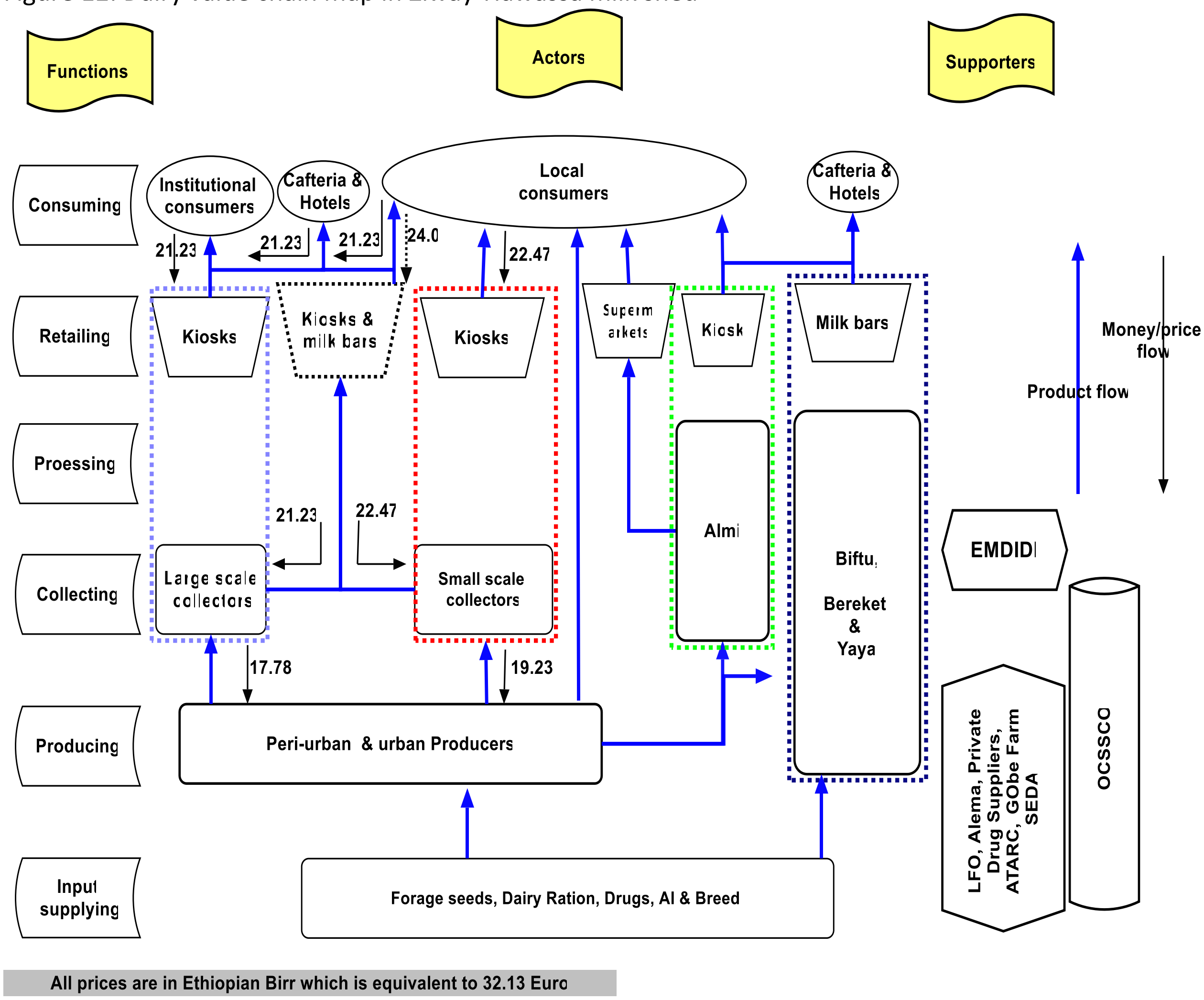
S. No	Parameter	N	Percent
1	**Source of income**		
	Only milk trade	20	56
	Milk and other sources	16	44
	Total	36	100
2	**Reasons for engaging in milk trade**		
	Good money-making business	23	64
	Personal interest	7	19
	No alternative	6	17
	Total	36	100

In the Ziway-Hawassa milk shed, the most extended experience in milk collection and processing business was 21 years. The mean experience of the respondents' working in milk collection and processing activity was 8.2 ± 6.5 (Appendix 5).

4.4. Milk collection and distribution procedures in Ziway-Hawassa milk shed

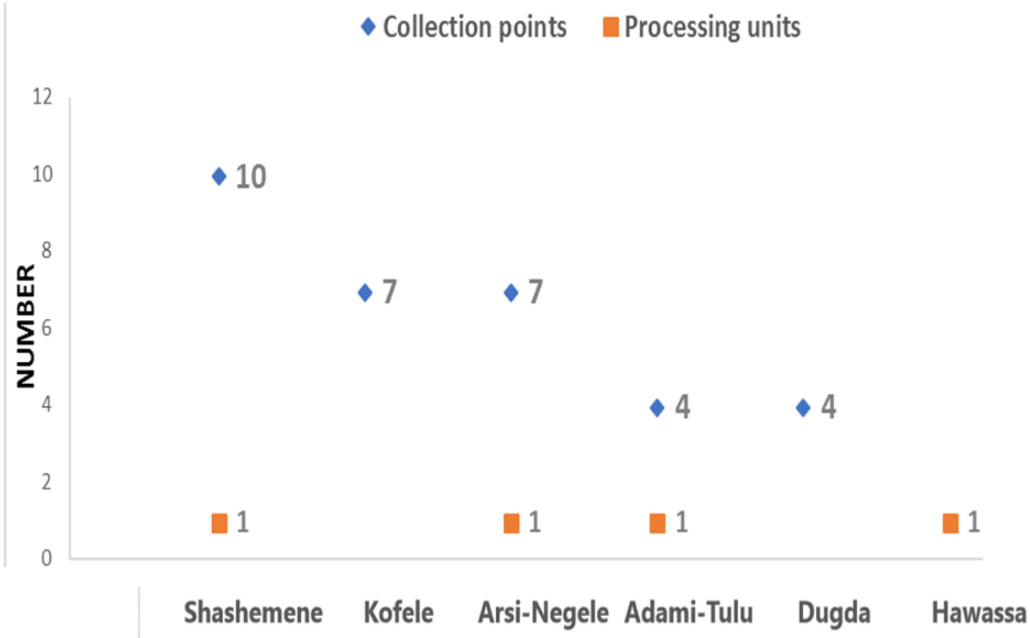
Milk was sourced from urban and peri-urban dairy farmers and then distributed to large and small-scale collectors, processors and consumers. As indicated in Figure 12, processors monopolise the chain starting from milk-producing up to retailing functions. The supports and services of most chain supporters were limited at producers and input suppliers' level. That means there was no strong support for milk collectors and processors. Only Ethiopian meat and dairy industry development institute (EMDIDI) has been provided with some training for very few collectors and processors.

Figure 12: Dairy value chain map in Ziway-Hawassa milk shed



In Ziway-Hawassa milk shed, around 32 milk collection points and four processing units were identified during this field study (Figure 13). Most of the collection points were located at Shashemene town, likely a result of the availability of a high number of consumers and the ideal location of the city between the major potential areas of milk production in Arsi-Negele and Kofele districts. No milk processing units were reported in Kofele and Dugda districts.

Figure 13: Identified milk collection and processing units in Ziway-Hawassa milk shed



Almost all collection points collect milk directly from urban and peri-urban milk producers (Figure 12). Only 3% of the respondents purchased milk from other milk collectors besides producers. Collecting from the same sources lead to unhealthy competition among collectors and could be a cause for high fluctuation of the purchasing price of milk. Therefore, instead of paying attention to quality, everyone cares about quantity.

Milk is transported from producers to collectors and or consumers by carts, on foot or via public transport, and private transportation trucks. Except for few large volume collectors that use their own milk transportation truck, the Bajaj (small three-wheel vehicle) was mainly used for collection of milk within the town. However, across districts like from Arsi-Negele or Kofele to Shashemene, either public or private transportation trucks were used. Some respondents (33%) also indicated that a mixed transportation system (public transport from one area, on-foot from another area and or private truck from somewhere) was used for milk collection (Table 5).

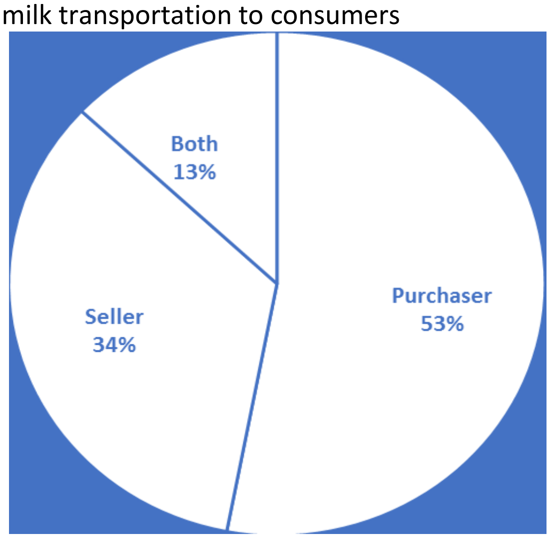
Table 5: Means of milk transportation during collection and distribution

S. No	Means of transportation	During collection		During distribution	
		N	Percent	N	Percent
1	On-foot	9	25	20	55
2	Public transport	3	9	5	14
3	Own transportation truck	12	33	5	14
4	Mixed	12	33	4	11
5	Carts (donkey + horse)			2	5
	Total	36	100	36	100

Within the town, Bajaj was used for distribution of milk to consumers and or retailers which are located somewhat far distance and required a relatively large volume of milk per day. Large volume collectors mainly used their own transportation truck for distribution of milk to institutional consumers such as prisoner's corrective institution, health centres and some known hotels and restaurants. Table 5 shows that 55% of milk collectors distributed milk on-foot to the consumers. Because most collection points have been established near to high population density sites, milk can be purchased throughout the day. Therefore, due to the proximity of consumers, on-foot distribution is most effective and profitable. Moreover, it is an emission-free means of transportation.

As indicated in Figure 14, the purchaser was responsible for the transportation of milk from collection point to his home or institute in the Ziway-Hawassa milk shed. However, collection centres were responsible for the delivery and transportation of milk purchased to some big hotels and institutes, mainly through contract agreements.

Figure 14: Responsibilities of milk transportation to consumers



Milk marketing channel

Since the study focused on the collectors and processors level, a channel that leads to direct flow of milk from producers to consumers was not included. Therefore, three lines of milk pathways were identified throughout the Ziway-Hawassa milk shed. The major route of milk distribution to the consumers in all study districts was Producer → Collector → Consumer (Table 6), because most collectors performed milk collection and retailing functions at the same time and place. On the contrary, the channel that directly connected producers to processors was not common. Moreover, this route was not reported in Adami-Tulu and Dugda districts.

Table 6: The routes of milk distribution to the consumer (Percentage)

Milk distribution routes	Districts					Total
	Shashemene	Kofele	Arsi-Negele	Adami-Tulu	Dugda	
Producer→Collector→Consumer	46	72	67	50	75	62
Producer→Processor→Retailer→Consumer	8	14	17			8
Producer→Collector→Retailer→Consumer	46	14	17	50	25	30
Total	100	100	100	100	100	100

4.5. Relationships among chain actors (Chain governance)

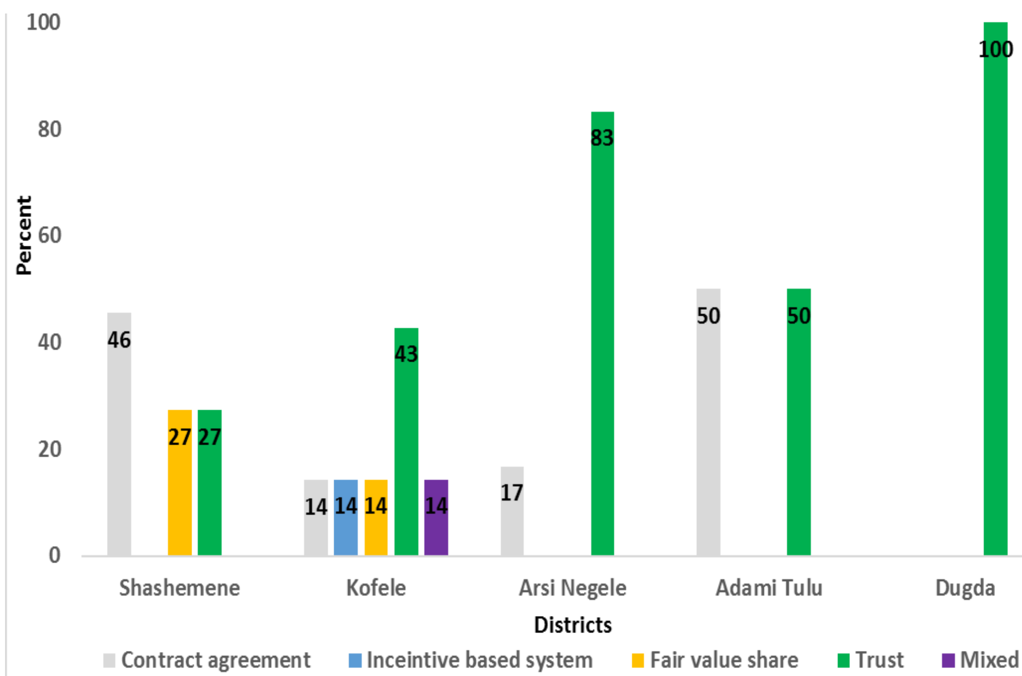
Milk collectors and processors reported different milk procurement strategies that helped to maintain their relations with producers. As indicated in Figure 15, the major strategy used by milk collectors and processors for securing milk procurement was contract agreements, incentive-based system, creating fair value share and maintaining trust. Depending on the interest of the producers and collectors; the type of relationship was determined in the way that creates a continuous supply of milk for collectors and sale for producers including in fasting season at which the demand of animal products dropped.

Creating a fair value share was mainly reported in Shashemene town. Most collection points in this district attracted milk producers by rearranging a way that producers can access concentrate feed for a fair price in near distance and create fair value shares from the collected milk. To simplify the work, collection points have a registration book that has the name of suppliers, amount of supplied milk in every milking session and every 15 days payment was accomplished through the supplier's bank account. This system helps the collection point to control the quality issue and to have a continuous supply of milk.

The incentive-based system was the main milk procurement strategy of milk collectors in Kofele districts. The form of the incentive was either by setting an extra price for suppliers or to maintain the price of the milk during the fasting season. Some respondents in Kofele district also used a mixed strategy according to the interest and nature of the suppliers.

In Arsi-Negele and Adami-Tulu districts, only trust and contract agreement were reported. In Arsi-Negele trust was the major one whereas simple contract agreement was in Adami-Tulu district (Figure 15). In Dugda district, chain relationship was poorly understood and implemented. According to the survey result, the only trust was developed among collectors and producers.

Figure 15: Milk procurement strategies in Ziway-Hawassa milk shed



Even though the quality issue was the big problem in the shed, only few milk collectors practised some test during purchasing. Table 7 shows that 56% of milk collectors applied milk tests during procurement. The remaining proportion of collectors did not test milk quality using adequate equipment. Few of them reported traditional means of quality measurement that is through smelling and visual observation. The main justified reason for the absence of quality measurement materials was due to the financial limitation to purchase it. But, the milk collectors had high interest to have the testing equipment and provide good quality tested milk to their customers.

Table 7: Quality testing practices and decisions for bad milk quality

Parameter		N	Percent
Quality testing practices	Lactometer	12	33
	Lactometer & Alcohol	8	22
	Traditional test	2	6
	No test at all	14	39
	Total	36	100
Decision for bad quality milk	Reject	15	83
	Purchasing with warning/advising	3	17
	Total	18	100

In the Ziway-Hawassa milk shed, the lactometer was mainly used for testing of milk quality at a collection point (Figure 16). Some collection points practised a combined quality testing method (lactometer with alcohol) for a better-quality assurance (Table 7).

Figure 16: Milk collectors checking quality by lactometer at the collection point

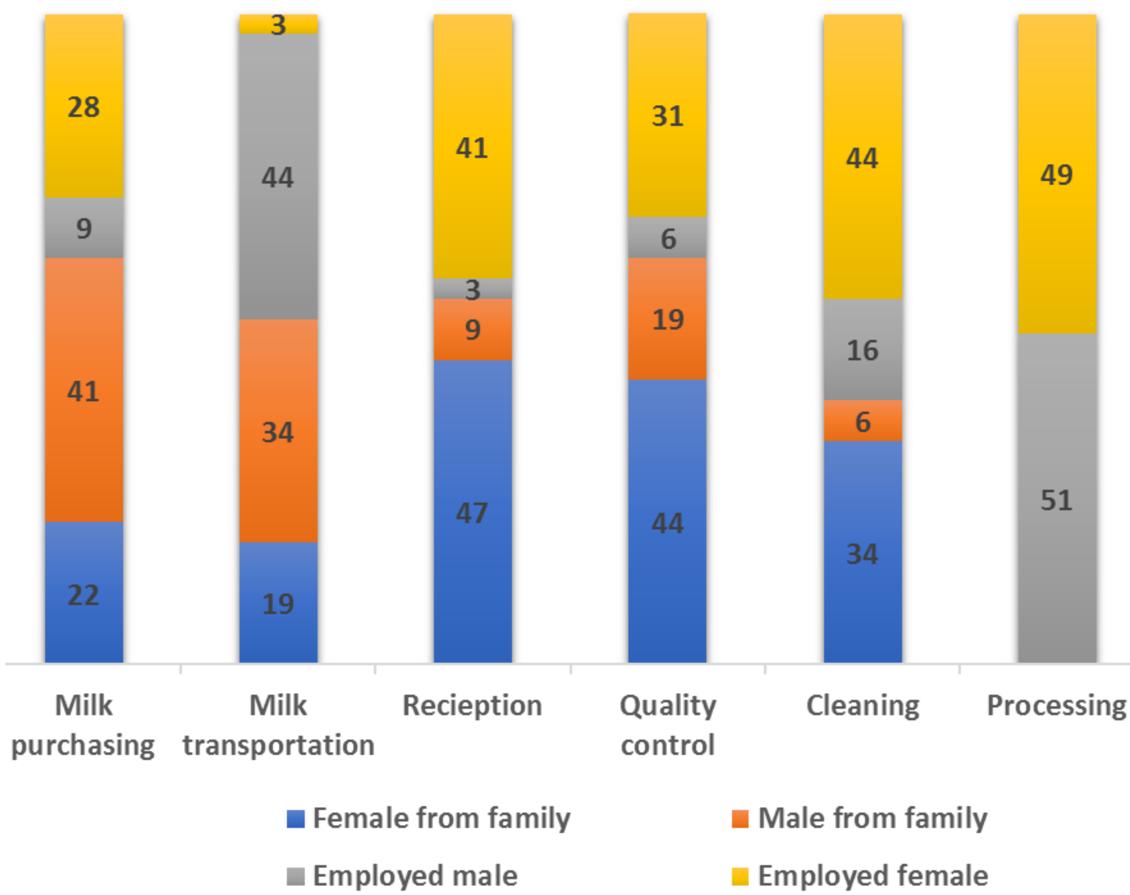
Those who showed quality measurements reported two decisions on their tests. The majority of them (83%) preferred to reject the milk with quality defect (Table 8). Meanwhile, a chance was given to the suppliers to observe their milk quality defects at that moment. On the other hand, some respondents purchased the defected milk by providing a warning or advice to the suppliers, and then the milk would not be used for human consumption; instead for pet animals or added to biogas pits. According to FGD participants, this was done to maintain the established relationship with the suppliers. However, for repeated cases, the suppliers would be registered in the blacklist. If the case happened unknowingly or beyond his control, technical and or financial support was given that could help him/her to solve it. If it was done deliberately and a lack of willingness to improve the quality, it would lead to removal of him/her from the suppliers list.

According to the survey result, 9000 litres of milk per year was spoiled only from 24 milk collection points. On average 375 ± 418 litres of milk was lost throughout the year due to spoilage problem. The amount is relatively high when we consider the actual quantity of milk collected by each collector in the shed.

4.6. The role of gender in downstream dairy value chain

In Ziway-Hawassa milk shed, family labour was more common than employed labour in milk purchasing activity. Notably, the male from the family was given the responsibility to purchase raw milk. Besides, males were mainly assigned for milk transportation activity. According to the focus group discussion participants, milk transportation requires more energy which is the reason why males were assigned to it. Females were more active and dominant in milk reception and selling activities at the collection point. As indicated in Figure 17, either from family or employed, females were principally assigned for milk reception and quality control tasks. The first FGD revealed that milk handling and traditional processing systems were the cultural practices under control of females; that might be a reason for females' dominance. As a result, the community considered females to be very efficient to maintain the quality of milk. Processing of milk was mainly done by using hired labour. Females and males were actively involved in the milk processing functions in Ziway-Hawassa milk shed

Figure 17: Gender involvement in the downstream dairy value chain (Percentage)



Similarly, cleaning of equipment's and the collection points as a whole was also done mainly by female individuals rather than male workers. For cleaning purpose, most collection points used employed female workers (Figure 17). Females were actively involved in the reception, quality control, processing and cleaning activities and played a significant role in maintaining the quality until it reached the consumers. Therefore, females' contribution towards climate-smart practice was highly appreciated by reducing milk spoilage.

4.7. Economic Analysis

4.7.1. Average purchasing and selling price of milk

The average purchasing and selling price among large- and small-scale collectors showed the same trend. That means in both cases small-scale collectors purchased and sold by a higher price than large scale collectors. The mean purchasing price per litre of milk for large scale collectors was 17.78 ± 2.0 Ethiopian Birr (ETB) and 19.23 ± 2.1 ETB for small-scale collectors (Table 8). But, the means were not significantly different between the two clusters (P>0.05).

Table 8: Average milk purchasing and selling price

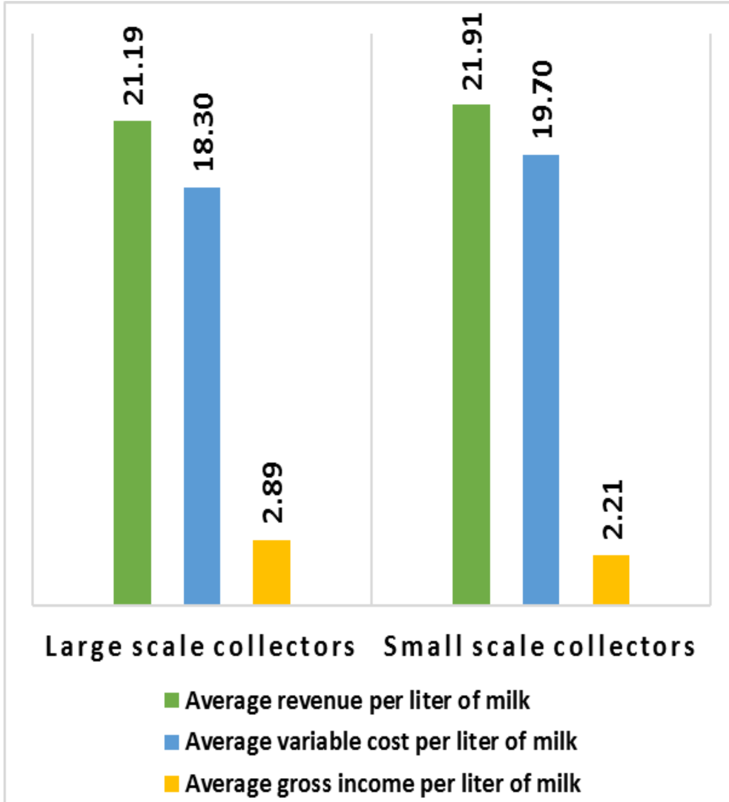
S. No	Parameter	Large scale collectors	Small scale collectors	P-Value
		Mean ± Std. deviation	Mean ± Std. deviation	(CI = 95%)
1	Purchasing price/liter	17.78 ± 2.00	19.23 ± 2.10	0.06
2	Selling price/liter	21.23 ± 1.70	22.47 ± 2.04	0.07
3	Transportation, labor and related costs/liter	0.53 ± 0.43	0.49 ± 0.53	0.82

Milk collectors have also expenses related to transportation, labour, detergents, electricity and water fee. The mean of these costs is dependent on the collected volume of milk and efficient arrangement of a transportation facility. Therefore, large scale collectors had 0.53 ± 0.43 ETB per litre of milk which was not statistically higher than the cost of the small-scale collector (Table 8).

4.7.2. Revenue and total variable cost

The revenue generated by large scale collectors from a litre of milk was slightly lower compared to that of small-scale collectors. Even though small-scale collectors had a better revenue, their gross income per litre of milk was inversely lower compared to large scale collectors, because small-scale collectors had higher average variable costs per litre of milk than large scale collectors (Figure 18).

Figure 18: Average revenue and gross income of milk collectors



4.7.3. Gross margin, added value and value shares

All the downstream chain actors had the same cost items such as transportation, labour, water and electricity, detergents and government taxation costs. Moreover, processors had extra processing and packaging costs. For large- and small-scale collectors, the average value of costs was considered for further analysis as indicated in Table 9.

Table 9: Average cost and selling price of milk and milk products

Items (measured ETB/ litre)	Collectors	Processors	Retailers
1. Purchasing price of			
- Fresh Milk	18.50	18.50	21.85
- Pasteurized milk			28.00
- Yoghurt			34.00
- Butter			221.3
2. Processing & packing cost		2.00	
3. Transport cost	0.16	0.32	0.15
4. Labor	0.25	0.45	0.12
5. Cost of electricity, water, detergent & tax	0.10	0.28	0.10
Total Cost price/unit			
- Fresh milk	19.01		22.22
- Pasteurized milk		21.55	28.37
- Yoghurt		21.55	34.37

- Butter (10-liter milk = 1 kg of butter)		215.5	221.67
Sale Price/unit			
- Fresh milk	21.85		24.00
- Pasteurized milk		28.00	30.00
- Yoghurt		34.00	47.00
- Butter		221.30	225.00

In Ziway-Hawassa milk shed, processors carried out two chain functions which were collecting and processing tasks, and they had the same purchasing costs as collectors for fresh milk. Since this study focused on the downstream dairy value chain actors, the producers cost price was obtained from the member of the project team who focused on the producer's level. Therefore, this data was used to estimate gross margin and value share of producers and downstream chain actors.

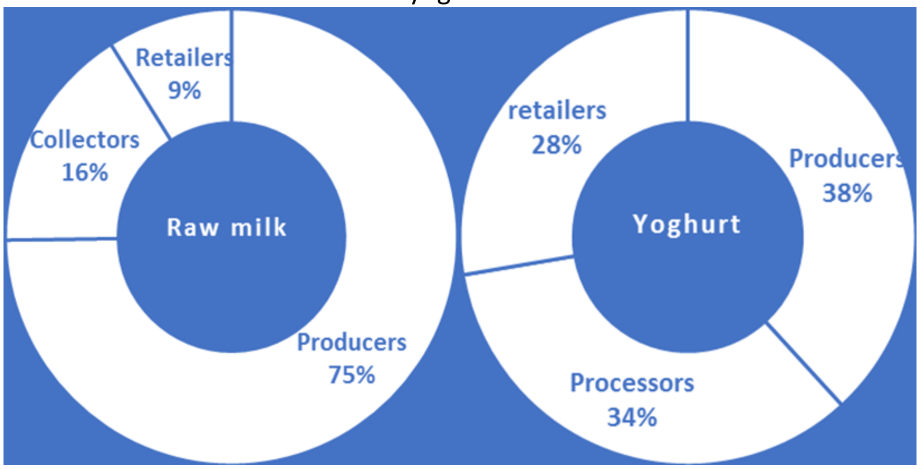
Gross margin and value shares of chain actors varied among the different milk products. In pasteurised milk and yoghurt, processors had the highest gross margin compared to other chain actors. However, value addition and share were higher for producers (Table 10).

Table 10: Gross margin and value shares of dairy value chain actors

Products	Actors	Cost price	Sale price(revenue)	Gross income	Added value	% Gross margin	% Value share
Fresh Milk	Producers	16.69	17.95	1.26	17.95	7.02	74.79
	Collectors	19.01	21.85	2.84	3.90	13.00	16.25
	Retailers	22.22	24.00	1.78	2.15	7.42	8.96
Pasteurized milk	Producers	16.69	17.95	1.26	17.95	7.02	59.83
	Processors	21.55	28.00	6.45	10.05	23.04	33.50
	retailers	28.37	30.00	1.63	2.00	5.43	6.67
Yoghurt	Producers	16.69	17.95	1.26	17.95	7.02	38.19
	Processors	21.55	34.00	12.45	16.05	36.62	34.15
	retailers	34.37	47.00	12.63	13.00	26.87	27.66
Butter	Producers	166.9	179.50	12.60	179.50	7.02	79.78
	Processors	215.5	221.30	5.80	36.30	2.62	16.13
	Retailer	221.67	225.00	3.33	3.70	1.48	1.64

The producer's value share in all products was higher than the other actors. As indicated in Table 10, collectors had a low-value share (16%) but a better gross margin (13%) than producers in raw milk, whereas producers had 74.79% value share and only 7.02% gross margin. Vale share for yoghurt was distributed in a proportional manner among producers, processors and retailers (Figure 19)

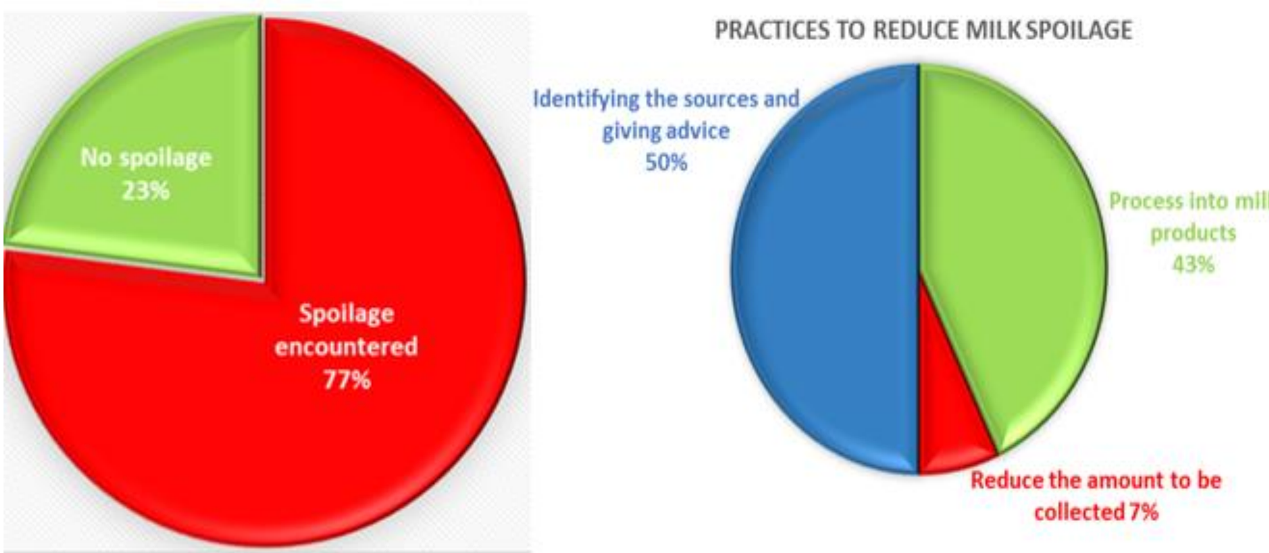
Figure 19: Value share of actors in raw milk and yoghurt



4.8. Common climate-smart practices of milk collectors and processors

To reduce milk spoilage, some respondents performed different activities like converting excess milk into milk by-products, identifying the sources of the spoilage and treating it accordingly, and others also took an alternative to reduce the amount of milk to be purchased during fasting season (Figure 20). But, reducing the purchasing amount of milk affects the future relations with the supplier.

Figure 20: Occurrence of milk spoilage (left side) and practices against it (right side)



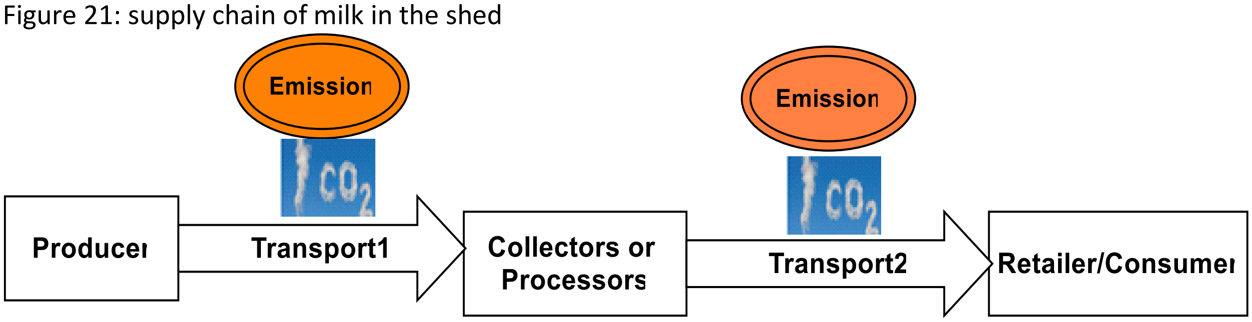
FGD participants revealed that some milk collectors had advised their milk suppliers to cultivate and feed improved forage to milking cows instead of purchasing costly dairy rations. In connection to this, they acted as an extension worker and involved themselves in bringing forage seeds. Some large-scale collectors and processors cultivated trees in the surrounding of their collection and processing units by aiming to tackle climate change. Maintaining the quality of milk until it reached final consumers was a common practice by a few milk collectors. This was mainly done to escape from loss due to spoilage other than caring for climate change. During observation of the collection and processing units, the following activities were identified. Proper waste disposal (converting spoiled milk into biogas) was practised by one large scale milk collector and processor. Improving the safety of the environment by practising appropriate water waste disposal was reported by Almi fresh milk and milk products processing unit. Some collectors and all processing units had safety tanks for collection and disposal of the liquid waste drawn from its centres.

Efficient utilisation of power was one of the best climate-smart activities practised by milk collectors and processors. In Ziway-Hawassa milk shed, switching off power in unnecessary time was practised by the majority of respondents (87%) (Appendix 6). This was not only aiming at reducing the effect of climate change but also to reduce expenses requested by the electric source supplier. In one way or the other, it is a good and climate-friendly activity adopted and practised by the respondents.

4.9. Greenhouse gas emission by milk collectors

Milk collectors emit greenhouse gas throough transport and cooling machines. As indicated in Figure 21, transport was used in two phases along the supply channel milk. The first one was used (transportation 1) to collect raw milk from producers to collection points, whereas the second was used for distribution from collection points to retailers and or consumers. Therefore, estimation of a carbon footprint from transport considered this situation.

Figure 21: supply chain of milk in the shed



4.9.1. Types of vehicles, volume of collected and distributed milk

In the Ziway-Hawassa milk shed, almost the same types of vehicles were used during the collection and distribution of milk. Chilled transportation was not reported in the shed. The type of vehicles used for transportation of milk was mainly minibuses and Bajaj (Table 11). Some milk collectors had their own minibus that was used for milk transportation by detaching the chair (that is called milk car), whereas others used minibuses along with public transport. Accordingly, the milk car was used for transportation (collection) of 1,650,740 litres of milk. To collect this high volume of milk, the milk cars travelled a total distance of 120,484 km per year. Similarly, the milk car was also reported for the distribution of high volume of milk.

Table 11: Total travelled distance and collected volume of milk in the shed

Source	Vehicle type	Total distance travelled (km)/year	Total milk transported or collected (ltr)/year
Transport1	Public transport (minibus)	75,816	130,000
	Milk car (Minibus)	120,484	1,650,740
	Isuzu	6,240	41,600
	Bajaj	26,718	615,888
	Motor	728	13,104
	Sum	**154,170**	**2,451,332**
On-foot collected milk (ltr)/year			539,812
Sum (ltr of milk collected)/year			**2,991,144**
Transport2	Public transport (minibus)	114,660	315,764
	Milk car (Minibus)	23,244	871,192
	Bajaj	3,099	144,528
	Sum	**141,003**	**1,331,484**
On-foot and carts (donkey + horse) distributed milk/year			1,650,660
Sum (ltr of milk distributed)/year			2,982,144

Annually, in the Ziway-Hawassa milk shed a total of 2,991,144 litres of milk was collected with emission based transportation (2,451,332 litres) and emission-free means of transport (539,812 litres) (Table 11). In the milk distribution phase (transport 2), annually 1,331,484 litres of milk was distributed through emission-based means of transportation. Unlike milk collection, the milk distributed through emission free means of transportation was higher than emission-based means of transportation.

4.9.2. Utilization efficiency of Vehicles

Vehicles used only for milk transportation purpose were considered in the estimation of utilisation efficiency. But, vehicles used for transportation of milk with public or other items were not included in this efficiency estimation.

Not all collectors did use the full loading capacity of the vehicles during milk collection and distribution phases. However, a better loading efficiency was reported by large scale collectors. They utilised milk cars up to 30% of their loading capacity, but it was only 9% for small-scale collectors (Table 12). Using less loading efficiency of vehicles leads to the increase of carbon footprint per litre of milk.

Table 12: Average loading efficiency of vehicles in Ziway-Hawassa milk shed

S. No.	Vehicle type	Large scale collectors		Small scale collectors	
		N*	Average loading efficiency (%)	N*	Average loading efficiency (%)
1	Milk car	8	30	4	9
2	Bajaj	5	74	10	10
3	Motorbike			1	72

N* is the number of vehicles

4.9.3. Carbon footprint of milk during collection (Transport 1)

Carbon footprint was estimated from total milk collected per year and fuel consumed by the vehicles during milk collection. A total of 2,169,440 litres of milk collected by large scale collectors and to do that 20,566 litres of diesel and gasoline type of fuel was consumed. Large- and small-scale collectors together contributed a sum of 79,757 kg of CO_2 to the environment per year (Table 13).

Table 13: Carbon footprint of milk during collection

S. No	Collectors	Total volume of milk collected (ltr)/year	Total fuel consumed for collection (ltr)/year	Total CO_2 emission (kg)/year
1	Large scale collectors	2,169,440	20,566	49,886
2	Small scale collectors	281,892	11,898	29,871
	Sum	2,451,332	32,463	79,757

Table 14 shows that the mean carbon footprint per litre of milk was significantly different between large scale collectors and small-scale collectors ($P<0.05$). Therefore, small-scale collectors contributed higher carbon footprint per litre of milk than large scale collectors.

Table 14: The estimated mean of carbon footprint per litre of milk

Collectors	Mean ± Std. Deviation	P-value (CI = 95%)
Large scale collectors (N=13)	.021 ± .020	.044
Small scale collectors (N=15)	.089 ± .115	

4.9.4. Carbon footprint of milk during distribution (Transport 2)

As indicated in Figure 14, milk was mainly distributed by purchasers. However, some collectors were responsible for the transportation and distribution of milk to some customers especially for institutional consumers and large volume retailers through vehicles. Therefore only 13 collectors were considered for estimation of carbon footprint in the distribution phase (transport 2). To distribute 1,331,484 litres of milk annually, 76,508 kg of CO_2 was released to the environment (Table 15).

Table 15: Greenhouse gas emission during milk distribution

Total volume of milk distributed (ltr)/year	Total fuel consumed for distribution (ltr)/year	Total CO2 emission (kg)	Average CO_2 (kg)/ltr of milk
1,331,484	31,554	76,508	0.06

4.9.5. Carbon footprint from cooling machine

Besides transportation, cooling facilities also contributed to carbon footprint through power utilization. All collection points used only electric sources for their power requirement; no one had reported a generator.

Utilization efficiency of cooling machine

Efficient utilisation of cooling machines can reduce carbon footprint per litre of milk. Most large-scale collectors used a relatively high number of medium-sized refrigerators. On average large-scale collectors utilised their cooling machines up to 46% of its holding capacity (Table 16). However, small-scale collectors preferred and mostly used low size refrigerators with the utilisation efficiency of 11%.

Table 16: The utilisation efficiency of cooling facilities

Size (number of refrigerators)	Large scale collectors		Size (number of refrigerators)	Small-scale collectors	
	N	Efficiency (%)		N	Efficiency (%)
250 liters (3)	3	44	250 liters (12)	10	11
500 liters (23)	5	50	500 liters (3)	3	6
2000 liters (2)	2	45			
Average efficiency		46			9

The carbon footprint of milk from collectors' cooling machines was estimated through energy consumption (Kwh) utilised per year. The refrigerators of large-scale collectors were used for cooling of 1,228,955 litres of milk throughout the year. This, in turn, printed a total of 9,915 kg of carbon to the environment annually (Table 17). Similarly, small-scale collectors contributed 1,547 kg of carbon to the environment.

Table 17: The Estimated carbon footprint of milk from cooling machine

Collectors	Total amount of milk cooled (ltr)/year	Total energy utilised (Kwh) /year	Kg of CO_2 emitted/year	Kg of CO_2 emitted/litre
Large scale collectors	1,228,955	76,268	9,915	0.0081
Small scale collectors	187,610	11,898	1,547	0.0083
Sum	1,416,565	88,166	11,462	0.0081

In general, in Ziway-Hawassa milk shed a total of 167, 727 kg of carbon footprint was contributed by milk collectors in the collection, distribution and cooling of milk (Table 18).

Table 18: Summary of carbon footprint released by milk collectors

Sources of emission	Total Kg of CO_2/year	Kg of CO_2/liter of milk
Collection of milk (Transport 1)	79,757	0.056
Distribution of milk (Transport 2)	76,508	0.060
Cooling of milk (Electric)	11,462	0.008
	Sum = 167,727	Mean = 0.041

4.10. Greenhouse gas emission by processors

The survey identified four milk processors, one was relatively big, and the other three were small-scale processors. The products processed by all processors were butter, yoghurt and cottage cheese. The small-scale processors used locally made electrical churner machine (Figure 22) and the cottage cheese was prepared by using firewood. Carbon footprint was estimated for processors based on two sources being electrical power and fuel used in generators. Due to information limitation, allocation of energy for each processed product was not possible, and estimation of carbon footprint per product was not carried out in this study.

Figure 22: Milk churner machine used by small-scale processors

Carbon footprint from electric and generator sources

Almi-fresh milk and milk product processing centre is one of the modern milk processing units in the shed and process a relatively large volume of milk per day. Even though this processing unit processed a variety of products, the biggest proportion of the collected milk was allocated to pasteurised milk and yoghurt. The price of these two products is affordable; they have a high demand by almost all types of consumers. The other products were mainly demanded by institutional consumers like hotels and pizzeria houses. Therefore, for the processing of milk and milk products, Almi utilised 475,373 kWh energy from the electric source. As a result, a total of 61,799 kg of carbon footprint per year was made by this processing unit (Table 19).

The other three small-scale processors used relatively low amounts of energy. Initially, they were collectors and retailers of milk, but through time processing started to save unsold milk from spoilage. As indicated in Table 20 from electric source Bereket, Yaya and Biftu milk processing units contributed 3043, 2257 and 908 kg of carbon per year respectively.

Table 19: The estimated carbon footprint of milk from processing units

Processing unit	From electric source		From generator source	
	Energy consumption (kWh)/year	Kg of CO_2 emitted/year	Fuel consumption (ltr)/year	Kg of CO_2 emitted/year
Almi	475,373	61,799	91,104	220,472
Bereket	23,407	3,043	769	1,860
Yaya	17,358	2,257	2,197	5,316
Biftu	6,987	908		
Sum	523,124	68,006	94,069	227,648

Except for Biftu, the other milk processing units had a generator as a reserve for electric power interruption. Since Almi fresh milk and milk product processing unit is a relatively big factory, a high-power generator that can adequately supply the required power for the machines was used. Therefore, the generator consumed a huge quantity of fuel per hour and caused an emission of 220,472 kg of carbon footprint per year. In general, at processors level a total of 295,654 kg of carbon footprint from both electric and generator sources was emitted to the environment per year (Table 18). The average carbon footprint emitted for processing of a litre of milk was found to be 0.16 kg (Table 20).

Table 20: Carbon footprint released for processing of litre of milk

S. NO.	Processors	Total volume of milk processed/year	Total Kg of CO_2 emitted/year	Kg of CO_2 emitted/ to process a litre of milk
1	Almi	1,328,600	282,274	0.21
2	Bereket	273,000	4,903	0.02
3	Yaya	182,000	7,573	0.042
4	Biftu	67,704	908	0.01
	Sum	1,851,304	295,658	mean- 0.16

4.11. Roles and contributions of collectors and processors for sustainability of the chain

As indicated from the chain map, the downstream chain actors had multiple roles. The roles of most large-scale collectors practised in a better way that can contribute to chain sustainability (Table 21).

Table 21: Roles and contributions of collectors and processors for the sustainability of the chain

Actors	Roles in the chain	Contributions for sustainability (3P)
Large scale collectors	Milk collection, retailing and supporting their milk suppliers	**People**: - Most large-scale collectors present relatively quality tested milk in a fair selling price for consumers. Also, they have established firm relations with producers. Creates a job for a considerable number of males and females **Planet**: - Better utilisation efficiency in cooling machine (46%) and vehicles, and emits low carbon footprint/ litre of milk (0.021 kg) **Profit**: - Generates a better gross income (ETB 2.89 / litre of milk), had relatively lower average variable cost (ETB 18.30/liter of milk)
Small-scale collectors	Milk collection and retailing	**People**: - Most small-scale collectors had no milk quality testing equipment, and even some of them were unlicensed traders that distributed inferior quality milk to the consumers. They interrupt uptake of milk during fasting season. No or little job creation **Planet**: - Inefficient utilisation of cooling machine (9%) and vehicles. Moreover, the contribution of carbon footprint to the environment was higher (0.089 kg of CO2/liter) **Profit: -** Generates relatively low gross income per litre (ETB 2.21/ litre of milk). They had no stable purchasing and selling price of milk throughout the year. Higher variable cost/ litre of milk (ETB 19.70)
Almi-fresh milk and milk products processing unit	Milk collection, processing, distribution, retailing and supporting its suppliers	**People**: - Presents a variety of processed quality milk and milk products, creates a job for 32 male and 28 females. Have long relations with producers **Plane**t: - Emitted relatively a huge carbon footprint (on average 0.21 kg of CO_2 to process a litre of milk). Used proper waste disposal tanks. Cultivated dense forest in the surrounding of the processing unit by aiming climate change **Profit**: - Generates ETB 6.45 and 12.45 / litre of pasteurised milk and yoghurt respectively. Even the gross margin was higher than from producers and retailers.

Biftu, Bereket and Yaya milk processing units	Milk production collection, processing, retailing and supporting its suppliers	**People**: - Presents good quality products for local consumers, creates a job for some persons (up to 9 persons per unit & gender inclusive), **Planet**: - Contributes a low amount of carbon footprint (on average 0.024 kg of CO_2/liter of milk). Converting spoiled milk and milk products into biogas **Profit**: - The gross income and margins were the same as Almi.

4.12. Constraints of milk Collectors and processors

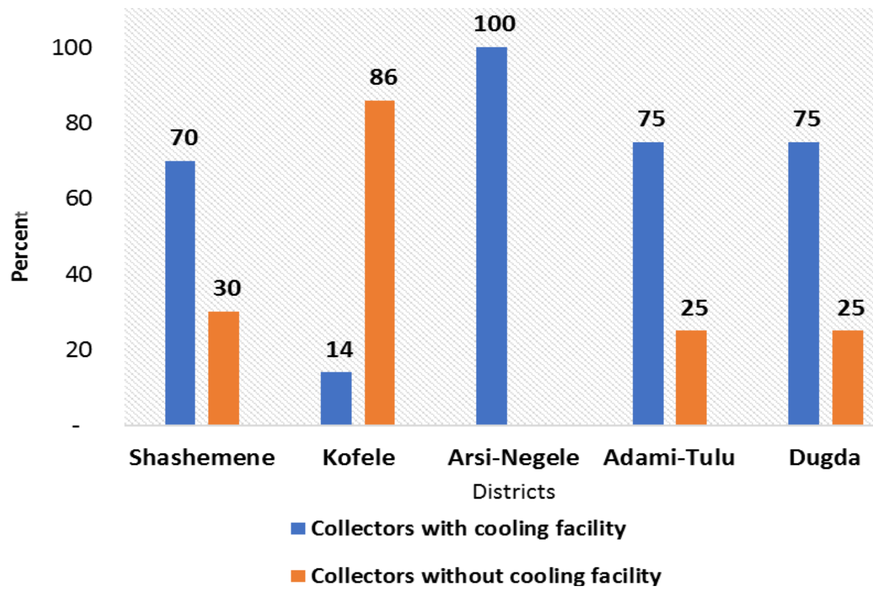
According to the FGD participants, milk quality in the shed was inferior and risk full for human consumption. Almost half of the milk collectors did not have any quality control equipment. Milk was sold along the road for any consumers who want to purchase it. Especially some milk traders in Kofele district brought milk to Shashemene with public transport and sold it at roadsides like non-perishable solid commodities.

FGD participants confirmed that there was no chilled transportation system throughout the milk shed. Besides, some collection points had no cooling machines, and it could be a cause for the rise of spoiled milk quantity. The participants also revealed that most producers are located in the rural side where road accessibility lacks and which makes the milk collection system very difficult.

The same to FGD participants, the survey also indicated that milk spoilage was common in Ziway-Hawassa milk shed. Most of the respondents (77%) showed that milk spoilage was their common problem (Figure 20). According to the FGD participants, on average once per month a certain quantity of milk has spoiled at the collection point.

There were many factors stated as a reason for the spoilage of milk in the shed. Poor hygienic practices during milking, transportation and storage, and weak market linkage took the lion share for the causes of spoilage. Notably, in the fasting season, selling of animal products becomes very difficult, and it leads to spoilage of milk and milk products. Also, the high-power interruption was one of the reported causes for high milk spoilage in the shed. Financial problems and accessibility of low volume of milk were reported as a major reason for absence of cooling machines at collection points. The communities preferred to consume fresh and raw milk rather than processed milk products. Therefore, most of the time low volumes of milk would be collected by some collectors and sold it freshly to the consumers. In Kofele district, most collectors did not have a cooling machine. Along with the financial shortage, they reason out that the area is too cold and no need of the cooling machine. But, in Arsi-Negele, all sampled respondents had cooling machine unlike the other districts (Figure 23).

Figure 23: Availability of cooling facilities at collection points



Most chain supporters did not address their services and inputs to milk collectors and processors. According to FGD participants, the input, service and training providers of the dairy chain in the shed always focused on producers' level only. In a rare case, few known collectors and processers received training from EMDIDI. Small-scale processors used inefficient wooden made churning machines. During the churning process, it leaks milk to the ground, and even the fat molecule spreads on the edge covering part of the machine (Figure 22). For the production of a kilo of butter or cheese, a high quantity of raw milk was needed.

PESTEC analysis of milk collector and processors

In the Ziway-Hawassa milk shed, milk trading and processing activities were influenced by many political, economic, social, technical, environmental and cultural factors (Table 22). FGD participants and some interviewer respondents from milk collectors and processors suggested possible solutions for sustainable improvement of milk trading and processing business in the shed.

Table 22: PESTEC analysis

PESTEC	Constraints	Suggested solutions for improving sustainable milk trading and processing business
Political	Lack of land for expansion and long bureaucracy to get permission	Starting from rearranging suitable land, a genuine support from districts municipality may encourage milk collectors and processors
	Unfair and high taxation	Tax should be determined according to the real working capital of collectors/processors. Government should focus and revise exaggerated taxes loaded on collectors and, promote on-time auditing
	Late auditing system	
	Ethnic-clash and political instability	

	Weak control for illegal traders and milk quality from gov.t bodies	Decentralizing the EMDIDI to districts level may help to control illegal milk traders actively, and detect the quality problem.
	Absence of strong supports for milk collectors and processors	Establishing robust linkage with research institutes and Universities will enrich and empower them through the provision of services and inputs
Economical	High price fluctuation	Controlling illegal traders and establishing contract agreement is advisable to have stable price of milk
	Poor market linkage	Establishing links to areas where demand is high throughout the year (Muslim dominated area).
	Imbalance of demand and supply	Encouraging farmers through awareness creation, grouping and strengthen producer's capacity, encouraging investment on dairy farming
	Finance limitation for expansion and purchasing of the cooling machine	In-kind support from any NGOs and Government body may be better for encouraging and strengthen collectors and processors capacity
	Shortage & expensiveness of packing materials, inputs & machines spare parts	Allowing free or low levy for the importation of this spare parts and expensive inputs is expected from Government body
	Quality problem	Improve quality-test and awareness of chain actors through training about hygienic practices
Socio-cultural	Poor awareness of milk hygiene, transportation and handling	Knowledge supporters like Universities, ATVET colleges, and research institutes may revise and update their supports into more practical based training
	Lack of practically trained manpower for processing	Universities and any NGOs may involve in providing practical oriented short-term training that can effectively improve the capacity of professionals
	Poor linkage with suppliers	Building and maintaining trust should be considered
	High raw milk consumption habits	
	Long fasting period in Orthodox religion followers	
Technological	Lack of chilled transportation facility	Supporting modern milk transporting system and processing equipment by grouping collectors may be expected from Gov.t
	inefficient processing machine	
	Inappropriate milking and transporting material	Presenting milking and transporting equipment at a fair price for producers is recommended, e.g. mazy gun, milk can
	Plastic collection tanks	Low or levy-free importation of milk cans, quality testing equipment's and related stuff is a solution
	Limited quality testing tools	
	Power and water supply interruption	
Environmental	High temperature in some parts of the year	Establish a cold chain in the group will be better to maintain the quality

4.13. Proposed business models

CANVAS business model was used as a participatory tool to understand the current business models practised by milk collectors and processors. Based on the findings of the survey and FGD, some items were included in the existing business models. The newly incorporated items would help the milk collectors and processors to make their business more efficient and climate-smart. The red coloured was used to differentiate the new items proposed to the business CANVAS (Figure 24 and 25). According to the current business models, collectors contributed on average 0.041 kg of carbon footprint per litre of milk from collection, distribution and cooling practices (Table 18). But, if the collectors would adopt the proposed business model, the emission per litre of milk will be reduced to 0.029 kg of CO_2. Because the new CANVAS was developed from the perspective of large-scale collectors that have a better contribution for chain sustainability (Table 21). Therefore, the CANVAS will also improve their incomes since quality improved and spoilage or loss will be reduced.

Figure 24: Proposed Business CANVAS for collectors

Key Partners

- EMDIDI
- Livestock and fishery office
- Adami-Tulu research center
- Hawassa university
- Cooperative office
- Municipality office

Key Activities

- Milk collection
- Milk transportation
- Milk distribution

Key Resources

- Collection centre (chilling tank)
- Truck
- Quality testing tools
- Skill manpower

Value Propositions

- Quantity & Quality Milk (free from contamination, bad bacteria)

Customer Relationships

- Maintain milk quality
- Fair pricing
- Customer loyalty
- Transparency
- Contract agreement (quality & quantity)

Channels

- Processing centre
- Collection point
- Retailers shop

Customer Segments

- Milk processors
- Local consumers
- Milk retailers
- Institutional consumers

Cost Structure

- Transportation truck (fuel + driver)
- Milk purchasing
- Electric & water charge
- Labor

Revenue Streams

- Milk sale

Social & Environmental Cost

- Carbon footprint (0.029 kg CO2/liter)

Social & Environmental Benefit

- Low carbon footprint/ltr of milk (0.041 →0.029)
- Utilization efficiency of vehicles increased
- Utilization efficiency of cooling machine increase (at least from 9% →46%)
- Job opportunity generated
- Environmental safety increase
- Safe milk for consumption, health

Figure 25: Proposed business CANVAS for milk processors

Key Partners

- EMDIDI
- Livestock and fishery office
- Adami-Tulu research institute
- Hawassa university
- Municipality office

Key Activities

- Transporting raw milk
- Milk Processing
- Distributing products

Key Resources

- Chilled transportation truck
- Processing unit
- Quality testing tools
- Skilled manpower

Value Propositions

- Pasteurized milk
- Pasteurized yoghurt
- Cheeses
- Butter

Customer Relationships

- Maintain products quality
- Fair pricing
- Customer loyalty
- Transparency
- Contract (with quantity & quality)

Channels

- Processing centre
- Retailers shop

Customer Segments

- Hotels
- Pizzerias houses
- Retailers
- Supermarkets
- Institutional consumers

Cost Structure	Revenue Streams
- Transportation cost - Raw milk purchasing cost - Processing cost - Electricity and water fee, labour	- Processed products sale

Social & Environmental Cost	Social & Environmental Benefit
- Carbon footprint (to process a litre of milk 0.16 kg of CO_2 released)	- Job opportunity generated

CHAPTER 5: DISCUSSION

5.1. Milk collection and distribution procedures

In Ziway-Hawassa milk shed, almost all collection points collect milk directly from milk producers (Figure 12). Only 3% of respondents purchased milk from other milk collectors besides producers. The major portion of milk was transported by using vehicles. In line to this report, a study in Pakistan showed that milk collectors used vehicles to collect milk from the farmers, so producers supply milk directly to the people in the vehicle (Raheem, 2010). In Ziway-Hawassa milk shed, on-foot and carts (donkey + horse) were also common means of milk transportation (Table 5). Similarly, in the Central highland of Ethiopia both in rural and urban areas, different means of transportation were reported. Consequently, most (90%) milk transporters used on-foot and or horse or donkey, sometimes bicycles are used too (Vernooij et al., 2010). In Ziway-Hawassa milk shed, all collectors distributed milk directly to retailers and or consumers. In contrast to this, Ongaro (2012) in Kenya reported that most milk collectors collect and sell milk to processors and sometimes to other traders. Only a few collectors sold the collected milk directly to consumers.

In the current milk shed, milk processors controlled the chain starting from milk-producing to retailing functions. All milk processors had milk and milk product retailing shops (Figure 12). In agreement to this report, FAO (2017) reported that some processors in and around Addis Ababa have also established their own retail outlets at strategic urban centres. In the present study, pasteurized milk, butter and yoghurt were the dominant products processed by milk processors (Table 10). Likewise, in and around Addis Ababa, the small-scale processors produced and sold principally two types of products being butter and yoghurt (Kitaw et al., 2012).

5.2. Relationships of chain actors' and milk quality measurement

For the sake of continuous supply of milk, collectors and processors have devised different mechanisms with producers. In the central part of Ethiopia, particularly Wolmera and Ejere districts, written contract agreement, trust-based relationship and benefit from profit share were developed and used by milk sellers and buyers (Amentae et al., 2015). In line with this report, the current study identified four types of strategies that were used in the milk procurement procedures and helped to maintain the existing relationships between collectors and producers, such as a simple contract agreement, incentive-based system, creating fair value share and building trust (Figure 15).

According to Drost and Van Wijk, (2011) in Oromia region and Southern part of Ethiopia, hardly any formal contractual agreements exist between milk collectors and producers. Everything was based on trust, and there was no formal contractual agreements and advanced payments. However, in the current study, a simple contract agreement was reported as a main milk procurement strategies of milk collectors particularly in Shashemene and Adami-Tulu districts (Figure 15). The contract agreement used by milk collectors and producers in Ziway Hawassa milk shed lacks the quantity and quality information. This form of agreement promotes side selling during high demand season when the price goes up. In Addis Ababa milks hed, mainly Wolmera district, milk collectors have formal contract agreement and made payment for milk producers either every two weeks or sometimes on a monthly basis (Kitaw et al., 2012). Similarly, in Shashemene district, to create a fair value share, milk collectors were making a payment every two weeks to their suppliers. Likewise, Vernooij et al., (2010) reported that in Central Highlands of Ethiopia notably peri-urban area, most milk collection centres pay their suppliers every two weeks by the already settled agreements.

In Addis Ababa milk shed, all actors engaged in milk collection and processing conduct at least one or more types of milk quality analysis (adulteration test, microbial contamination test and milk compositional test) during the buying and selling process (Kitaw et al., 2012). However, in Ziway-Hawassa milk shed, only adulteration test by using lactometer was practised by 55% of milk collectors (Table 7). There was no as such convincing and robust milk quality test for bacteria load, fat and protein content. This agrees with Vernooij et al., (2010) who reported that in the Central Highlands of Ethiopia the payment for raw milk was only based on quantity, as there were no facilities to test the milk fat and protein content and to pay for quality. Because, in Ethiopia, the major testing equipment found and used at most milk collection centres includes lactometers, alcohol test, filter by sieve and visual observation (Vernooij et al., 2010).

5.3. Gender involvement in the downstream dairy value chain

In the Ziway-Hawassa milk shed, the gender roles in the downstream dairy value chain were balanced and significant. In the present study, female's involvement in the processing of milk were reported to be 49% (Figure 17). This is supported by a study conducted in Kenya which showed that females play a significant role in home-processing of dairy products for sale in informal channels (Katothya, 2017). Similarly, in Kiambu County of Kenya, rural women have become successful milk traders by using the relatively well-developed public transport system. In Bungoma and Nandi Counties, some women own motorbikes and hire men to use them. Tasks are allocated according to traditional gender roles, causing work-load disparities between men and women (FAO, 2016). In agreement to this, the involvement of male in the milk transportation system was dominant in the current study. But, at the collection point female's role in the reception of purchased milk, quality control and cleaning activities were stronger than males.

5.4. Costs, gross margin and value share

In Addis Ababa milk shed Wonbera district, the producers sales price of milk varied by the type of collectors. It, however, ranged between 10 – 15 ETB per litre in the terminal market (Kitaw et al., 2012). In Ziway-Hawassa milk shed, a relatively high average selling price of milk was reported. Even the purchasing price of milk for large- and small-scale collectors varied. On average large-scale collectors purchased by ETB 17.78 per litre of milk, whereas small-scale collectors by ETB 19.23 for a litre of milk (Table 8). This difference occurred because of the potential for bargaining power. Large scale collectors had strong relations with producers throughout the year. They collect the usual quantity of milk both in the fasting and non-fasting season by a stable price. However, some small-scale collectors break their relations with the suppliers during the fasting season, or they want to reduce the purchasing price or purchased quantity of milk. After the end of a fasting season, producers increased the milk price for collectors that started to source milk from them. According to FAO (2017) report, the price of fresh milk in Ethiopia particularly Degen district varied from ETB 5.5 to 10 per litre. This big range was created due to the seasonality of milk supply, variability in demand (fasting and non-fasting period), and to some extent, distance from processing and chilling centres. In general, the price of milk reported in Ziway-Hawassa milk shed was higher (ETB 16 to 22 per litre). Even a lower purchasing price of milk was also indicated by Tegegne et al., (2017) in Dessie Zuria district. In connection to this, the same author showed that the costs of milk collectors for transportation, labour and related costs was the same compared to the average costs of the small scale (ETB 0.49/liter) collectors in the current study (Table 8).

The gross margin of milk collectors at Producers—Collectors—Retailers—Consumers channel was reported 13% (Table 10). In the milk channel which has the same arrangement, a relatively higher (15.13%) gross margin was reported by Tegegne et al., (2017) in Dessie Zuria district. Based on the same author finding, retailers had a better gross margin than collectors which was 28.87% on the same channel. But, in the current study, retailers had a lower gross margin which was 7.4%.

In and around Addis Ababa, there was a high-value addition at the processing stage; for example, the family processing factory in the Degem value chain buys milk at ETB 10.5 per litre and sells pasteurised milk at ETB 19.5, adding 85 percent to the value of liquid milk (FAO, 2017). Similarly, in Ziway-Hawassa milk shed, processors purchased milk by ETB 17.95 per litre and process it to pasteurised milk and sold it by ETB 28, adding 56% to the value of raw milk (Table 10). Between the processor and final retail point in Addis Ababa, 5-26% of the value was added, whereas in Ziway-Hawassa milk shed, it was only 7%. Besides, between 1-20% of value can be added through the collection in Addis Ababa (FAO,2017), but a relatively higher (22%) value was added by milk collectors in Ziway-Hawassa milk shed. In agreement to the present study, almost similar value addition (23%) by collectors was reported in Lemu-Bilbilo district in the Arsi Highlands of Ethiopia (Yami et al., 2012).

5.5. Carbon footprint of milk

In Ziway-Hawassa milk shed, large- and small-scale collectors contributed a different amount of carbon to the environment. A total travelled distance for milk collection was 154,170 Km (Table 11) that gave an average emission of 0.056 kg of CO_2 per litre of milk. Similarly, Ulrich et al. (2012) in the United States of America (USA) reported that an average round-trip distance of 850 km resulted in tailpipe emissions of 0.050 kg CO_2 per litre of milk delivered. Even if the distance covered for transportation of milk was varied, the average emission contributed for a litre of milk was almost the same. In the same country, a relatively higher (0.070 kg CO_2 per litre of milk) was reported by Thomas et al. (2013). But this figure is still lower than the average carbon footprint (0.089 kg of CO_2 per litre of milk) contributed by small-scale collectors in the present study. A study in Sweden showed that transportation of milk from farm to processing unit was emitted 0.07 kg of CO_2 per litre of milk (Flysjö, 2012). In addition, a study conducted in Europe showed that the average carbon footprint released for transportation of milk was 0.03 kg per litre of milk (FAO, 2010). This is relatively comparable to the average emission of CO_2 per litre (0.021 kg) contributed by large scale collectors in the present study.

In Ziway-Hawassa milk shed, the average carbon footprint emitted during milk distribution (from collection point to the retailers/consumers) was 0.06 kg of CO_2 per litre of milk. Thomas et al. (2013) reported relatively higher finding (0.072 kg of CO_2 per litre of milk) for distribution of products from processing unit to retailers/consumers in the USA. The average emissions released from the cooling of milk in the present study was 0.008 kg of CO_2 per litre of cooled milk. In the USA, milk refrigerators contributed relatively higher results (0.099 kg CO_2 per litre of refrigerated milk) (Thomas et al., 2013).

In the USA, emission from the processing of products was reported to be 0.077 kg of CO_2/packed milk (Thomas et al., 2013). Similarly, a study in Europe showed that on average 0.086 kg of CO_2 per litre of milk (FAO, 2010), and particularly in Sweden 0.05 kg of CO_2 per litre of processed milk (Flysjö, 2012) was emitted from processing factories. These all reported values in the USA and Europe are lower than the average emission value which was 0.160 kg CO_2/liter contributed by milk processors in Ziway-Hawassa milk shed. However, nearly the same value was reported in Iran dairy plants which emit on average 0.163 kg CO_2/liter of pasteurised milk (Daneshi et al., 2014).

5.6. Constraints of the milk collection and distribution

In Oromia region and Southern part of Ethiopia, the significant constraints of milk collectors were the absence of mandatory quality standards, the absence of a proper regulatory body or testing laboratory, high taxation, low investment in research, technology and in the financial system (Drost and Van Wijk, 2011). In Eastern Ethiopia, specifically Dire Dawa, lack of quality control of milk, milk spoilage and a seasonal decline in demand for milk were major problems for milk traders (Seifu and Doluschitz, 2014). Comparable to these reports, the absence of government control for illegal traders and weak quality control system from government bodies were reported as the main constraint in Ziway-Hawassa milk shed (Table 22). The attention of these illegal traders is only for their profit but not for the quality of milk and the health of the consumers. Even, their work was limited in a season at which the supply and demand become high. Also, the taxation system was determined by presumption, and it is very discouraging for collectors. It was not based on real capitals and profits generated from the business.

In Ziway-Hawassa milk shed, low volume or supply of milk was stated as a problem for milk collectors. On top of that, the existence of many fragmented collectors made the situation worse and invites for unhealthy competition. Most collectors, particularly in Kofele district, had not had a cooling machine (Figure 23). The previous study in Oromia region, Southern and Eastern part of Ethiopia confirmed that milk traders were affected by low productivity and absence of cooling systems (Drost and Van Wijk, 2011, and Seifu and Doluschitz, 2014). In Wolmera and Ejere districts, a similar constraint was also indicated by Kitaw et al. (2012).

In Wolmera and Ejere districts, local small-scale processors complained about low demand for their processed products and the bureaucratic ups and downs when trying to secure credit for the establishment of processing plants (Kitaw et al., 2012). In the current study, processors were constrained by lack of enough and suitable land for planting the factory and expansion of their business. Besides, the extended bureaucratic procedures and time to request and obtain land were reported as a vexing problem by sampled processors in the shed.

In Oromia region and southern part of Ethiopia, processors lack high-tech technology and equipment to produce specialised dairy products, and it is difficult for them to compete with imported good quality dairy products (Drost and Van Wijk, 2011). Similarly, in Ziway-Hawassa milk shed processors suffered by the lack of modern and efficient processing technology, shortage of packing materials for processed products, lack of inputs and spare parts of machines. Even the available spare parts are costly. When one spare part is broken, the machine will stop for a week or more until that item ordered from China has reached the centre. In addition, the milk collection and storage materials are plastic tanks because of the high and unfair prices of milk cans. Collecting or storing milk in plastic collection tank makes the milk easily spoiled by heat.

CHAPTER 6. CONCLUSIONS

In Ziway-Hawassa milk shed, the milk collection and processing activities are mainly carried out by licensed collectors and processors. However, few illegal traders specially in Kofele districts were identified in the study. Milk trading and processing business was the only income source for the majority of collectors and processors. Milk trading in the shed was also seen as a nice business to generate good money. The structure of the existing downstream milk value chain in Ziway-Hawassa milk shed was operated by different large- and small-scale collectors, processors, and one supporter. In the shed, all milk collectors and processors sourced milk directly from producers and distribute it to the retailers and or consumers by themselves. Producers→Collectors→consumers channel was the dominant milk route in the shed. Few large-scale collectors and processors performed all functions of the chain starting from producing up to retailing to the consumers. Next to vehicles, on-foot was the main means of milk transportation to and from collection points. The milk procurement strategies of milk collectors and processers in the shed were simple contract agreement, creating fair value share, providing a different form of incentives and building trust. In the collection process, males were principally assigned for milk transportation whereas milk reception, selling, and quality control activities were mainly given for females. Milk transportation, processing and cleaning activities were left for employed workers, and family labour was largely involved in purchasing and quality control.

The gross margin of milk collectors for fresh milk was 13% while producers and retailers had 9.19 and 7.42% respectively. Value share for collectors on fresh milk was less than the share of producers but greater than from retailers in the chain. A relatively proportional share of value was observed among producers, processors and retailers on yoghurt.

Annually, a total of 2,991,144 litres of milk was collected by milk collectors and processors. Out of this, 2,451,332 litres of milk was collected through different types of vehicles that contributed greenhouse gas emissions for the environment. The vehicle utilization efficiency was better in large scale collectors than small-scale collectors. Efficient utilization of vehicles can reduce carbon footprint per litre of milk. Hence, the means of carbon footprint per litre of milk was significantly different between large and small-scale milk collectors. In general, milk collectors contributed 79,757 kg of CO_2 during collection and 76,508 kg of CO_2 during the distribution of products from collection points to the consumers and or retailers. While Processors in Ziway-Hawassa milk shed contributed a relatively huge (227,648 kg of CO_2) amount of carbon footprint per year. General, the contribution of large scale collectors for chain sustainability was far better than the other downstream dairy value actors.

Most of the dairy chain supporters do not reach the collectors and processors. Instead, they restrict their services and support only to producers' level. Milk collection and processing was constrained by lack of suitable land and finance for expansion, imbalance of supply and demand, the presence of none licensed traders (illegal trader), poor awareness for producers and collectors about milk quality, weak market linkage, inappropriate and inefficient milk handling equipment and processing machines.

CHAPTER 7. RECOMMENDATION

Recommendations are suggested for selected key partners of milk collectors and processors which were proposed in the new Business CANVAS (Figure 24). These key partners were selected and included in the business CANVAS based on the nature of their works that directly links with the problems observed in the milk collectors and processors. In the current situation, these partners are not providing support and services for milk collectors and processors. Therefore, based on the findings, discussion, and conclusion of the study, the following possible areas of interventions were identified and recommended to be addressed by the indicated supporters/key partners:

Adami-Tulu research center and training Institutions (Hawassa University and ATVET colleges):

- ✓ First, they need to revise and update their supports into the practical based system. Then, besides producers, reaching or including the downstream dairy value chain actors in their support and services may be better for the effectiveness and sustainability of the chain.
- ✓ Updating the knowledge and skills of milk collectors and processors about proper and efficient milk handling systems, quality measurement techniques and possible actions to reduce spoilage/loss.
- ✓ Providing short-term training on the effect of climate change, possible sources of greenhouse gas emissions from their business centres and efficient utilization of the available resources (like vehicles, cooling facilities). This will improve and empower the capacity of milk collectors and processors leading to profitable and sustainable business.
- ✓ Generating practically skilled manpower that will fill the right demand for proficient expertise in the modern milk processing system.

Livestock and Fishery Office:

- ✓ Rearranging the supply of suitable milk handling materials, quality testing tools and transporting trucks at a reasonable price for milk collectors and processors is advised. E. g. milk cans.
- ✓ Facilitating for permission of free or low levy importation of some processing machine spare parts and expensive inputs from concerned Government body will be expected.
- ✓ Linking milk collectors and processors with research institutes, Universities and if there are NGOs.

Marketing and Cooperative Office:

- ✓ Assisting and grouping small-scale milk collectors. This will help to empower them in their financial capacity that needs to fulfil inputs like the appropriate milk storage and transportation system. Besides, it will also remove unhealthy competition occurring by fragmented small-scale collectors and improves the utilization efficiency of transporting trucks and cooling machines.
- ✓ Creating proper market linkage to the areas where demand is always high (e.g. areas where Muslim and Protestant religion followers are more dominant). This will help to reduce milk loss due to spoilage and improve the profitability.

Ethiopian meat & dairy industry development institute:

- ✓ Decentralizing its office to district level may help to control illegal milk traders actively, and detect the quality problem.
- ✓ Providing regular and practical based training related to proper milk handling, transportation, quality testing and processing are needed in order to reduce milk spoilage in the shed.

Milk Collectors:

In general, the proposed business CANVAS under Figure 24 is recommended for milk collectors to be used it and make their business more profitable and climate-smart. In addition to the existing practices special emphasis should be given to the following items of the CANVAS:

- **Value proposition**: Currently, milk collectors focus on the quantity of milk. However, along with quantity, giving high attention to the quality parameter is advisable. Therefore, during purchasing of milk, assuring its cleanness from adulteration and contamination of bad bacteria's is highly valuable for the effectiveness and sustainability of the business.

- **Customer relations**: Even though the existing relations are good, improving the form of contract agreement is crucial to secure the quantity and quality of purchased milk. The agreement should be established in a formal written way with the prescribed quality parameters and a specific amount of quantity. In addition, transparency should be developed and applied in milk procurement procedures.

- **Customer segments**: All the possible customers are linked with milk collectors in the existing situation. However, processors are suffering from shortage of raw milk and in the other way collectors face a low demand problem in some seasons. Therefore, targeting processors as customer segment will ripe mutual benefit for collectors and processors, of course, close contact and communication is needed.

- **Key resources**: Some collection points lack the quality testing tools, and even those who have lactometer did not usually use it for testing milk. Therefore, containing milk quality testing tools as a mandatory and essential resource is advisable to increase the detection and control of milk spoilage. In addition, using skillfull employees shall be recommended especially for large-scale collectors.

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APPENDICES

Appendix 1: Survey (questionnaire) for milk collectors and processors

I. For milk collectors/trader

A. General information

Questionnaire Code : ________ Date of interview _______________village_________________

1. Sex 1) male 2) Female
2. What is your age? ___________
3. What is your education level?
   1) illiterate/none 2) primary 3) junior secondary
   4) Senior Secondary 5) TVEC or college diploma 6) University

B. Specific information

1. What is your experience in milk trade/collection business? _______ Years
2. Is milk trade/collection business the only source of your income? 1) yes 2) no
   2.1. If no, what are your additional income sources? ____________, ______________
   2.2. If yes, what is your main reason for engaging in milk collection/trading business?
   1) No other alternative 2) Tradition/hobby 3) Best money-making alternative
   4) Others (specify) ____
3. Do you have legal license to operate the business? 1) Yes 2) No
   3.1. If no, why? _____________________________________
4. Please indicate the involvement of gender in your business unit and justify the reason; use this code (1= female from family; 2= male from family; 3 = male employee; 4 = female employee)

S. No.	Activities	Answer				Reason
		For milk Collectors	No.	For milk Processers	No.	
1	Purchasing of milk					
2	Transportation of milk					
3	Reception					
4	Selling milk/milk products					
5	Processing					
6	Distribution of processed products					
7	Cleaning					
8	Quality control					
9	Packaging					

5. From where do you collect milk? 1) directly from producer 2) from other trader/collectors 3) From milk brokers 4) If others, specify _________________, ____________
6. What is the means of transportation during milk collect? 1) by donkey 2) On foot 3) public transport 4) own transportation truck

7. Please indicate specific place of milk source, respective volume, distance and means of transportation on the following table:

S. No.	Places (villages)	Volume of milk(ltr)	Purchasing price/ltr	Distance (Km)	Means of transport	Other costs (transportation, labor…) on average
1						
2						
3						
4						

8. What is milk procurement strategy? 1) Contract 2) incentive-based system 3) creating fair value share 5) Trust 6) if others specify _______________,_________________,______________
9. Do you test the quality of milk during procurement? 1) yes 2) No
   9.1. If Yes, what type of test do you use _______________
   9.2. If yes and the quality is not good, what do you do? 1) reject 2) purchase by reducing the price 3) if others specify __________________, ___________________
   9.3. If no why? ________________, _________________,_____________________
10. For whom do you sell your milk? 1) consumers 2) other collectors/traders 3) processors 4) Café and restaurant 5) Supermarkets and shops 6) Wholesalers 7) Cooperatives
11. What is the distribution system of milk to customers? 1) by own car 2) donkey 3) On foot 4) public transport
12. Who is responsible for distribution of milk from your center to receiver customers? 1) myself 2) purchaser
13. Please indicate your milk selling history, corresponding volume, distance and means of transportation on the following table:

S. No.	Purchasers place	Volume of milk(ltr)	Selling Price /ltr	Distance (Km)	Means of transport
1					
2					
3					
4					

14. Do you have cooling facility in your collection point? 1) Yes 2) No
   14.1. If no, Why? ___________________, _____________________, ______________________
   14.2. If yes, please fill the following information on the following table

S. No.	Capacity of the cooling machine	Average volume of milk(ltr) cooled /day	Power consumption of cooling machine/hour	Remark
1				
2				
3				

14.3. If yes, what is the source of power for your cooling facility? 1) Generator 2) Electricity 3) both

14.4. If the answer is both, on average for how many hours do you use generator per day__________ (hrs) and Electricity_______(hrs)

14.5. How many ltrs of fuel the generator consumed per hour? ____________

15. What is the average electricity consumption (Kwh) per month or year? ____________
16. How often do you turn off lights and power when not required?
    1) Always 2) Frequently 3) Sometimes 4) Never
17. Do you have encountered spoilage/ loss of milk? 1) yes 2) No

17.1. If yes how often do you encountered? 1) always 2) sometimes 3) Rarely

17.2. If yes, in case of spoilage detected, how many liters of milk is spoiled from the total collected milk? ____________

17.3. If yes, what is the reason of spoilage? 1) poor hygienic practice 2) lack of cooling facility 3) Power interruption 4) inaccessible market 5) others, specify _____________, _______

17.4. If yes what do you practice to reduce spoilage? _________________, __________________

Please, give your general suggestion to improve milk collection and distribution procedures in your area?____
____
____

II. For milk processors

A. General information

Questionnaire code: ________ Date of interview _______________village_________________

1. Sex 1) male 2) Female
2. What is your age? ___________
3. What is your education level? 1) illiterate/none 2) Primary 3) Junior secondary
   4) Senior Secondary 5) TVEC or college diploma 6) University

B. Specific information

1. What is your experience in milk processing business? _______ Years
2. What are the main activities in your business? 1) processing only 2) transporting and processing 3) collecting, transporting and processing 4) processing and wholesaling 5) processing and retailing
3. From where do you bring(source) raw milk? 1) own collection center 2) any milk traders 3) directly from producers 4) if others, specify ________________, __________
4. Please indicate about how you organise the transporting and processing of milk:

S. No.	Sources (places)	Volume of milk(ltr) transported	Means of transportation	Loading capacity	Distance travelled (km)	Remark
1						
2						
3						
4						

5. Please indicate the processed types of milk products and associated cost structure:

S. No.	Average volume of milk (ltr) collected/day	Purchasing price/ltr	Cost of processing, labor & transport/ltr	Processed products/day	Selling price/ltr kg	Remark

6. For whom do you supply your products? 1) wholesalers 2) Shops and supermarkets 3) Cafes and Hotels 4) Directly to consumers
7. What is your power sources? 1) Generator 2) Electricity 3) both
   7.1. If the answer is both, on average for how many hours do you use generator per day__________ (hrs) and Electricity_______(hrs)?
   7.2. How many ltrs of fuel the generator consumes per hour? ____________
8. What is the install processing capacity of the factory? _______________
9. What is the current processing capacity of the factory? ______________
10. What is milk procurement strategy? 1) Contract 2) incentive-based system 3) creating fair value share 5) Trust 6) if others specify ______________,________________,_____________
11. What is milk products distribution strategy? 1) Contract with wholesalers/retailers 2) By using own retailing or wholesaling shop 3) Contract with Hotels/cafeteria 4) others, specify_________
12. Please indicate the power utilisation of your factory on the following table:

S. No.	Types of processed products	Volume of milk (ltr) required/unit of processed products	Processing time /product (hr.)	Power consumption of the machine/hr. (Kwh)	Remark
1					
2					
3					
4					
5					
6					

13. Do you know the effect of climate change? 1) yes 2) No
    13.1. If yes, what measures do you take to reduce the effect of climate change from your business perspective? __________, ___________, ____________
14. Please, give your general suggestion to improve the processing efficiency of factory?____
    ____

III. For milk and milk product retailers (wholesalers)

1. When do you start retailing of milk and milk products? __________(Years)
2. Is the demand for milk and milk products vary with the season? 1) yes 2) no
   2.1. If yes, in which season is high______________ and low_____________________
3. From whom do you bring(source) milk and milk products? 1) Directly from producers 2) traders 3) collection points 4) wholesalers 5) Processors

4. Please indicate the following information on the table below

S. No.	Product types	Purchasing price/unit	Selling price/unit	Other costs (transport, labor…)	Remark
1	Raw milk				
2	Pasteurized milk				
3	butter				
4	yoghurt				
5	Cream				
6	Cottage cheese				
7	Hard cheese				

Appendix 2: Observation checklist for milk processing factories and collection points

Date: ___________________________________

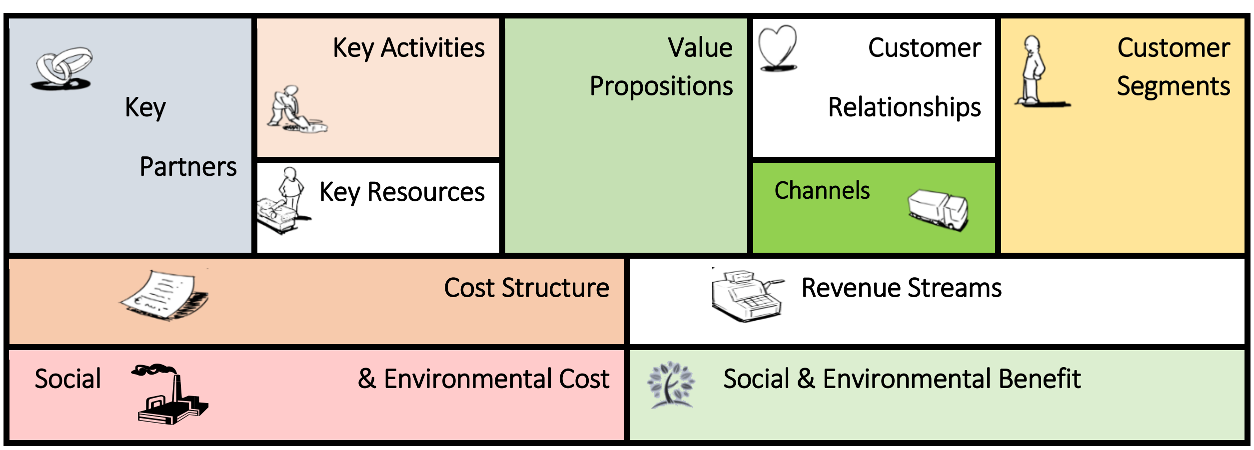
Observed units	Checklist points	Researcher Remark
Collection center/point	- Milk storage equipment - Hygienic condition of the equipment's - Quality testing system - Workers (gender) - Cooling machines (actual holding capacity vs current holding, power consumption, efficiency) - Electric bills	
Processing factories	- Processing system - Hygienic condition of the equipment's - Specification of the machines (power consumption, efficiency) - Workers (gender) - Packaging system - Electric bills - Cooling machines (actual holding capacity vs current holding, power consumption, efficiency)	

Appendix 3: Interview checklist for focus group discussion with milk collectors and processors

Date: ____________________________

Key informant	Checklist points	Researcher Remark
Challenges and opportunities	- Supply, price and quality of milk - Market demand, linkage, - Trust - Policy and technical support, - climate change, - Transportation and distribution - Electricity power supply/interruption - Cultural, - Profitability, - Financial support, - Gender issue, - Labour condition,	
Climate-smart practices	- Power utilisation system - Full capacity transportation - Heating water for washing - Spoilage reduction practices - Full capacity of cooling machines	

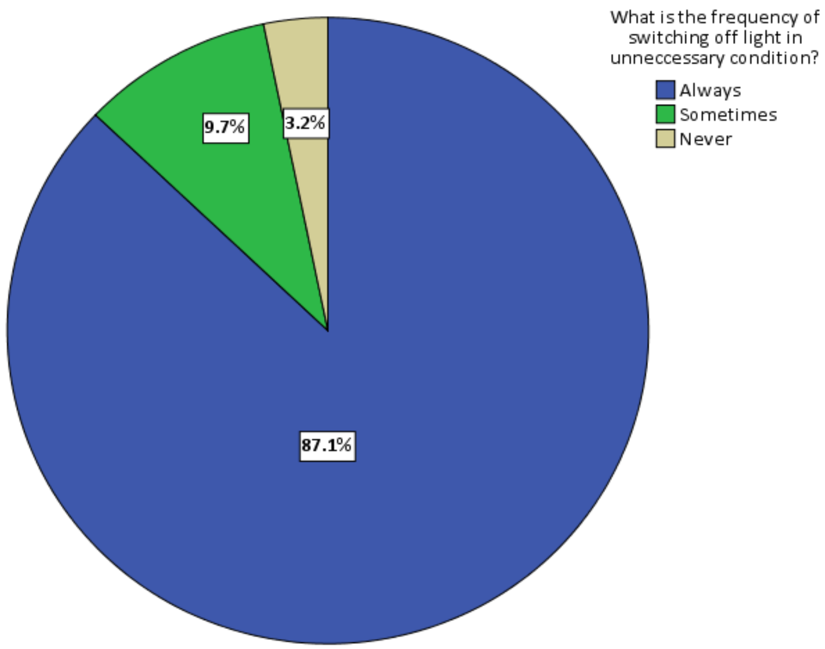
Appendix 4: Participatory tools



Appendix 5: Age of respondents and experiences on the business

S. No	Parameter	N	Minimum	Maximum	Mean ± Std. Deviation
1	Age	36	19	65	35±2
2	Experience	36	1	21	8 ± 6.5

Appendix 6: The frequency of power control at collection points



Appendix 7: Pictures depicting survey, FGD and observation

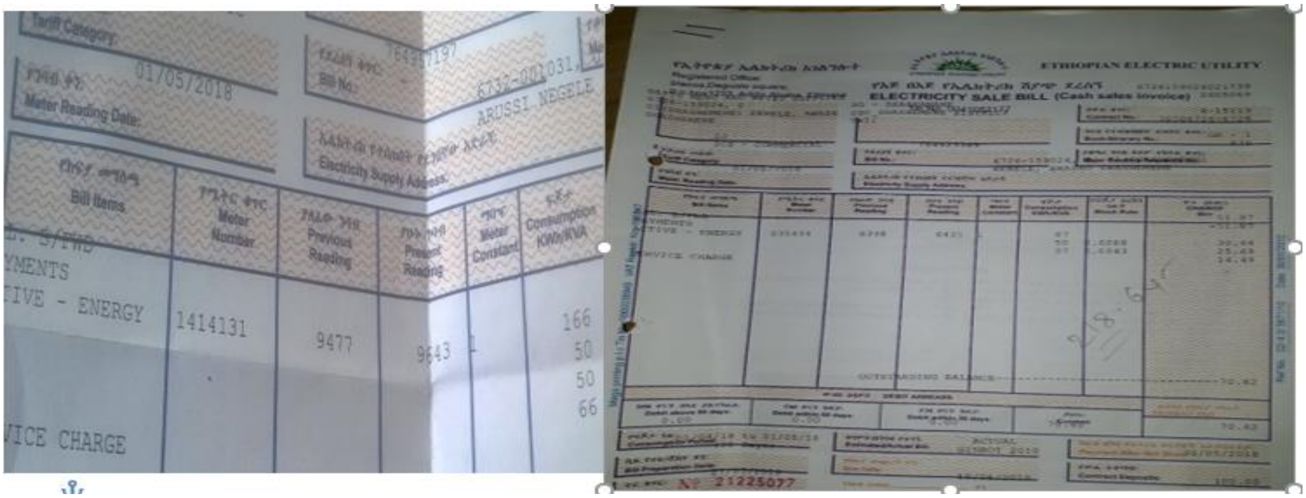
FGD and Participatory business CANVAS development

Interview of milk collectors and processors

Observation of cooling machine utilization

Observation of collection procedures and collection tanks

Observation of electric bills (Power consumption)



Observation at Almi processing center