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# ASSESSMENT OF FOOD LOSS ALONG THE DAIRY VALUE CHAIN:

# A CASE STUDY

# OF KITINDA AND KAPTAMA DAIRY FARMERS COOPERATIVE SOCIETY IN BUNGOMA COUNTY- KENYA


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## DEDICATION

This dissertation is dedicated to Gian Jelagat, my beautiful little girl. You were my inspiration and motivation during my master's degree in the Netherlands. This work is also dedicated to my family: Grandma (Maria), Uncle Philip, and Mum Flomena, who has always loved me unconditionally and whose good examples have encouraged me to strive hard for the goals I want to reach and to never give up on life. I am fortunate to have you in my life as a source of support and encouragement in my life.

Contents

## Lists of figures

## List of tables



## List of Acronyms and Abbreviations

| | |
|---|---|
| **CO2 eq** | Carbon dioxide equivalent |
| **CF** | Carbon Footprint |
| **FCPM** | Fat and Protein Corrected Milk |
| **Maziwa Mala** | Fermented milk |
| **FAO** | Food and Agriculture Organization of the United Nations |
| **GHG Emissions** | Greenhouse Gas Emissions |
| **GDP** | Gross Domestic Product |
| **Kaptama DFCS** | Kaptama Dairy Farmers Cooperative Society |
| **KEBS** | Kenya Bureau of Standards |
| **KBD** | Kenya Dairy Board |
| **KNBS** | Kenya National Bureau of Statistics |
| **KES** | Kenya Shillings |
| **Kg** | Kilogram |
| **Kitinda DFCS** | Kitinda Dairy Farmers Cooperative Society |
| **MoALFIC** | Ministry of Agriculture, Livestock and Fisheries |
| **NARIGP** | National Agricultural and Rural Inclusive Growth Project |
| **NAIP** | National Agriculture Investment Plan |
| **SHDP** | Small Holder Dairy Producers |
| **USAID** | United States Agency for International Development |
| **VHL** | Van Hall Larenstein |

ABSTRACT

Milk and milk products are responsible for around 21% of worldwide food losses, with annual after-harvest milk losses ranging from 10% to 23%. Losses in production, post-harvest, and distribution are more typical in economically underdeveloped countries like Kenya. FORQLAB is a Kenyan Programme aimed at reducing post-harvest losses and improving food quality along the avocado and dairy value chains. Bungoma County in Kenya is experiencing milk handling difficulties, resulting in massive rejections and spillages. The goal of this study was to identify milk loss hotspots in Bungoma that have major economic and carbon footprint implications along the Kitinda and Kaptama smallholder dairy value chains.

Purposive sampling was utilized to identify 40 smallholder dairy farmers from two cooperatives, Kitinda (n=20) and Kaptama (n=20). A questionnaire poll was used to collect data, as were 20 surveys, 1 FDG with 8 participants, and 7 key informant interviews per cooperative. SPSS was used to analyses the quantitative data collected, which was then shown in tables and figures. While the qualitative data analysis involved item segmentation, categorization, and prediction.

It was found that, Kitinda milk shed suffers the most losses at the cooperative, with a total loss of KES11.5 million/year. Whereas the Kaptama milk shed had a total loss of KES 4.7 million/year. With 230,809 and 112,010 $CO_2$ eq./kg FPCM carbon footprint contribution. Nonetheless, except for the lost milk, it appears that all losses experienced along the dairy chain are merely losses to the cooperative rather than losses to the food system as the product is eventually sold or given to animals

Furthermore, current strategies used to reduce milk loss identified along the Kitinda and Kaptama dairy value chains include keeping milk clean, separating morning and evening milk, and correctly storing milk. Training is also offered, as is the ability to cool milk. However, the key obstacles are high milk production costs, limited financial resources, and infrastructure gaps.

The recommended treatments were to create partnership with financial institutions for procurement of milk cans (KDB certified) and milk testing equipment, start collecting evening milk, establish a Savings and Credit Cooperative Organization (SACCO) in both cooperatives. While Kitinda was create partnership with Brookside firm to market their milk, Kaptama was asked to strengthen farmers to deliver quality milk.

**Key words: Food loss and waste, milk loss, hotspots, smallholder dairy producers, Kenya**

# CHAPTER 1: INTRODUCTION

## 1.1 Background information

Milk and milk products account for roughly 21% of global food losses, with annual after-harvest milk losses ranging from 10% to 23% (Gustafsson et al., 2013; FAO, 2011). Dairy industry losses vary greatly by global region. When milk purchased by customers expires before it is consumed, a large percentage of losses occur in developed countries. Production, post-harvest, and distribution losses, on the contrary hand, are more prevalent in economically developing countries like Kenya (Gromko et al., 2019).

On the other hand, Kenya suffers from recurrent food shortages. Nutritional insecurity is strongly tied to poverty as well as agricultural output growth that has been unsatisfactory. Around 25% of the country's population suffers from long-lasting food insecurity and poor nutrition, and over USD 1.3 billion is spent on food imports each year to meet demand. Furthermore, approximately 5% of the country's population is constantly supported by food aid as a result of massive losses in total harvested quantity, which aggravate seasonal and regional shortages as well as price fluctuations in food items (Affognon and Mutungi 2013).

Bungoma County in Kenya's western region, as reported by the Kenya National Bureau of Statistics (KNBS), is one of the most food insecure counties, with a poverty index of 52.9 percent against the national poverty index of 46 percent and food insecurity of 43 percent (2010). Nonetheless, Bungoma County is Kenya's medium-potential dairy-producing region, with women outnumbering males (35.2%) by a margin of 64.8 percent. Milk production is estimated to be over 97 million litres per year, with an average of 5- 8 litres/cow/day, with large contributions from Tongaren, Kimilili, and Mt. Elgon sub-counties. (2018 Mwendia and Notenbaert)

Bungoma is a beneficiary of the NARIG programme, which assists underprivileged groups. The initiative's primary beneficiaries are rural small and marginal farmers, particularly women and vulnerable and disadvantaged groups, as well as other stakeholders throughout agricultural value chains (Bungoma CIDP,2018)

## 1.2 Project description

The research project Food Waste Reduction and Food Quality Living Lab (FORQLAB) will be conducted in Kenya with Van Hall Larenstein (VHL) as project coordinator, working with a consortium of universities (2 Kenyan, 4 Dutch), commercial sector players, organizations supporting those chains, and associate partners who help the category through co-financing, guidance, and reflection. In addition, VHL students will participate in the project by linking their research thesis to the dairy and avocado value chains in Kenya.

The consortium wishes to contribute to the structural reduction of after-harvest losses and the enhancement of food quality in Kenyan avocado and dairy value chains through the use of technical solutions and tools, as well as improved chain governance competencies. For both commodities, the FORQLAB project focuses on two places in Kenya: a rather well-developed chain in the central highlands and a less-developed chain in western Kenya.

The strategy is business-to-business, and the selected regions have a high potential for effective chain development. Using a live lab network methodology, the results are scalable for different fresh and processed product chains. The project is divided into five work packages (WPs): 1. Inventory and the status quo, and inception, 2. Applied research, 3. Dissemination of research outputs via living lab networks, 4. Translation of project output into curricula and trainings, and 5. Communication among partners and WPs.

The applied research will be carried out in collaboration with all partners, with students from the consortium institutions doing most of the field studies and the other partners supporting and interacting according to the WPs. The following outcomes are anticipated: two knowledge exchange platforms (Living Labs) supported by hands-on sustainable food waste reduction implementation plans (agenda strategy); an overview and proposals for ready ICT and other tech solutions;

communication and teaching materials for universities and TVETs; action perspectives; and knowledge transfer and uptake.

The project involved nine VHL master's students, four from the dairy value chain and four from the avocado value chain. Two livestock students conducted research on a food loss audit and technical intervention in food loss reduction in Githuguri, while the other two conducted research on a food loss audit and governance in western Kenya.

### 1.3 Business case: Assessing milk losses in Bungoma County

Kenyans take around 130 litres of milk per person per year, making them one of the world's poorest countries with the highest intake per-unit population (Kasirye, 2015). With demand for milk and dairy products predicted to expand substantially due to rising population and the need for urban markets in Kenya, yearly per capita consumption levels are expected to climb to 220 litres by 2030 (Blackmore et al.,2020).

Moreover, home consumption dominates the sector; 47% of the milk produced is for family consumption. 80% of marketed output is sold directly to consumers rather than through a processor or formal market (Ministry of Livestock Development 2010). Milk is sold in both informal and formal marketplaces. Dairy cooperatives are a formal market structure, with farmer cooperatives processing around 18.7 million litres of milk worth at KES 5.6 billion (KNBS 2020). Informal market sales are especially essential for rural families and women's income since they have less influence over earnings from official market transactions. (Wilkes et al., 2020a; Tavenner and Crane, 2018)

Dairy cooperatives/organizations, which are owned jointly by dairy farmers, play an essential part in the region's milk production coordination. These farmer organizations frequently help to organize milk transportation from their members to dairy processors through collecting hubs (Gromko et al., 2019). However, not all milk produced is sold or consumed; some is lost or discarded during the supply chain's production, collection, or processing stages. These stages are known as milk loss hotspots. According to Gromko et al., 2019, significant milk losses occur between the smallholder producer and the processor.

Rejection accounts for a major portion of milk losses at the collection/cooperative stage. Evening milk, which accounts for 40% of daily cow output, is usually lost owing to a lack of refrigeration on the farm. The entire milk production is lost when a farmer combines evening and morning milk (Omondi et al. (2020). Milk is collected and transported in unsanitary circumstances, exposing it to high temperatures, resulting in the growth of pathogens and eventual spoiling, leading to losses. (Orregård, 2013; Kashongwe, 2017).

Furthermore, milk is commonly delivered to collection points in plastic containers that are not only difficult to clean, but also have the potential to break, resulting in losses. The primary mode of transportation is by motorcycle. Transporters, on the other hand, engage in anti-practices such as deliberate adulteration of milk with water, flour, or margarine to increase milk volume and hydrogen peroxide to increase milk shelf life hence being rejected at collection centres (Kihiu, 2021; Odongo et al., 2016).

Milk is tested for milk hazards such as hydrogen peroxide, antibiotic residues, bacterial load, and somatic cell count before it is accepted or rejected at milk collection centers. Milk may be accepted at the collection point in some cases, but it will eventually spoil due to receiving milk with a short shelf life. Aside from that, due to unsanitary milk handling practices, milk periodically re-deteriorates after pasteurisation (Lindahl et al., 2018). The majority of milk losses (84 percent) occur at the cooperative and milk collection centre levels (Omondi et al., 2020).

Balkishina (2021) noted that milk losses also contribute to economic impact; over 95 million litres of milk produced in Kenya are lost each year, amounting to an estimated 22.4 million litres. Furthermore, in Kenya's western region, Nandi and Kakamega counties reported annual milk losses of 26,000 and 20,000 litres, totalling KES 10 million and KES 1.8 million, respectively (Omondi et al., 2020).

Milk losses, on the contrary side , are not only a missed opportunity for the economy but also a waste of all natural resources used in production, processing, packaging, transporting, and marketing, all of which contribute to greenhouse gas emissions, which are measured in kilograms of CO2-equivalents (carbon footprint) (FAO,2011). As a result, in this study, the economic and carbon footprint of actual milk losses along the dairy value chain were measured and compared between Kitinda and Kaptama Farmers' Cooperative Society.

### 1.4 Case study description

#### 1.4.1 Kitinda Farmers' Dairy Cooperative Society

The Kitinda Dairy Farmers Co-operative Society (KDFCS) in Bungoma County commenced in 1957 as a disease control station but was subsequently turned into a milk transit centre. The state, in partnership with the Finnish government, launched the factory in 1986 as a part of a program known as "Country Dairy Management." Finnish investors acquired and managed the processing machinery for three years, processing 16,000 litres of milk each day with 9,000 members.

It was widely renowned in the late 1980s and early 1990s for having the most powerful milk processing facility in East Africa, after Finnish investors withdrew in 1989, the factory's board of directors was unable to manage it. The plant encountered issues ranging from inadequate leadership to obsolete machinery and it closed in 1995. In 1999, PK Bhatia leased the facility for ten years, but the same difficulties arose, and the firm went bankrupt.

Since 2013, the Bungoma county government has been attempting to restore the factory. Later, the factory's board of directors was unable to run it after Finnish investors left in 1989, resulting in its closure in 1995. PK Bhatia leased the plant for ten years in 1999, but he ran into the same problems, and the company went bankrupt. The county government revived the plant in 2013. (Masimbo, personal communication)

**Kitinda FDCS milk supply channel**

Kitinda FDCS has 1,000 SHDP members, including 550 women, 380 men, and 70 young people. Not all of the milk produced by members, however, is sold to Kitinda; some is sold to the informal market. Kitinda collected 8,000 litres of milk every day from 16 milk collection points spread around the Kanduyi subcounty using motorcycles.

Twenty percent of the milk collected is used to make maziwa mala/lala (fermented milk), yoghurt, and cheese. The remaining 80% is sold to institutional customers such as institutions, hospitals, and milk vendors as pasteurized fresh milk. However, due to high milk rejection, the cooperative is unable to meet current demand or generate sufficient profits for future growth.

Figure 1: Kitinda Milk Supply channel

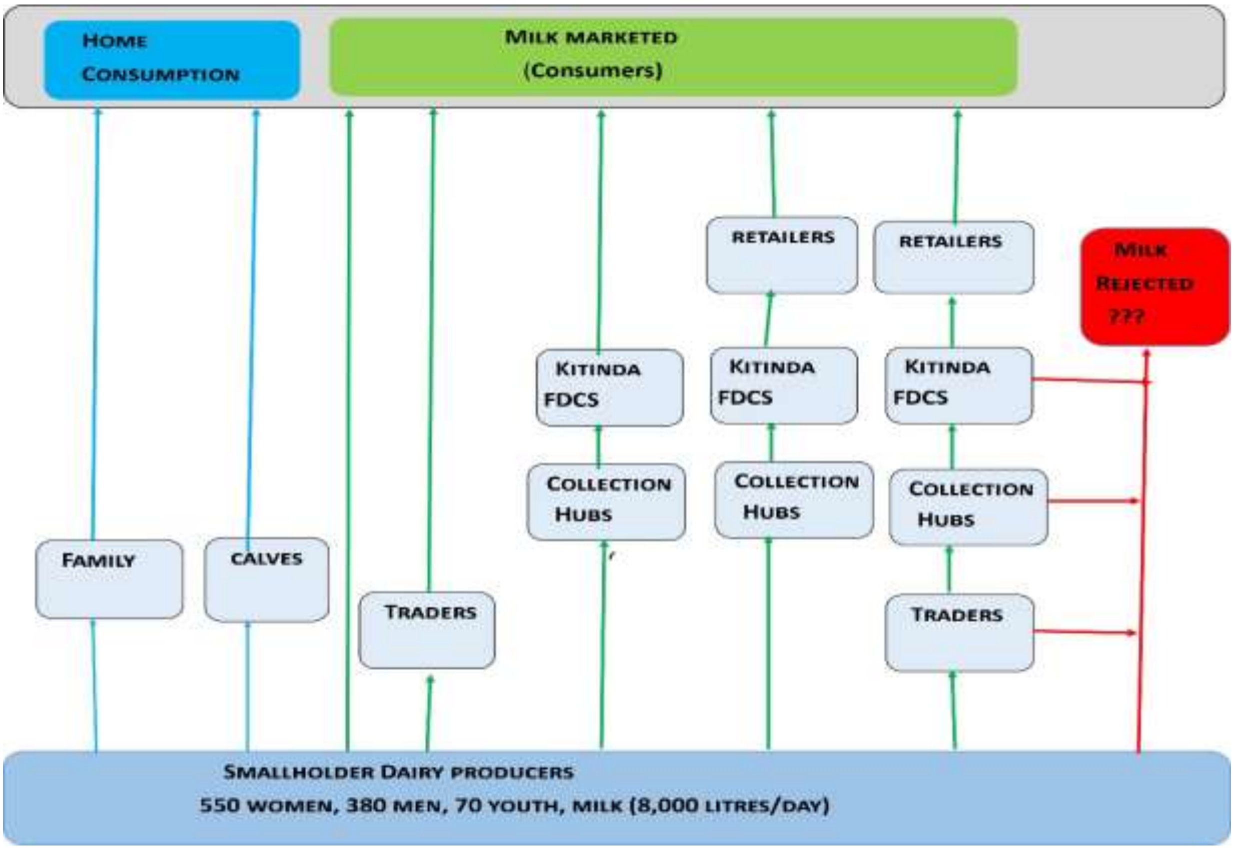
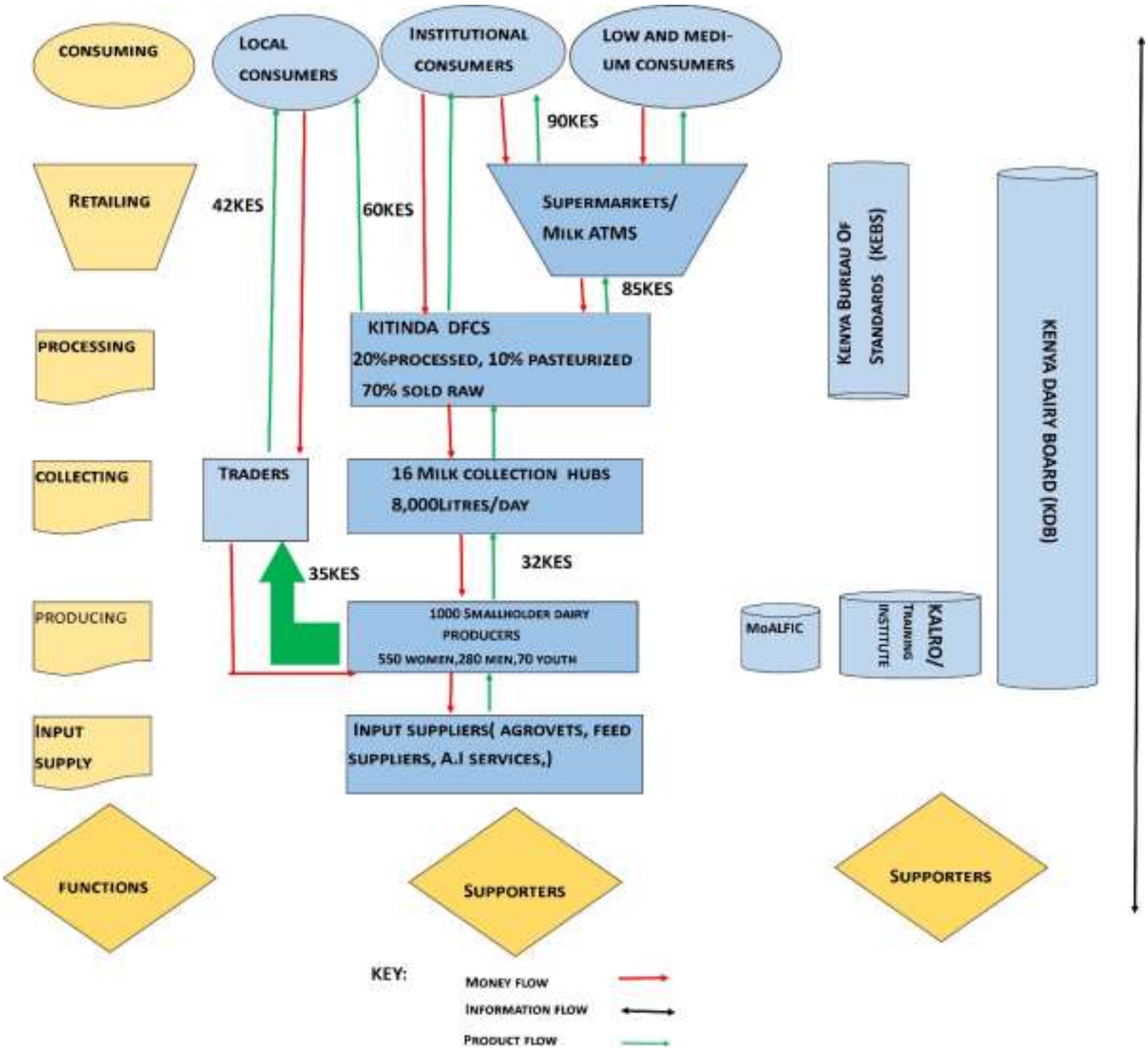


Figure 2: Kitinda DFCS Value Chain




## 1.4.2 Kaptama Farmers Dairy Cooperative Society

Kaptama FDCS began in Mt. Elgon Sub County in 1958 as a dairy farmer-owned cooperative. The dairy cooperative then ceased for twenty years. Twenty years later, the World Bank rebuilt and reopened the society through one of its local development arms, the Western Kenya Community Driven and Flood Mitigation Programme (WKCDD/FMP).

**Kaptama milk supply channel**

The Kaptama FDCS cooperative is made up of 1,260 active smallholder dairy farmers (504 men, 756 women) who produce 3,800 litres of milk per day in peak season or wet season and as lowest as 600litres/day in dry season. Wet seasons occur from April to October, while dry season is between November to march.

The cooperative's primary activities include the collection and transportation of fresh milk, quality control, and the storage and sale of fresh milk. The cooperative chills and sells milk to Brookside

Dairies, one of Kenya's largest dairy processing company accounting 45% of the market (Wambui,2018).

Figure 3:Kaptama FDCS Supply chain

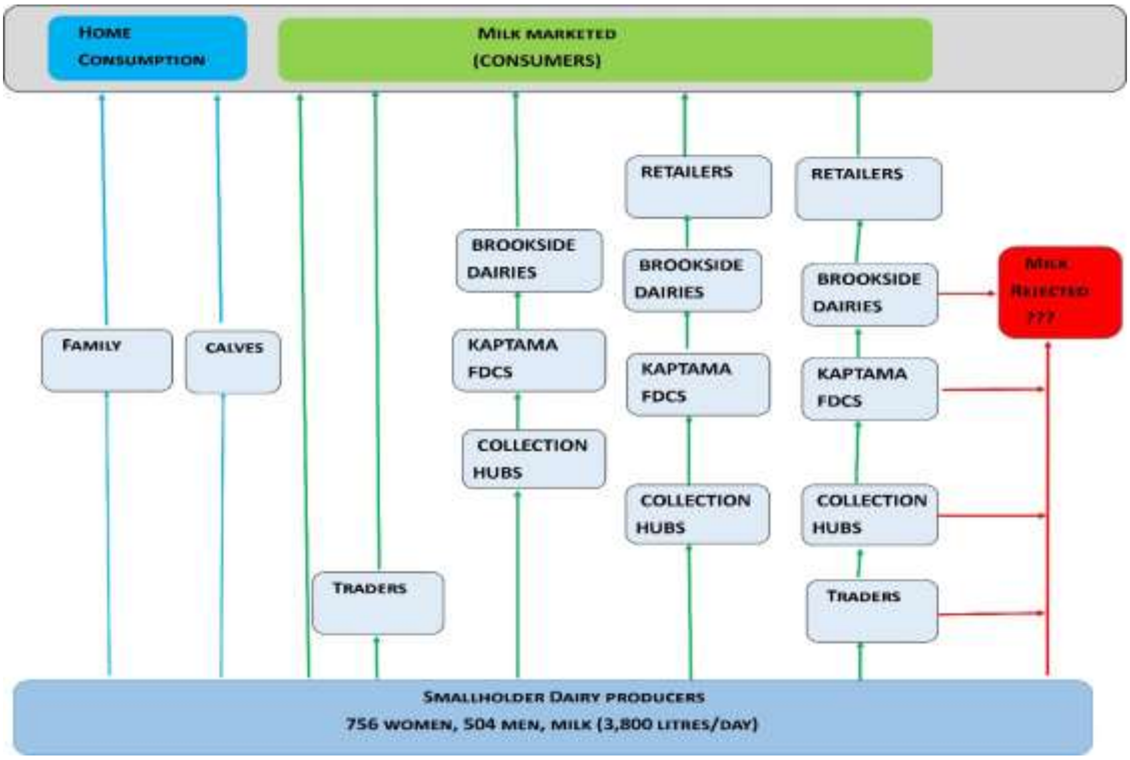
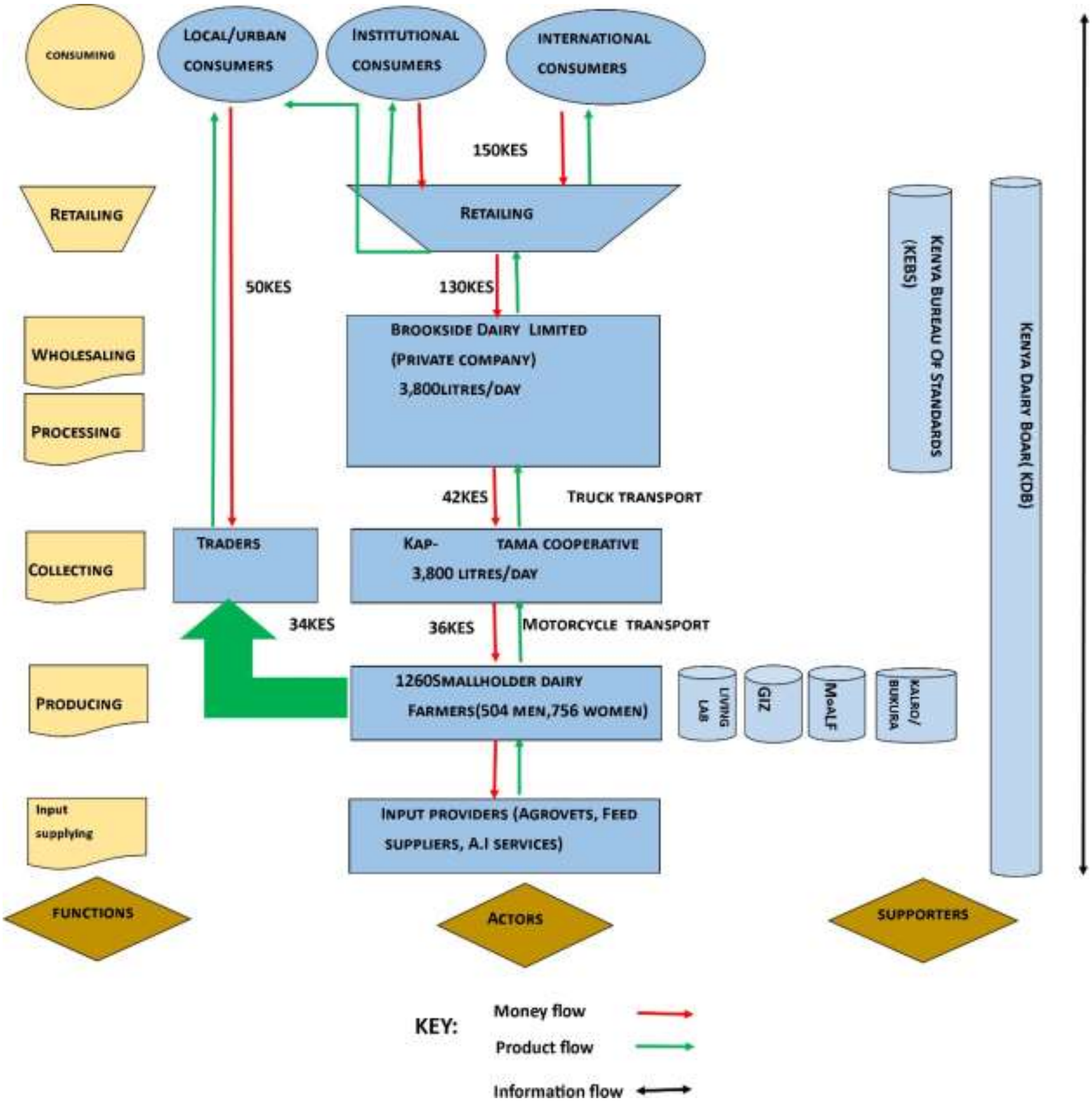


Figure 4: Kaptama FDCS Value Chain Map




## 1.5 Problem statement

The biggest concern in Bungoma county's Kitinda and Kaptama FDCS is improper milk handling throughout the value chain (production, collection, processing, and marketing). Milk adulteration, spoilage, and spillage are all common occurrences. This is because of a combination of morning and evening milk, inadequate milk storage among smallholder dairy farmers, and a longer distance between collecting centres and farmgate.

There is also the use of plastic containers for milk transportation, as well as poor road infrastructure, intentional adulteration of milk by transporters, and insufficient milk storage at distribution. Furthermore, antibiotic residues, a high bacterial count, a high somatic cell count, and re-contamination of milk during the processing stage all result in massive milk losses. This has economic and carbon intensity (carbon footprint) implications. Food and nutrition security, women's and children's livelihoods, gender justice, resource utilisation, producer income, and consumer price are all jeopardized.

According to Mutungi et al. (2013), the problem of increasing post-harvest losses began in 2006, peaked in mid-2008, and continued to rise in 2011, resulting in food price hikes. Food loss reduction has emerged as a critical component of ensuring food security. Kenya has played an important part in identifying the underlying causes of current losses and the provision of milk coolers to reduce milk losses. However, in Kitinda and Kaptama DFCS, the actual amount of milk lost and milk loss hotspots with a high impact on the economy and carbon footprint are unknown.

Without comprehensive verification of present milk loss levels, the possibility of eliminating milk losses will be assumed. As a result, this research was conducted with the aim of assessing milk losses and identifying hotspots along the value chain with high economic and carbon footprint impact by comparing Kitinda and Kaptama FDCS. This helped in formulating interventions to solve it as well understanding current strategies used, and challenges.

### 1.5.1 Research objective

To assess milk loss hotspots with high economic and carbon footprint impact along the Kitinda and Kaptama smallholder dairy value chains to recommend milk loss mitigation interventions to the two cooperatives and FORQLAB for improved milk quality and reduction of milk loss, resulting in value chain sustainability.

### 1.5.2 Research questions

i. **What are the milk loss hotspots with high economic impact and carbon footprint along the Kitinda and Kaptama smallholder dairy value chains?**
   a) What is the food value share of milk loss at the key hotspots?
   b) What is the economic impact of milk losses?
   c) What is the impact of milk loss on the carbon footprint?
   d) What happens to the milk that is rejected at cooperative/collection centres?

ii. **What are the loopholes in reducing milk loss along the Kitinda and Kaptama smallholder dairy value chain?**
   a. What are the current strategies for reducing milk loss?
   b. What are the potential obstacles to reducing milk loss?

## CHAPTER 2: LITERATURE REVIEW

### 2.1 Overview of previous research

Food loss and waste (FLW) is a major global topic that has sparked greater research due to its magnitude, with an estimated three-quarters of a trillion-dollar worth of food lost and wasted each year. This includes food crops and livestock products such as milk. It is also projected that if FWL can be reduced by half, food security can be achieved by 2050 (FAO,2014).

#### 2.1.1 Milk losses in Kenya

Kenya has the highest rate of milk loss during post-harvest processing and storage processes. 11% occurs during transportation and storage, 0.1% during manufacturing and packing, 10% during dissemination, and 0.1% during usage, according to Gustafsson et al. (2011). This is due to a lack of market access, inadequate handling procedures, and irregular power supply in milk factories, resulting in rejection and spillage.

Additionally, FAO (2014) reported that Kenya loses 7.3% of its milk along the supply chain, with 5.7% lost during production, 0.6% lost during collecting, 0.2% lost at the cooperative level, 0.1% lost at the processing level, 0.1% lost at informal/traders, and 0.6% lost at milk bars. This is because of a shortage of storage, cooling facilities, spillages caused by motorcycle transportation, rejection, and infrastructure (Table 1).

Table 1: Milk Losses along Milk Supply Chain

| Stage in the Supply Chain | Percentage Loss | Percentage of produce handled at each stage | Weighed Losses % | Drivers of Losses |
|---|---|---|---|---|
| Smallholder Farm | 6.0 | 95 | 5.7 | Spoilage due to suboptimal storage facilities |
| Family Consumption | - | 35 | 0 | - |
| Community supply | - | 17 | 0 | - |
| Trader collection centres | 1.5 | 40 | 0.6 | Suboptimal cooling facilities |
| Co-op / SHC | 0.6 | 30 | 0.2 | Suboptimal cooling facilities |
| Traders / Hawkers | 0.9 | 10 | 0.1 | Spillage due to motorbike transport on suboptimal roads |
| At milk bars and others | 2.0 | 28 | 0.6 | Suboptimal cooling systems and infrastructure |
| Processors' collection centres | 0.4 | 20 | 0.1 | Milk rejected by processor |
| **Total loss along the supply chain** | | | **7.3** | |

Source: FAO,2014

#### 2.1.2 Bungoma Smallholder Dairy Value Chain

Bungoma county is home to 14 dairy cooperative organisations that produce 618,783 litres of milk per cow per day. There is a total of 10,062 farmers in these dairy cooperative groupings. The county contains more Zebu cattle (259,940) than dairy crossbreds (102,183), which may explain why milk output is low, necessitating milk imports from neighboring counties such as Trans-Nzoia, Uasin Gishu, and Nandi. (MoALFIC, 2015).

Bungoma Dairy Cooperative Societies play an important role in milk collection, grading, bulking, milk chilling, and value addition to specialised commodities such UHT milk, cheese, and instant milk powder. However, Bungoma county, like many other counties in western Kenya, is experiencing milk crisis (Wanjala,2014).

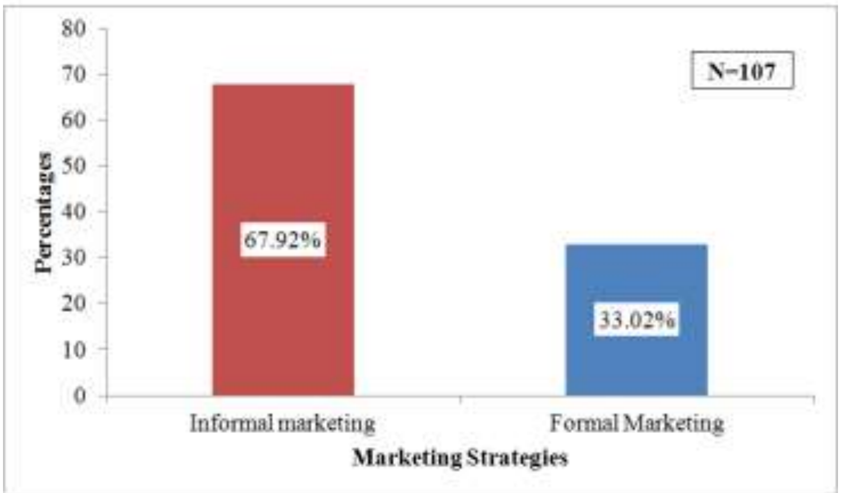
Kitinda FDCS, for example, pasteurizes and distributes fresh milk, produces maziwa lala (fermented milk), and creates yoghurt only on demand. In contrast, Kaptama Farmers' Dairy Cooperative Society chills and stores fresh milk before distributing it to Brookside for processing.

### 2.1.3 Dairy product marketing

**Informal marketing**

According to Koyi and Siamba (2017), a large percentage of Bungoma County dairy farmers (67%) sell their milk in informal markets, while 33 percent market their milk formally. Dairy farmers either sell their milk directly to consumers or to intermediaries, who then sell it to end consumers or processors in the informal market.

Figure 5: Bungoma Marketing Strategies




**Source: Koyi and Siamba (2017).**

**Formal marketing**

Formal milk marketing entails selling milk to dealers via an agreement, which can be verbal or written. Contracting and cooperative marketing are the most common formal milk marketing techniques in Bungoma County. Formal marketing has numerous advantages, including the development and marketing of high-quality milk and milk products, increased storage life, quality standards oversight, and support with a well-designed and elaborate milk collection structure (Koyi et al., 2017).

Kaptama and Kitinda DFCS use cooperative marketing. Cooperative marketing not only gives farmers a reliable market but also offers its members an opportunity to run their dairy businesses in the best interests of the members. Collaborations between cooperative organizations and farmer groups have resulted in the establishment of milk collection hubs.

These collection points connect farmers to processors or cooperatives. According to Nyokabi et al., (2021), the widespread use of plastic containers in both formal and informal value chains for bulking and transportation to collection hubs or processing not only violates sanitary standards but also results in milk losses. Milk is bulked and transferred to chilling facilities from a central location in the majority of formal value-chain cooperatives.

The milk is then transported to processing plants, where value addition occurs to produce specific products such as yoghurt, cheese, ghee, and maziwa mala, among others, which are then supplied to wholesalers, retailers, and distributors. If milk is collected and delivered in unsanitary conditions and at high temperatures, microorganisms will grow, resulting in spoilage or rejection.

On the other hand, milk in the informal value chain is bulked by small-scale transporters by the side of the road in unhygienic circumstances, exposing it to microbial contamination and causing deterioration. Furthermore, milk is transported uncooled on motorcycles for a longer distance in a warm environment, resulting in additional milk losses. The most common causes of milk losses at milk collection and chilling centers are noncompliance with quality regulations and spillage losses during transit.

## 2.2 food loss concept

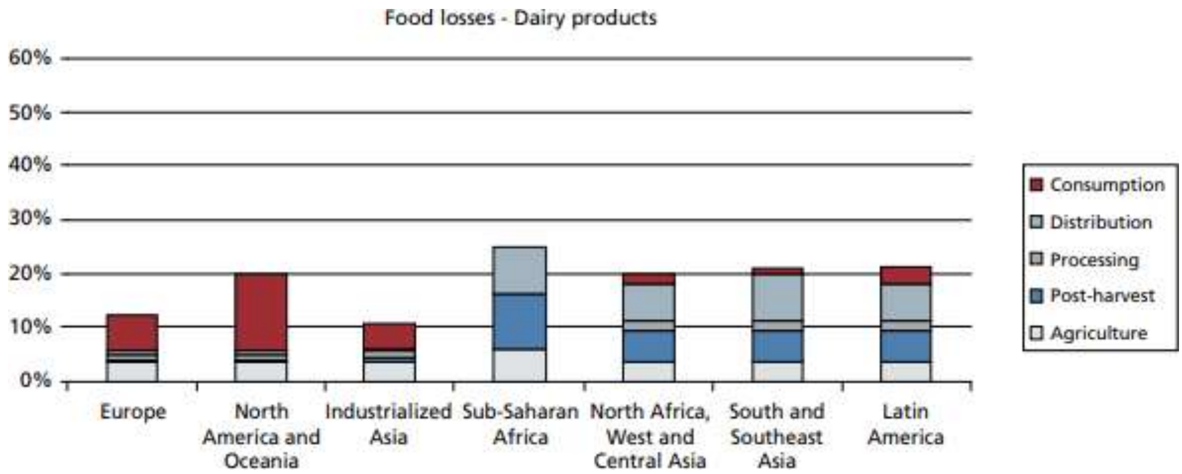
The terms "Food Loss" ("FL"), "Food Waste" (FW), "Post-Harvest Losses" (PHL), and "Food Loss and Waste" (FLW) are frequently used synonymously, but they rarely refer to the same concept. Some authors associate the difference with the stages of loss. Others differentiate based on the cause of the food loss and whether it was intentional or unintentional, as described by Delgado et al. (2021).

According to FAO (2019), food loss and waste are defined as a decrease in food volume and quality along the food supply chain. Food loss occurs from produce and sales, which doesn't include food waste at the retail or utilization level. Logistic support, a lack of advanced technologies, limited supply chain stakeholders' expertise, awareness, and organizational capabilities, and inadequate market access are primarily to blame.

Milk loss" is used in this study to refer to dairy food losses. Milk losses are losses that occur after milking on the farm and continue all the way through the supply chain to retail. This is milk that is rejected, spoils, or spills due to improper handling, lack of refrigeration, or inefficiencies along the supply chain, whether raw, fresh, or in its various product forms (Munyori, 2019). However, according to Bungoma value chain actors, milk loss refers to milk that is not harvested due to a high prevalence of drought, cow diseases, and poor breeding (Kaptama cooperative representative).

Milk loss during after-harvest storage and handling as well as distribution is relatively high in all African countries, including Kenya (figure 5).

Figure 6: Milk Loss Percentage at Various Stages of Supply Chain worldwide




**Source: FAO, 2O11**

### 2.2.1 Losses in the milk supply chain

**Milk losses at producer/farm level**

Milk rejection and spoilage at the farm level account for the lion's share of the milk losses. Poor hygiene has been identified as the primary source of milk contamination at the producer level. Post-harvest milk handling, such as using unhygienic milking vessels, plastic transport equipment, and personal hygiene of the milker, remains the primary source of microorganism contamination in milk. (Reta et al., 2016; Ahmad et al., 2015).

Similarly, high bacterial counts in milk as a result of poor milk handling and high somatic cell counts as a result of clinical and subclinical mastitis are the main contributors to producer milk losses, according to Kashongwe et al., (2015).

**Milk loses at collection hubs, Processing and Distribution**

**I**nfrastructure is an integral part of the dairy value chain and plays a critical role in milk distribution from producer level to market. Due to the perishability of milk, the quality of storage and transportation infrastructure, including cooling (chilling and refrigeration), and roads, is the key determinant of losses incurred in the dairy industry. According to FAO (2011), the lack of a cooling system (cold chain), particularly in the informal market, and an insufficient cold chain in the collection hubs and during distribution are the root causes of milk losses.

Coolers are typically avoided because of the additional costs associated with cooling. Milk standards, on the other hand, recommend that milk be cooled at a temperature of 4 °C immediately after milking or within two hours of milking. However, milk collection hubs are often located far from the farm gate, and depending on the landscape and proximity, it may take 2–6 hours to reach the milk collection hubs (Kaindi et al., 2011, Wafula et al. 2016).

The extensive distance thus raises milk acidity levels, which is an indirect indicator of the fermentative Lactobacillus species in milk. Thus, a high initial bacterial count reduces the shelf life of raw or pasteurised milk, resulting in spoilage (Kaindi et al., 2011, Wafula et al., 2016). Furthermore, the lack of a uniformly monitored quality control system, which leads to violations of quality standards such as adulteration, is one of the major impediments to the growth of the Kenyan dairy industry. When adulterants such as water and hydrogen peroxide are added to milk, its safety and quality are not only jeopardized, but milk losses increase.

Antibiotic residues also endanger food safety. Tetracyclines, sulphonamides, trimethoprim, nitrofurans, aminoglycosides, beta-lactams, and quinolones are the most used treatments in food-producing animals in Kenya, in addition to antimicrobial residue standards set by the Codex Alimentarius Commission (FAO and WHO 2011). Several studies have discovered antibiotic residues in milk. Kenyan dairy farmers, in contrast, are said to be antimicrobial illiterate (Kosgey, 2018; Orregård 2013).

Numerous studies have been published on the effects of farmers and traders failing to meet milk quality requirements on food safety. Noncompliance frequently results in milk rejections, resulting in massive losses. To develop a mitigation strategy, it is critical to quantify the actual milk losses caused by noncompliance with quality requirements. According to Ndambi et al. (2018), Happy cow processor implemented a quality-based milk payment system (QBMPS) pilot in Kenya to determine how investment in quality infrastructure reduces milk rejection at collection centers

### 2.2.2 Impact of milk losses

**Economic impact**

Ethiopian studies on smallholder dairy farmers' economic impact of subclinical mastitis reported a financial loss of USD 79 per cow per lactation (Tesfaye et al. 2010). According to Muturi (2020), milk quality loss results in economic loss due to the somatic cell count of milk and milk withdrawn during and after antibiotic treatment as well as treatment costs. Furthermore, Hodges (2020) contends that consumers pay a lower price for inferior quality products, resulting in economic losses.

Failure to fulfill consumer needs is worsened by losses at different points throughout the supply chain, which are estimated to be roughly 25% of total output, resulting in a USD 23 million yearly economic loss (Kabwanga and Atila, 2015).

**Carbon footprint**

Apart from producing only 3.5% of total milk products globally, Sub-Saharan Africa has the highest number of dairy herds (21%), implying that milk yield per cow is lower than the global average, resulting in three times the world's GHG emissions, implying that the higher the GHG emissions, the lower the milk output (FAO, 2022). Furthermore, the FAO's Global Cattle Environmental Assessment Model (GLEAM10) estimates that greenhouse gas emissions (GHG) from dairy cattle production in Sub-Saharan Africa total up to 119 million tons of CO2-Eq (FAO 2017).

The emission intensity of milk production is associated with higher emission intensities in developing dairy regions such as South Asia, Sub-Saharan Africa, West Asia, and North Africa (ranging from 4.1 to 6.7 kg CO2 eq. per kg FPCM) than in developed dairy countries (ranging from 1.3 to 1.4 kg CO2 eq. per kg FPCM), FAO and GDP (2018).

Kenya's average annual milk production is lower (about 1,800 kg/cow/year, compared to 8,000–9,000 kg in Europe or 10,000 kg in the US and Israel). Increasing productivity is vital in addition to avoiding milk loss in the dairy supply chain (Gromko and Abdurasulova, 2019). Moreover, Kenya has three times the global average emissions per unit of milk produced (Opio, 2013), with milk product demand for milk products predicted to quadruple in 2050, raising it even more (Herrero et al., 2014).

The dairy sector in Kenya is a substantial source of GHG emissions in the country, while the proportion of GHG emissions is still debatable. Based on national dairy data, roughly 5.2 kg of CO2 equivalent are emitted for every kilogram of milk produced (including enteric emissions and manure management), or 12.3 Mt CO2 e per year in Kenya (WRI CAIT 2.0 2017). Kenya's overall GHG emissions in 2013 were

60.2 Mt CO2 e, implying that dairy industry emissions account for roughly 20% of total emissions (USAID 2017).

Wilkes et al., (2020) claim that the average carbon footprint (CF) in central Kenya ranged between 2.19 and 3.13 kg CO2e/kg FPCM, whereas Ndung'u et al., (2021) claim that the total carbon footprint (FP) in western Kenya, which was carried in three counties Nandi, Nyando and Bomet was 2.3 kg CO2-eq/kg milk. Aside from milk loss being a major issue in dairy, determining its contribution to GHG emissions is vital.

### 2.2.3 Milk loss mitigation strategies

Multiple approaches to reducing milk loss have been developed, according to Affognon et al. (2015). Fostering public-private partnerships and attempting to improve storage are just a few examples of what could be done. On the other hand, the lack of solid data on food loss along the supply chain sabotages efforts to reduce it.

Good agricultural and manufacturing practices, combined with an effective control system, reduce the likelihood of a production chain failure necessitating the discard of dairy products to ensure product safety and quality. Milk hygiene in milk production facilities and during transportation; animal health; antibiotic prevention; milk equipment; heat treatment; and sanitation are also suggested mitigation strategies. However, a lack of data on milk loss can result in massive losses and a low level of commitment to loss reduction.

For example, actors may exaggerate the amount of milk lost, limiting their understanding of the benefits of eliminating it. Several proposals to reduce milk losses have been made, including a continuing push to change the legislation governing the use of shelf-life information to protect the industry from avoidance of unnecessary litigation, promotion of customer safety, and prevention of food losses or waste (Bremmers et al., 2015). Furthermore, Kaipia et al., (2013) and Gobel et al., (2015) argue that one way for increasing long-term collaboration along the value chain is to share information and responsibilities across stakeholders.

These studies also revealed that in the dairy business, actors' willingness to adjust in order to reduce losses or waste is high. Losonci et al. (2011) and Turesky and Connell (2010) found that stakeholders' perceptions of their ability to effectively implement proposed changes are influenced by their commitment to change. This should be tracked and strengthened over time. As a result, the purpose of this research is to better understand stakeholders' perspectives on milk loss reduction in the dairy value chain.

## 2.3 Definition of concepts

**Food loss and waste(FLW)**: defined as food intended for human consumption that is lost over time between post - harvest and utilization (HLPE 2014; FAO, 2011).

**Food**: is defined as any substance fit for human consumption, whether processed, semi-processed, or raw, and includes beverages as well as any substance used in agricultural production.

**Food loss**: occurs when food is spilled or spoiled prior to the final product or retail stage. This could be due to problems at any stage of the value chain. It could also be the result of problems with markets, institutions, and policy frameworks.

**Food waste:** includes any food that is safe for human consumption but is not consumed because it is left to spoil or is disposed of by retailers or users.

**Post-harvest loss** refers to the reduction in quantity or quality of produce between harvest and sale.

**Qualitative postharvest milk loss** refers to the reduction in milk freshness and nutritive value and/or economic worth due to noncompliance with quality standards. This may result in reduced nutritional value. A drop in milk quality may result in unsafe food, posing health risks to customers.

**Quantitative postharvest milk loss** refers to the reduction in the amount of milk intended for human consumption when it is removed from the food supply chain; it is caused by decisions and actions taken by food suppliers throughout the supply chain**.**

**Hotspots** are areas where there is a high risk of pre- and post-harvest losses with economic, social, and environmental consequences; or activities in the food life cycle that require intervention to prevent, completely eliminate, or keep food loss and waste to an acceptable level.

**Value chain** refers to the entire set of activities required to transform products or services from conception to delivery to the final consumer and final disposal after use. (Porter, 1985).

**Supply chain** is the link that connects inputs to the farm and then to storage, processing, transportation, and distribution to the consumer for a specific product via a single chain.

Figure 7: Conceptual Framework

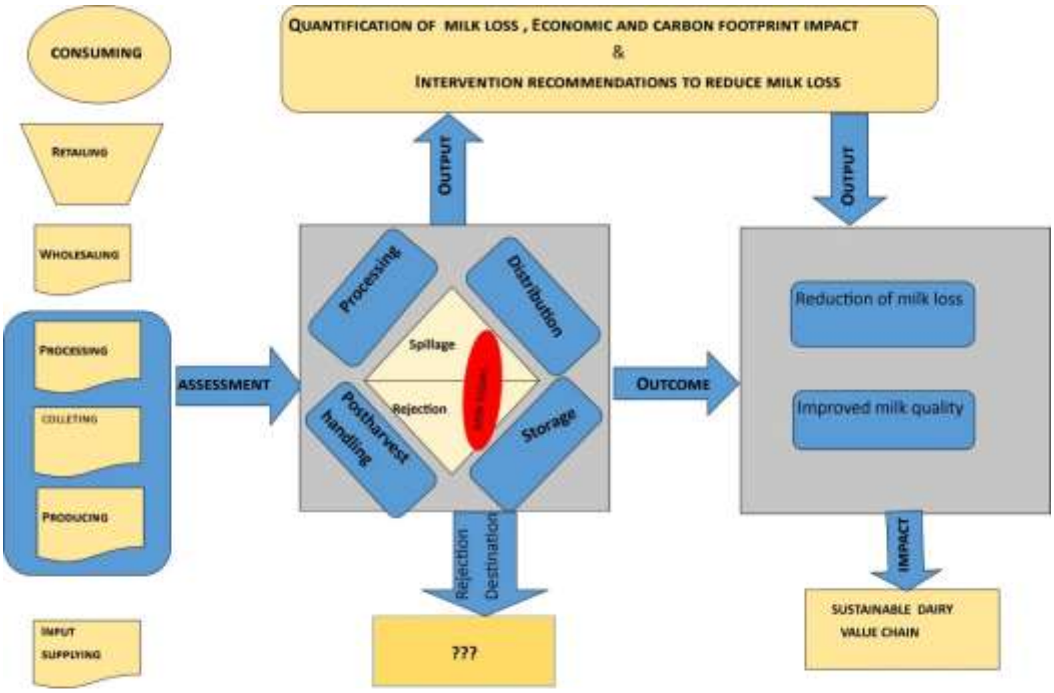


Figure 8: Operationalization

## CHAPTER 3: RESEARCH METHODOLOGY

### 3.1 : study area description

The county of Bungoma is the major focus of the research. The county is located between latitudes 00 28' and 10 30' north of the Equator and longitudes 340 20' and 350 15' east of the Greenwich Meridian. The county has a total area of 3032.4 km2. It is surrounded to the north-west by the Republic of Uganda, to the north-east by Trans-Nzoia County, to the east and south-east by Kakamega County, and to the west and south-west by Busia County. Furthermore, due to varied degrees of attitude, the county's monthly rainfall ranges from 400mm (lowest) to 1,800mm (highest), with the county's yearly temperature ranging from 0°C to 32°C. (2018-2012 CIDP).

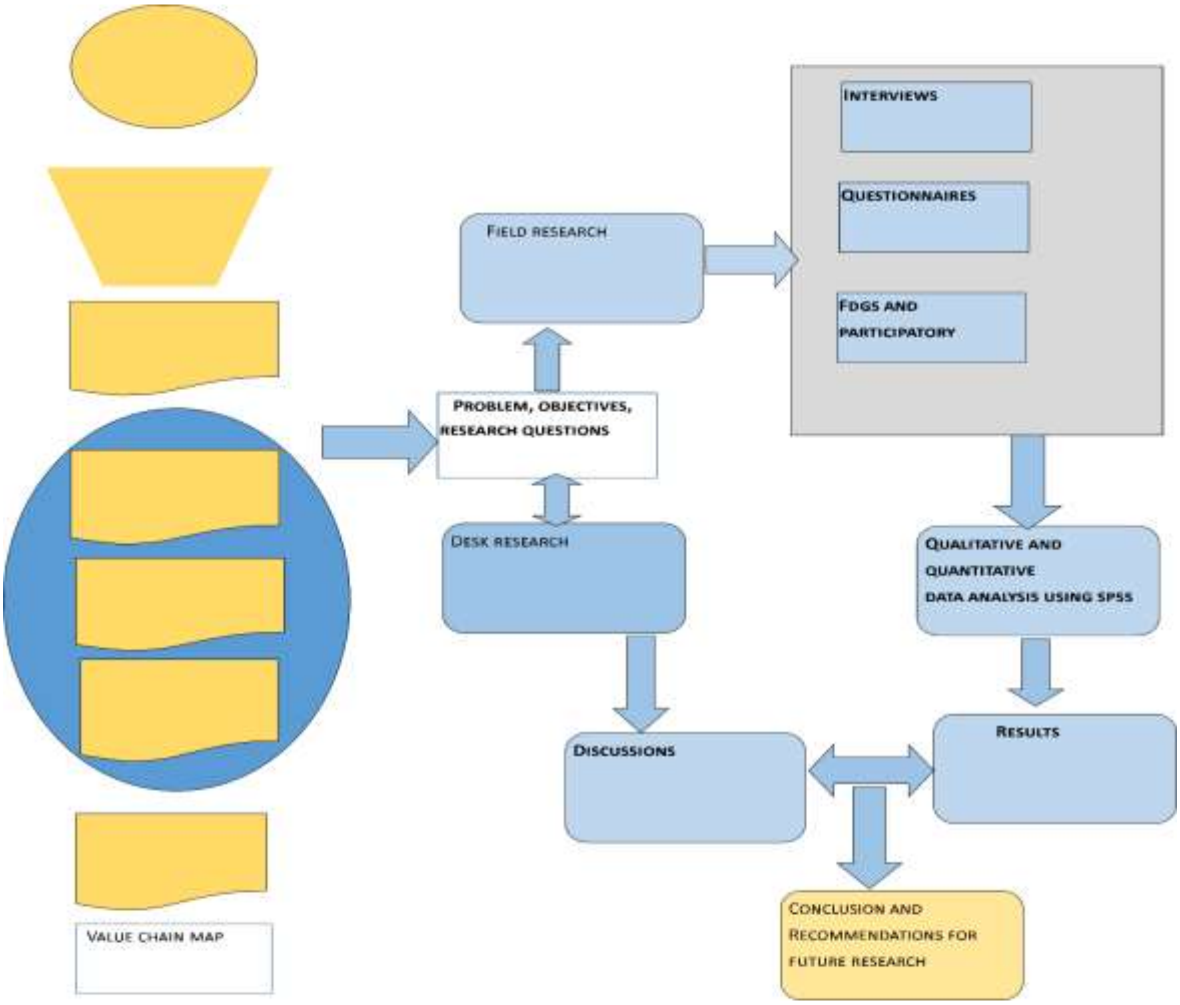
The County is divided into nine administrative Sub-counties: Mt. Elgon, Kimilili, Webuye West; Webuye East, Tongaren, Kabuchai, Kanduyi, Sirisia, and Bumula; however, the research will concentrate Kanduyi and Mt. Elgon because these are the locations of Kitinda and Kaptama DFCS. The Mt Elgon subcounty, which spans Trans Nzoia and Bungoma counties, is famed for maize production, but due to guaranteed payments for milk delivered to processors, more farmers are shifting to dairy farming (2018-2012 CIDP)

Figure 9: Map of Kaptama showing Kitinda and Kaptama KFDC

Source: adopted from Wamboka et al. 2015

## 3.2 Research framework

Figure 10:Research Framework




The research project employed both qualitative and quantitative study methodologies and used a diverse range of primary and secondary data sources to increase the confidence and richness of the findings. In addition, the study employed a descriptive inference design to fully understand the interpretation of milk losses at various stages of the value chain in order to provide informed recommendations and conclusions for developing milk loss reduction strategies. The inferential design was based on descriptive statistics and assertions that illustrate a data set of the entire population of the case study (Saunders et al., 2016).

## 3.3 Sampling Methodology

The 14 key informants were chosen through purposive sampling (actors and supporters). To select 40 dairy producers from the Kitinda and Kaptama FDCSs, simple random sampling was used, with 20 respondents from each cooperative. In addition, 2FGDS respondents were sampled, with each cooperative having eight participants.

*Table 2 Sampling Type and Criteria*

| Stakeholder | Sampling method | criteria |
| --- | --- | --- |
| Smallholder dairy producers | purposive | Members of cooperative |
| Collection clerks | purposive | Working at collection centres |
| Processors | purposive | Processing milk of the cooperative |
| supporters | purposive | KALRO, KDB, MoALFIC, Extension |

Source: Author,2022

## 3.4 Research approach

### 3.4.1 Data collection methods and Tools

a) Desk study

The desk research was conducted using existing secondary data from literature reviews, government official reports, and publications on previous and current investigations. This included information on Kenyan milk losses as well as Bungoma County losses.

b) Case study

The research was conducted on two sub-counties in Bungoma: Kanduyi and Mt. Elgon, which are part of the Kitinda and Kaptama DFCSs, to gather insight into the quantity of milk lost, where it occurs, awareness, and measures to be implemented.

c) Survey

The survey was applied in this research, which covered a significant number of dairy value chain stakeholders, and purposely random sampling was used to collect a complete and wide variety of information about the study region based on the commissioner's interest (FORQLAB).

### 3.4.2 Description of data sources

**Structured questionnaires**

A farmer survey of smallholder dairy producers was organised by Kitinda and Kaptama DFCS. A semi-structured questionnaire (Annex 1) was distributed to 40 smallholder dairy producers, 20 from each cooperative. This was presented to respondents one on one to ensure they understood the question and to accommodate individuals who are unable to write or read. The questionnaire was used to collect both qualitative and quantitative data. To efficiently gather data on the many study elements, the questionnaire was separated into parts. These parts covered household information, milk output throughout the wet and dry seasons, milk rejection and spillages, use of morning and evening current milk reduction measures and obstacles encountered.

**Participatory Focus Group Discussion (FDGS)**

Focus group discussion was held in a hotel in Kaptama and a milk collecting site in Kitinda town. Smallholder dairy farmers who had previously been interviewed attended the conversation and contributed to it. FGDs were conducted a day following survey administration held as a preliminary session to discuss the outcomes of the questionnaires. Discussion was expected to have 8 participants some requested to joined and were allowed.

Probes, follow-ups, and confirmation questions were used to ensure that no information is overlooked. During the discussion, chain map images, seasonal calendars, and interactive tools were also used. Farmers were able to view their value chain map and identify locations where milk loss occurs, as well as show seasons with the highest losses and rank the most common type of loss. The main reason why FGD was conducted was to triangulate with questionnaire findings.

**Semi-Structured Interviews**

A mix of planned and unstructured interviews were done with key informants in each cooperative. Interviews were done at Kaptama Key informants were (6) Manager, extensionist, transporter, quality technician, and Brookside personnel. Kitinda DFCS's key informants interviewed are: chairman, manager, quality technician, and two transporters were also interviewed.

In addition, cooperative supporters, including the KDB, livestock director, and a KALRO representative, were questioned. Checklist forms were used to conduct interviews. The checklists assisted in the direction of the data collecting interviews, and the majority of the data was later triangulated using FGD findings.  During interview process, videos and notes were taken.

**d) Desk research**

The secondary data was used in the discussion to compare the results with what other researchers found. In addition to creating an interview checklist and survey questionnaire.

Figure 11: Number of farmers surveyed, key informants interviewed and FDGS members

| Data source | Goal | Data | Stakeholders | Numbers of stakeholders |
|---|---|---|---|---|
| Semi-structure Interviews | Depth on amount milk loss and create room for probing | Qualitative and quantitative data | Key informants: **Kaptama (6)** Manager, Extensionist, Transporter, Quality Technician, and Brookside personnel. **Kitinda (5):** Chairman, Manager, Quality Technician, (2) Transporters **Supporters (4):** KDB, Ward Livestock officer, Livestock Director, and KALRO representative | 15 |
| Structured questionnaires | Milk production, milk losses, strategies, obstacles | Qualitative and quantitative data | 40 Producer households | 40 |
| FDGs | In-depth information about group view on amount of milk loss | Qualitative data | 2 farmer groups of 8 members | 16 |

**Piloting**

Prior to collecting actual data, various data collection methods will be tested on classmates. They were tested for accuracy in identifying the desired data with the greatest degree of precision, in accordance with the desired data reliability and validity. The questionnaires were also be tested on two in a different county, to ensure that they are clear and understandable enough to provide the precise data required during field data collection.

## 3.5 Data Analysis

**a) Focus group discussions and Key informant interviews**

The information gathered was transcribed by going over notes and audio recordings from interviews and focus group discussions. Then, a major theme was identified; themes are the major ideas that emerged during your focus group discussion. The information was then organized and classified based on the question and response. Finally, the findings were interpreted, analyzed, and presented.

Figure 12: Focus group discussions

**a) Value chain analysis**

A value chain map was used as an interactive tool during group discussions. During the presentation of the results, a new chain map based on field data was created, highlighting the key leverage points for interventions**.**

### 3.5.2 Quantitative analysis

Quantitative data was analyzed both descriptively and inferentially using frequencies, percentages, mean and standard deviation. The findings were presented using tables and charts.

**b) Economic losses**

To analyze quantitative data that is both descriptive and statistical, the SPSS version 27 (Statistical Package for Social Sciences) was used. Annual milk production per household was estimated based on the following factors to calculate milk loss at each stage:

- The calculations derived from the collected data can generalize across the entire population of Kitinda and Kaptama Cooperatives

- That the dry season lasts if the wet season and is equal to half a year (180 days)
- Calving interval will between 14-22months
- Because peak milk production is 70% higher than average, peak/1.7 is the average milk production.

i. **Calculation of total herd and lactating cows/HH/year**
   a. Total herd size = Average herd/HH*number of HH in the coop
   b. Total lactating cows= Average lactating cows/HH* number of HH in the coop

ii. **Total milk production/cow/day in Kitinda and Kaptama milkshed**

Total average milk produced/cow/day = Average peak/1.7

iii. **Total milk production/lactation period**

Total average milk produced/cow/day x lactation length (days) x year/calving interval

**Total Milk production /HH/year(farm)**

= Total milk production/lactation/cow* number of lactating cows

**Total milk production/coop**

=Total Milk production /HH/year(farm)*number of HH/coop

iv. **Total milk consumed/HH/year**

Total consumed/ the HH level = total number of HH * Total milk consumed day x 360days

Calves number = Equal number of lactating cows/HH

Total amount of milk fed = Average calves-fed /day* 90days

Total milk consumed / HH level = (Total milk consumed + total milk fed to calves)

v. **Total milk lost/HH/year at production**

Total milk losses (litres) at farm level = (Total spillages/day/HH+ total spoilage/day/HH)

Total loss/year/HH= Average loss/day/HH* 360days

Total loss/year/coop = Total loss/year/HH* Number of HH

vi. **Total milk lost/year at cooperative level**

=. Total milk loss /day/HH (total rejection+ spillages)

=Total milk loss/day/HH *HH in coop

vii. **Total milk loss at processing level**

= The average milk rejection / day * 360 days

viii. **Total milk los/coop/year:**

Total Milk loss = ∑production losses + ∑/coop/collection losses+∑Processing losses

ix. **Food loss share**

Production share= (**Total Production losses/year/coop**)/ Total milk losses/year/coop*100%

Collection share= (**Total Collection losses/year/coop)/** Total milk losses/year/coop*100%

Collection share= (Total **Processing losses/year/coop)/** Total milk loss losses/year/coop*100%

x. **Economic losses impact = total milk loss/year/coop x*mean purchasing price.**

∑ production losses=average milk lost/year/coop* average price of milk

∑collection losses= Average milk lost/year /coop* average price of milk

∑processing losses= average milk lost /year/coop * average price of milk

xi. **Contribution of milk Carbon footprint (CF)**

Milk production in western Kenya contributes 80-85 percent of total Carbon footprint (FP) output, with 2.3 kg CO2-eq/kg milk, according to Ndung'u et al., (2021). The carbon footprint of milk losses in this study will be calculated using the Cf of centra Kenya of 2.19 and 3.13 kg CO2e/kg FPCM Wilkes et al., (2020) to calculate the GHG of milk losses because milk production/cow/year is low and CF is expected to be higher.

Average carbon footprint (CF)= total milk loss/kg FPCM*3.13kg CO2e/kg FPCM,

Fat %=4%

Protein% = 3.2%

## 3.6 Ethical considerations

This study was performed in accordance with research virtue ethics. Data was collected and stored securely and anonymously. Informed consent was obtained prior to collecting data, taking photographs, or recording. Furthermore, a fair deal on support, fairness, and participants' legal protections in data and publication was prioritized.

## CHAPTER 4: RESULTS

This chapter summarizes the research findings, which were derived from a literature review, survey questionnaires, and key informant interviews. Tables, figures, and descriptions were used to present the findings.

**SECTION A: RESULTS OF A SURVEY QUESTIONNAIRE**

**Profile of the respondents**

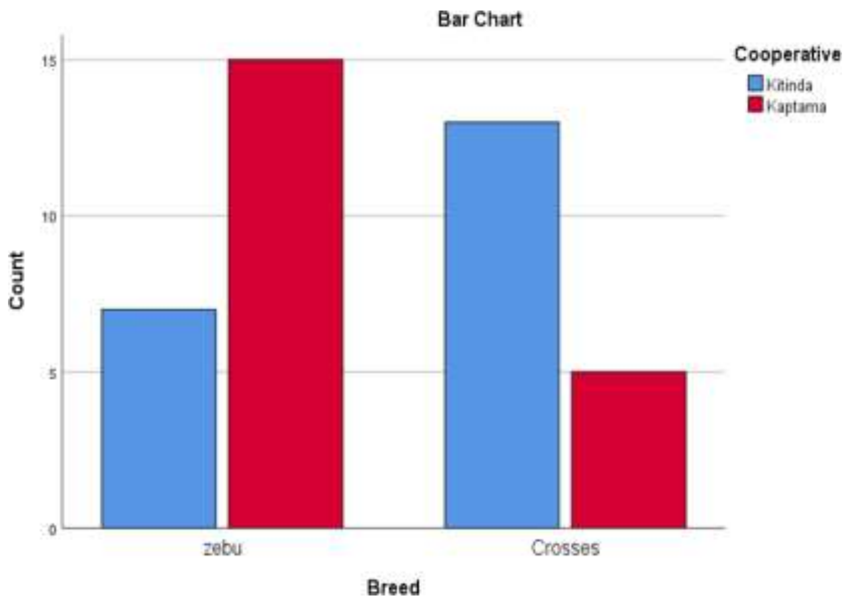
Most respondents (50%) were between the ages of 35 and 50, with just 9% being beyond the age of 55. While females made up the largest portion of the sample (58%), males made up the smallest portion (42%). In addition, the majority of those surveyed were well educated, with 60% having completed primary and secondary school and a few having completed university education **(annex 2).**

### 4.1 Total milk production

a) Breed

The results show that the main breeds in both cooperatives are 55% zebu and 45% crossbreds. Zebu breeds account for approximately 32% of Kitinda and 68% of Kaptama, while crosses account for 72% of Kitinda and 28% of Kaptama.

Figure 13: Breeds kept by both cooperatives




b) Herd composition

The T-test significance value is (P>0.05), indicating that there were no significant in variations the herd composition of kaptama and Kitinda Cooperatives, with an average number of lactating cows of 1.7 and 1.5 cows/HH at any time of the year

Table 3: total herd parameters according to smallholder farmers

| **Cooperative** | **Kitinda n=20**<br>**Mean ± Std.Dev)** | **Kaptama n=20**<br>**Mean ± Std.Dev)** |
|---|---|---|
| Average calves /HH | 2.0 ± 1.0 | 1.0 ± 1.0 |
| Average heifers/HH | 1.0 ± 0.8 | 1.0 ± 1.0 |
| Average bulls/HH | 0 .0 ± 0.0 | 1.0 ± 1.0 |
| Average oxen/HH | 0.2 ± 0.6 | 1.0 ± 1.0 |
| Average cows in lactating cows/HH | 1.7 ± 1.0 | 1.5 ± 1.0 |
| Average herd/HH | 4.9 ± 3.4 | 5.5 ± 5.0 |
| Cooperative HH members | 1,000 | 1,260 |
| Total lactating cows | 4,700 | 6,930 |
| Total herd size | 4,900 | 1,890 |

**Note***:* Total herd size = Average herd/HH*number of HH in the coop

Total lactating cows= Average lactating cows/HH* number of HH in the coop

**c) Total average milk production per cow/day in both the wet and dry seasons**

In Kitinda and Kaptama cooperatives, the average milk yield is 2.8 and 2.9 liters/cow/day, respectively. The t-test significance result is ($P>0.05$), showing that there were no substantial differences in milk production/cow in both Cooperatives all across the wet and dry seasons.

**Note**: Because peak milk production is 70% higher than average, peak/1.7 is the average milk production. Furthermore, milk left for the calf is included in the total average production because one of the teats is left for the calf during milking for the first three months(90days) before weaning.

Table 4:Total milk production/cow/day

| **Production Parameters** | **Kitinda(n=20)**<br>**(Mean ± Std.Dev)** | **Kaptama (n=20)**<br>**(Mean ± Std.Dev)** |
|---|---|---|
| Average peak milk production/cow/day<br>Wet season (180 days) | 4.6 ± 3.6 | 5.4 ± 11 |
| Average peak milk production/cow/day<br>**Dry season** (180 days) | 2.9 ± 1.7 | 2.7 ± 3.4 |
| Average peak /cow/day | 3.8 ± 2.7 | 4.1 ± 7.2 |
| Average milk production/day* | 2.2 ± 1.6 | 2.4 ± 0.4 |
| Calf production/day | 0.6 ± 0.1 | 0.5 ± 0.6 |
| Total milk production/cow /day<br>(calf + average milk/day) | 2.8 ± 1.7 | 2.9 ± 1.0 |

**Note*:** Total average milk produced/cow/day = Average peak/1.7

#### d) Production and economic parameters

The t-test significance value is P>0.05, indicating that there were no significant differences in production and economic parameters between Kaptama and Kitinda cooperative households (table 5).

Table 5: Production and economic parameters of Kitinda and Kaptama households (HH)

| **Production parameters** | **Kitinda (n=20) mean ± Std.Dev)** | **Kaptama (n=20) ((mean ± Std.Dev)** | **Total (n=40) (mean ± Std.Dev)** |
|---|---|---|---|
| Type | Smallholder | smallholder | |
| Land size(ha) | 0.6 ± 0.7 | 1.5 ± 2.2 | 1.0 ± 1.5 |
| Herd size | 4.9 ± 3.3 | 5.5 ± 5.0 | 4.5 ± 3.0 |
| Milking cows | 1.7 ± 1.0 | 1.5 ± 0.7 | 1.6 ± 0.9 |
| Calving interval (days) | 468 ± 144 | 501 ± 153 | 480 ± 150 |
| Milk /cow/day (Litre) | 2.8 ± 1.7 | 2.9 ± 1.0 | 3.9 ± 5.0 |
| Lactation length(month) | 8.4 ± 1.9 | 8.2 ± 1.8 | 8.2 ± 1.8 |
| Milk / cow / lactation day (Litre) | 706 ± 97 | 713 ± 57 | 710 ± 77 |
| Milk /HH/year (Litre)(farm) | 1,200 | 1,070 | 1,135 ± 126 |
| Milk/cooperative/year* (Litre) | 1,200,000 | 1,348,200 | 2,657,760 ± |

**Note*:** Total average milk produced/cow/day x lactation length (days) x year/calving interval

- Total milk/farm/year=milk yield/lactation* lactating cows
- P>0.05, there is no significant difference in production and economic parameters(table5)
- Kitinda (1,000HH), Kaptama (1,260HH**)**

#### e) Total milk consumption and total milk sold/day/HH in the research cooperatives

According to the study's findings, each HH in Kitinda and Kaptama consumes 1.6 and 1.7 liters of milk per day, respectively. During the wet and dry seasons, milk consumption includes milk used or consumed at home as well as milk fed to calves. The t-test significance level is P>0.05, indicating that there is no difference in total milk consumption and milk sold/day/HH between the wet and dry seasons.

Table 6: average milk consumption/day/HH

| Milk consumption parameters | Kitinda (n=20) (mean ± Std.Dev) | | | Kaptama (n=20) (mean ± Std.Dev) | | Total |
|---|---|---|---|---|---|---|
| **Season** | **Wet** | **Dry** | **Total** | **Wet** | **Dry** | **Total** |
| Home consumption | 1.7 ± 0.9 | 1.5 ± 0.9 | 1.6 ± 0.9 | 1.9 ±1.4 | 1.7 ± 1.0 | 1.7 ± 1.2 |
| Calf consumption | 1.2 ± 0.6 | 1.1 ± 0.3 | 1.2 ± 0.5 | 0.9 ± 0.8 | 0.9 ± 0.3 | 0.9 ± 1.1 |
| Milk sold | 2.2 ±0.9 | 1.3 ± 1.2 | 1.8 ± 1.0 | 2.1 ± 1.3 | 1.4 ± 0.9 | 1.8 ± 2.2 |
| Average milk consumption/day/HH | | | 4.6 ± 2.4 | | | 4.4 ± 4.5 |

**P>0.05,** there is no significant difference in consumption parameters between cooperatives (table 6).

## 4.2 Food loss share per cooperative

**Total milk lost at the farm/production level per year**

The study indicates that there is no difference in total milk lost due to spoilage and spillage between the two cooperatives. It was discovered that each HH in Kitinda and Kaptama lost 25 and 18 liters of milk each year, respectively.

Table 7: total milk losses (litres) at farm level

| | Kitinda (n=20) (1,000 households) | | | Kaptama (n=20) (1,260 Households | | |
|---|---|---|---|---|---|---|
| **Loss** | **Wet** | **Dry** | **Total annual** | **Wet** | **dry** | **Total annual** |
| Spoilage | 0.04 ± 0.07 | 0.01 ± 0.01 | 0.03 ± 0.04 | 0.03 ± 0.06 | 0.02 ±0.04 | 0.02 ± 0.05 |
| Spillage | 0.08 ± 0.2 | 0.03 ± 0.7 | 0.04 ± 0.13 | 0.04 ±0.1 | 0.02 ±0.04 | 0.03 ± 0.07 |
| Total loss/day | | | 0.07 ± 0.17 | | | 0.05 ± 0.12 |
| Total loss/year/HH | | | 25 | | | 18 |
| Total/year/cooperative | | | 25,000 | | | 22,680 |

**Total milk loss per year at collection points /cooperative as per farmers findings**

The t-test significance level in both Kitinda and Kaptama is P>0.05, indicating that there is no significant difference in total milk loss due to water adulteration and spillage in the dry and wet seasons. While the significance t-test for milk lost due to spoilage in both Kitinda and Kaptama cooperatives during the dry seasons is P< 0.05 indicating that there is a significant difference in milk spoilage (table 7)

Table 7: Total milk loss/cooperative/year(litres)

| **Type of milk loss** | **Kitinda (1,000 households) (Mean ± Std.Dev)** | | | **Kaptama (1,260 Households) (Mean ± Std.Dev)** | | |
|---|---|---|---|---|---|---|
| Season | **Wet** | **Dry** | **Total annual** | **Wet** | **dry** | **Total annual loss** |
| Rejection (water adulteration) | 0.2 ± 0.3 | 0.06 ± 0.8 | 0.13 ± 0.9 | 0.09 ± 0.2 | 0.06 ± 0.1 | 0.08± 0.2 |
| Rejection(spoilage) | 0.15 ± 0.3 | a0.25 ± 0.3 | 0.2 ± 0.3 | 0.06 ± 0.1 | b0.07 ±0.2 | 0.07 ± 0.2 |
| Spillage | 0.03 ± 0.07 | 0.03 ± 0.06 | 0.03 ± 0.07 | 0.04 ±0.07 | 0.02 ±0.04 | 0.02 ±0.06 |
| Total milk loss /day/HH | | | 0.36 ± 1.3 | | | 0.17± 1.06 |
| Total milk loss /year | | | 130 | | | 61 |
| Total milk loss /year/HH | | | 130,000 | | | 76,860 |

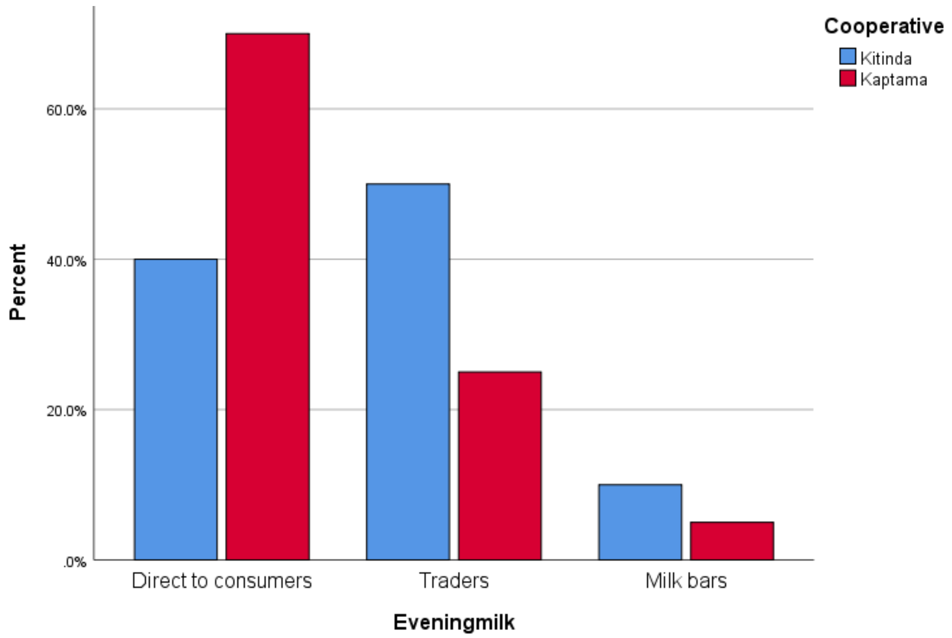
a-b **Significant difference at P<0.05**

**Evening milk selling channels**

Farmers sell most of morning milk to cooperatives, while farmers sell their evening milk through other channels based on data gathered by farmer to obtain instant cash and a higher price. According to a Cooperatives' key informant, the farmgate price of milk for traders and direct consumers is 45 KES/L in the wet season and 60 KES/L in the dry season, compared to the cooperative price of 33 KES and 35 KES per liter in the dry and wet seasons. Additionally, cooperatives don't buy evening milk.

Kitinda and Kaptama farmers both sell their milk to direct consumers, traders, and milk bars. Most farmers sell directly to consumers, such as hotels restaurants, and schools, with only a small percentage selling to milk bars. (See Figure 11)

Figure 14: Evening milk selling channels




**Milk storage and transporting cans**

Farmers in both cooperatives use plastic cans for milk storage and transportation, (figure 12). Despite the fact that the Kitinda cooperative has both aluminium and Mazzican (KDB-certified cans), farmers and transporters continue to use plastic cans for delivery. Kitinda key informant (transporter) continued by saying that he uses both aluminium and plastic cans but prefers plastic cans since they store more milk per trip (200 litres) and are lighter to handle. In contrast, the Kaptama cooperative delivers and stores milk in plastic cans in conjunction with farmers.

"**The use of plastic containers in the cooperative accounts for 60% of milk losses, with the main challenge being that Kaptama is a marginalized community with a high poverty index and thus cannot afford to buy those milk cans"** an interview with Kaptama key informant

Figure 15: Type of milk cans used in milk transportation and storage

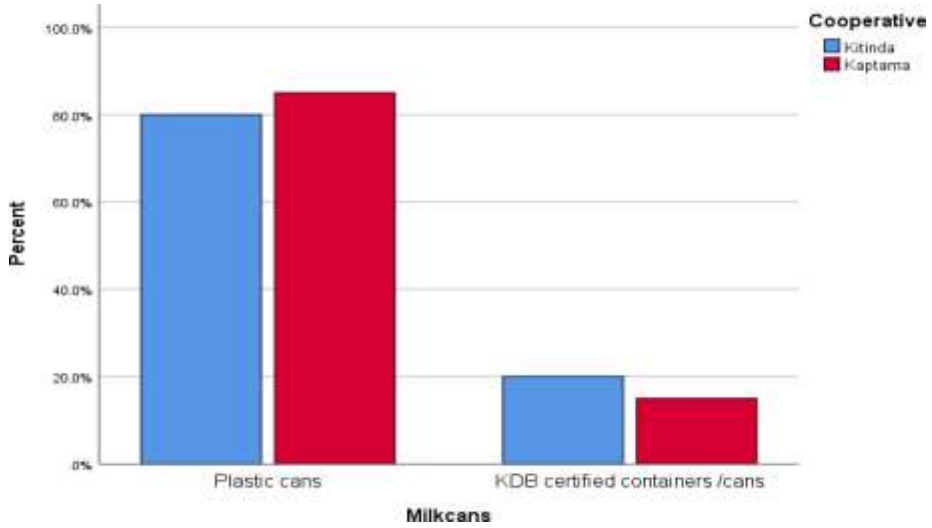


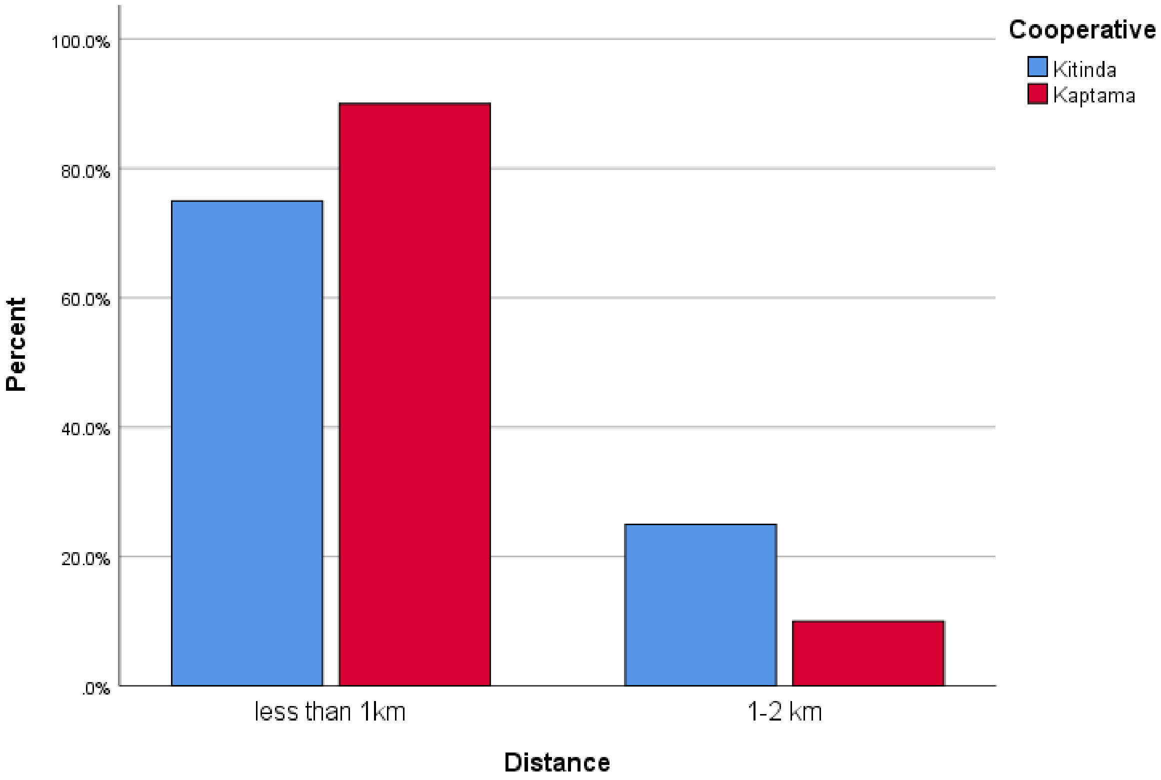

*Figure 16: Field photos showing milk transportation by use of plastics cans in Kitinda and Kaptama*

**Distance from farmers gate to collection point**

According to the findings, the average distance from the farm to the collection points in both cooperatives is less than a 1 km, indicating that collection points are close to farmers. However, the

average distance between the collection center and the cooperative is quite long, motorcycles are commonly used as a mode of transportation, and they are quite expensive.
The Kaptama livestock officer confirmed that the most distant area in Kaptama where milk is collected is Nomiro, 30 kilometers away. This contributed to milk delivery delays, resulting in milk losses. Additionally, Kitinda's milk quality technician stated that transporters take 3 hours before delivering milk due to bad roads that cause milk spoilage due to high bacterial count.

Figure 17: Distance between farm gate to collection point




**SECTION B: RESULTS FROM FDGS AND KEY INFORMANTS' INTERVIEWS**

FDGs was conducted after survey as a preliminary session to discussing outcomes of questions and to compare what individual respondents provided was in an agreement with group view. FDGs and interview results are presented in this section.

**a) Collection points per cooperative**

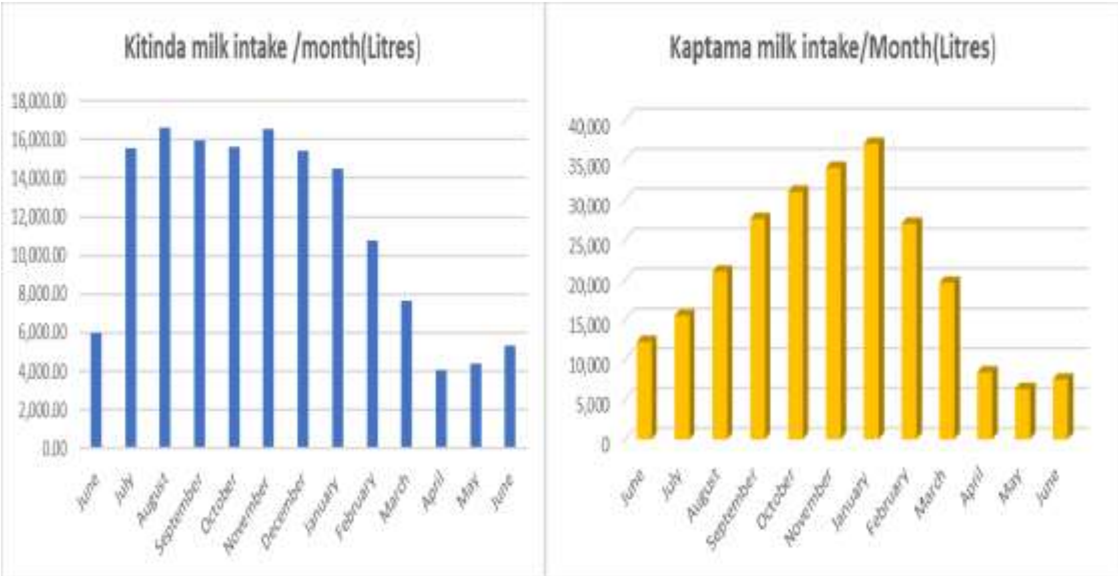
Kitinda has 16 transporters and 13 routes with milk collection points, according to research findings. Among the names are Main, Mabuusi, Namwacha, Kabuchai, Sikalame, Watwang'a, Mechimeru, Matisi, Bokoli, Jitolee, Kikai, Loom, and Mabanga Seminary. Kitinda also loses 10 to 20Litres per day per collection route/point due to the mixing of morning and evening milk during the wet season and water adulteration during the dry season, as explained by one of the transporters.

On the other hand, Kaptama cooperative has 16 collection points, according to cooperative transporter: Kaptama, Chepsinende, Chesito, Kaboywo, Chelillde, Kakunga, Machewa, Chemichemi, cherongos, Chemoge, Kiptiriko, Chepsoikei, Kongit, Chemses, Nomorio, Kamuneru. Key informant reported that each collection point loses approximately 20 litres per week as result of water adulteration. In addition, both cooperatives perform only lactometer test at the collection.

**b)** Milk intake/cooperative

Figure 14 depicts the milk intake of the Kitinda and Kaptama cooperatives from June 2021 to June 2022. The lowest daily intake occurs from February to June, while the highest occurs from July to January. This means that the months of February to June are dry and produce little milk, whereas the months of July to January are wet and produce more milk.

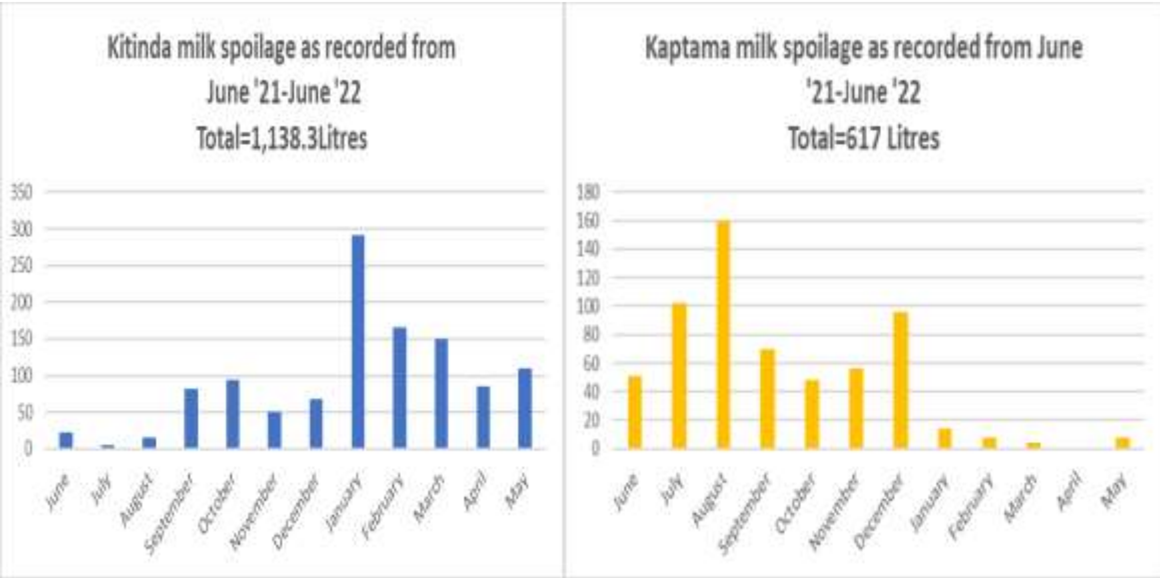
Figure 18: Kitinda and Kaptama milk intake recorded from June21'-June22'




b) Milk spoilage recorded from June 2021-June2022per cooperative

Two tests are performed at the cooperative level: the lactometer and the alcohol milk gun test. If the lactometer measurement is not between 1.028 and 1.032gm/ml, the milk is rejected owing to adulteration. While milk is rejected due to spoilage if tested with an alcohol gun and there is coagulation, clotting, or precipitation, as explained by key informants in both cooperatives. However, only spoilt milk is recorded (figure 15) and disposed of in the septic tank, but water adulterated milk is not recorded and it is re-sold to other dealers such as hotels.

Figure 19: milk spoilage recorded from June'21-June'22/Cooperative




**Milk losses computation at collection/cooperative based key informants**

As per key informants, total milk loss due to milk rejection at the cooperative is 71,339 and 17,897 Litres/HH/year in Kitinda and Kaptama cooperatives, respectively. Kitinda had the highest milk loss

Table 8: milk loss at cooperative/collection based on key informants

| | **Kitinda (n=20)** | | | **Kaptama (n=20)** | | |
|---|---|---|---|---|---|---|
| Losses | Amount /day (Litres) | Number of collections points | Total loss/year | Amount/day Litres | Number of collections points | Total/year(Litres) |
| Rejection at collection/cooperative | 15 | 13 | 70,200 | 3 | 16 | 17,280 |
| Total spoilage recorded Jun'21-June22 | | | 1138.6 | | | 617 |
| Total losses/year/cooperative (litres) | | | 71,339 | | | 17,897 |

**Total losses= amount of losses/day/collection point*collection points*360days**

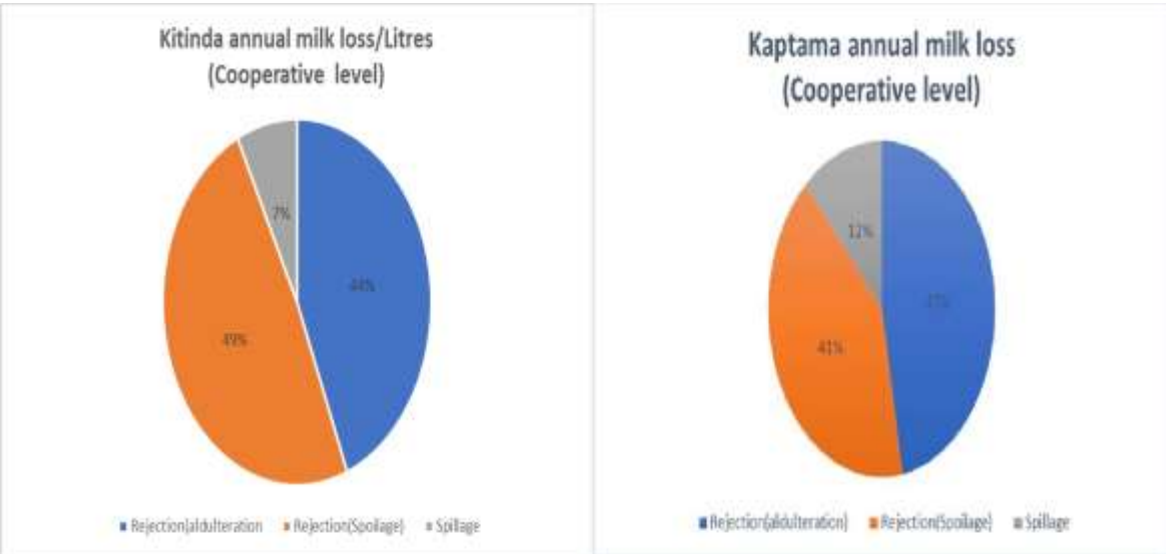
**Milk loss share at cooperative level**

Spillage contributed the least to milk losses in Kitinda and Kaptama, accounting for 7% and 12%, respectively. However, Kitinda has the highest proportion of rejection due to spoilage (49%) while Kaptama has the highest proportion of rejection due to water adulteration (47%) (Figure 16). According to a KDB key informant, milk is transported over long distances, causing acidification, and some transporters purposefully add water to milk to increase volume/money, so transportation causes the most losses.

Kitinda milk spoilage is attributed to the mixing of morning and evening milk and the long distance between collection points to the cooperative points as far as 10 kilometers causing milk spoilage due to high temperatures. However, during the wet season, milk spoilage is high due to poor farmer hygiene, long collection times of up to 3 hours because of poor roads as explained by the key informant.

Kaptama on the hand, has high rejection on water adulteration  as result as processor  strictly rules on milk density testing, milk is only accepted if the lactometer reading is between 1.028 to 1.030mg/l above or below is rejected (interview with key informant).

*Figure 20: share of milk losses at cooperative level*




**Milk loss at processing level/cooperative**

Milk loss at the processing stage occurs in both cooperatives on average once a month but in significant quantities; these losses are reported in both cooperatives. Most of the losses were related to infrastructure issues. Milk contamination by the processing dispenser caused losses in Kitinda, but power outages hampered milk chilling, resulting in milk spoilage at the processing plant in Kaptama**.**

**"We lost 60,000 liters in two weeks without knowing what was causing it. We later discovered that the milk dispenser was the source of the milk contamination "as explained by Kitinda key informant**.

Figure 21: mini-van transporting chilled milk to processing site at Kaptama:

Milk losses at processing level are therefore calculated using based on recorded that in both cooperatives as follows:

Table 9: milk losses at processing level/year

| | **Kitinda (n=20)** | | | **Kaptama(n=20)** | | |
|---|---|---|---|---|---|---|
| | Amount/month | Frequency | Total loss/year | Amount/month | frequency | Total loss/year |
| Average rejection/month | 2,500L | 2 | 60,000 | 400L | 1 | 4,800 |
| Total annually | | | 60,000L | | | 4,800L |

### 4.3 food value loss share

Milk loss in Kitinda and Kaptama cooperatives is 71,339 and 17,897 liters/year/HH, respectively, according to key informant research findings. In Kitinda and Kaptama, total milk loss based on respondents (farmers) is 131,400 and 73,120 liters/year/HH, respectively. Since of the greater sample size, milk loss based on farmers will be utilized to compute economic milk loss because it is more reliable than milk loss based on key informants.

**Kitinda cooperative**

The total food loss value share in Kitinda cooperative shows that production has the lowest milk loss of 850,000 KES (7%), with the highest losses of nearly equal proportion at the cooperative and processing of 5,850,000 KES (51%) and 4,800,000 KES (42%), respectively (table 15).

Table 10: Kitinda food loss value share

| Function | Kitinda milk loss/year | Loss percentage | Price mean/KES | Economic value | Food loss value share |
|---|---|---|---|---|---|
| Production | 25,000 | 12% | 34 | 850,000KES | 7% |
| Cooperative | 130,000 | 60% | 45 | 5,850,000KES | 51% |
| Processor | 60,000 | 28% | 80 | 4,800,000KES | 42% |
| TOTAL | 215,000 | 100% | | 11,500,000KES | 100% |

Total Milk loss = ∑production losses + ∑collection/Cooperative losses+∑Processing losses

**Kaptama cooperative**

The total food loss value share of Kaptama at various levels shows that the lowest milk loss per year is observed at production costing 771,120KES and the highest milk loss per year is depicted at the cooperative level value of 3.5MKES (figure16

Table 11: Kaptama food loss value share

| Function | Total milk loss/year(litres) | Loss percentage | Price mean/KES | Economic value (KES) | Value share |
|---|---|---|---|---|---|
| Production | 22,680 | 22% | 34 | 771,120 | 17% |
| Cooperative | 76,860 | 73% | 45 | 3,515,400 | 75% |
| Processor | 4,800L | 5% | 80 | 384,000 | 8% |
| TOTAL | 104,340 | 100% | | 4,670,520 | 100% |

**Total Milk loss = ∑production losses + ∑collection /Cooperative losses +∑Processing losses**

*Table 12: combined losses for Kitinda and Kaptama/year*

| | **Kitinda** | **Kaptama** | **Combined loss** | **Priceless** | **Economic value** |
|---|---|---|---|---|---|
| **Production** | **25,000** | **18,000** | **22,000** | **34** | **734,000** |
| **Collection** | **130,000** | **76,860** | **103,430** | **45** | **4,654,350** |
| **Processing** | **60,000** | **4,800** | **32,400** | **80** | **2,592,000** |
| **total** | | | **157,830** | | **7,980,350** |

## 4.4 Impact of milk loss on Carbon Footprint (CF)

The average carbon footprint in the western region is 2.3C02equivalent per one liter of milk produced (Ndung'u et al., 2021). However, due low production in both Kitinda and Kaptama CF is expected to higher, therefore an estimation 3.13 kg CO2e/kg FPCM from central Kenya will be used to compute the CF (Wilkes et al.,2020) and estimated 3.5%fat and 3.2% protein

Figure 22: carbon foot of Kitinda and Kaptama milk loss (CO2eq./kg)

| Cooperative | Total milk loss/year(kg) | Total milk loss (kg FPCM) | Carbon footprint/unit (Co2 eq./Kg FPCM) | Total carbon footprint of loss (CO2eq/kg FPCM). |
|---|---|---|---|---|
| Kitinda | 215,000 | 73,741k | 3.13 | 230,809 CO2 |
| Kaptama | 104,340 | 35,786 | 3.13 | 112,010 CO2 |
| total | | | | 342,818 CO2 |

**Total carbon footprint= Total milk loss/year*Co2eq. /Kg**

**kg FPCM = kg milk*(0.337 + 0.116*fat% + 0.06*protein**

Figure 23: Milk loss Carbon footprint percentage

| Cooperative | Total milk loss (CO2eq./kg FPCM) | total milk loss/CO2eq.ton/FPCM 1kg=0.001ton. | Total Kenya CF of loss CO2eq. | Total CF % contribution |
|---|---|---|---|---|
| Kitinda | 230,809 | 231 | 12.3million | 0.00002 |
| Kaptama | 112,010 | 112 | 12.3 million | 0.00001 |
| total | | 343 | | |

**Total contribution of CO2eq./HH**

**Average CF/HH/= total CF/ total number of HH for both coop**

**=343CF/ (1,000+1,260)**

**=0.2CF/ (CO2eq./kg**

## 4.5 Destination of rejected milk at MCC/Cooperative/Processing Level

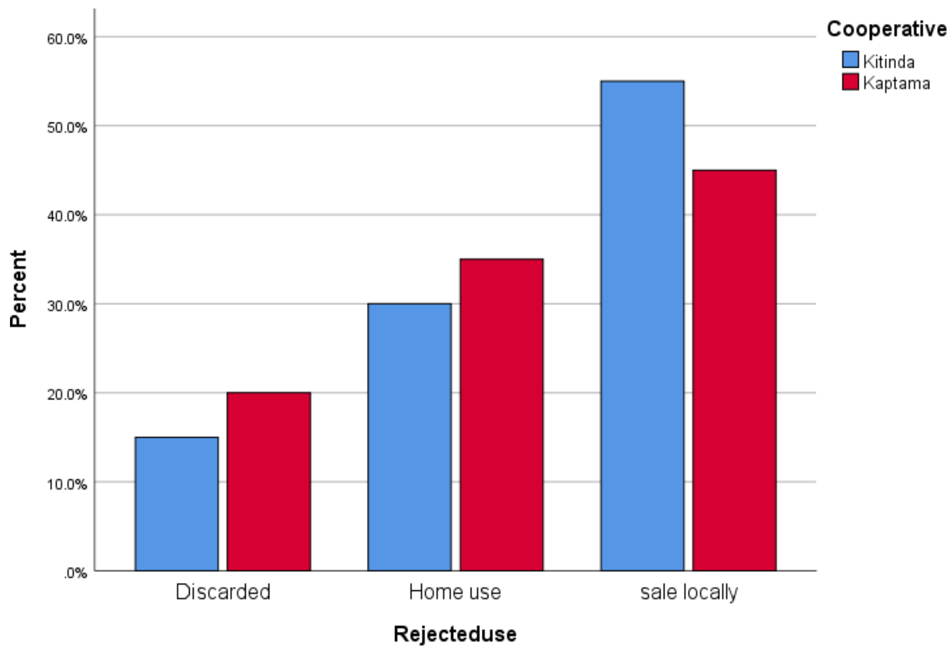
According to dairy farmers survey data, the majority of rejected milk makes its way to the market. This was reinforced by Kitinda's transporter, who stated that discarding milk is considered taboo in their culture. So, if the milk is rejected due to water adulteration, it is either sold locally or used for home consumption. If it is rejected due to spoilage it is either used to make fermented milk, sold to pig farmers, or fed to calves, dogs, and cats.

Kaptama key informants (transporter and extensionist) acknowledged the use of a lactometer at the collection locations. If the lactometer reading of milk is not between 1.028 and 1.030gm/ml, collection clerks notify farmers that their milk cannot be taken, but the milk can be utilized for other purposes They also stated that milk that is rejected at the cooperative due to water adulteration is resold to hotels and other customers. However, milk is disposed of in the septic tank when it is rejected due to high acidity levels.

This was supported key informant interview who stated that: "***It is illegal to use or sell rejected milk, but all rejected milk returns to the informal market and some is used for other purposes, such as feeding pigs, because consumers are not sensitive to purchasing quality milk."***

*On* the other hand, Kaptama Livestock Officer stated that all rejected milk is disposed of at the cooperative's septic, which was also supported by Kitinda's Quality Officer, who stated that allowing farmers to take up the rejected milk or re-sell their milk could tarnish the cooperative's reputation

Figure 24: Destination of rejected milk per cooperative.



### 4.6 Current milk loss reduction strategies are used per cooperative at each value chain level

Table 13:current  milk loss reduction strategies and challenges

| Dairy value chain level | Current strategies employed | Challenges |
|---|---|---|
| Production level | Proper cleaning of milk containers<br>Maintaining hygiene<br>avoiding the mixing of morning and evening milk<br>Proper storage of milk | Low milk prices<br>1nadequate funds to buy certified milk cans<br>Use of uncertified food grade plastic containers in milk transportation |
| Collection/cooperative level | Capacity building on clean milk production<br>Collection of milk early in the morning<br>Chilling of milk | Mixing milk from different farmers at the collection centre<br>Use of plastic cans in storage and transporting milk<br>Poor transport network<br>Prolonged delivery of delivery of milk to cooperative<br>Water adulteration malpractices s<br>Insufficient funds to purchase adequate testing equipment<br>Impassable road network<br>Lack of cold chain at collection points<br>Nonfunctional milk equipment<br>Power shortages<br>Less sophisticated testing milk kits<br>Raising quality standards by processors in wet season |
| Processing level | Capacity building for staff and farmers | Mechanical breakdown of processing equipment<br>Power shortages<br>Lack of refrigerated trucks |

### 4.7 Governance

Currently, Kitinda cooperative receives roughly 400 litres per day, but before COVID-19, the cooperative was receiving 8,000 litres per day. The pandemic had a significant impact on the cooperative because its primary market is institutional customers. As a result, milk intake in the cooperative has decreased significantly since 2020, when the pandemic began.

Earlier this year, there was a disagreement between the transporters and management, which resulted in milk transporters declining to deliver milk to the cooperative and instead selling it to the informal market. They ultimately agreed with management, but transporters switched their roles to traders. Currently, milk is procured from farmers and distributed to the cooperative by transporters.

This clearly indicates that governance in the Kitinda cooperative is under threat.
The value chain of governance represents the allocation of power and knowledge among various actors. Haggblade et al. (2012) Chain governance in the value chain involves chain coordination (who has authority), interactions among actors, farmer organisations, and an institutional framework (rules and regulations), which allows the value chain to function efficiently and smoothly.
The Robustness, Reliability, and Resilience of institutional governance are based on the 3-R framework governance structure. Chain robustness (chain relations): A chain is deemed robust if its members and stakeholders interact in an organised and responsible manner. The presence of trust throughout a chain lowers operational costs and hazards while improving product quality and increasing sustainability. (Rademaker et al. (2016); Bebe et al, 2018).

Institutional governance reliability: A chain is said to be institutional governance trustworthy if there is a public-private partnership, co-innovation, and a public fiscal and financial framework inside the value chain. When Resilience of innovation support systems: When information is communicated, resources are allocated, and co-innovation networks are coordinated to encourage technical or administrative capacity growth, the chain is regarded (Haggblade et al.,2012).
.

## CHAPTER 5: DISCUSSIONS

The study's findings, which were based on 40 survey questionnaires, two FDGs, and 12 key informant interviews, are also discussed in the chapter. The findings are organised around the research problems that the study aimed to answer, which included milk loss hotspots with substantial economic and carbon footprints, as well as loopholes hindering milk loss reduction across the Kitinda and Kaptama smallholder dairy value chains. The data's significance is also assessed by comparing it to past studies and looking for parallels and contrasts.

### 5.1 Food loss share along the value chain

**a) Respondent's profile**

The 58%of poll respondents were females, 42% only a few men. The average age was between 36 and 50 years old, and most were well educated. This was more in line with earlier research. FDGs and key informant interviews were used to triangulate survey findings. This was study comparable with previous studied with females dominating (KNBS,2020).

**b) Milk production**

According to the study, the main breeds kept in both cooperatives are Zebu crosses and pure zebu. Kitinda has most crosses, accounting for 72%, while Kaptama has the majority of zebu, accounting for 68%. This could explain the low milk production rates of 2.8 and 2.9 litres/cow/day, with annual milk production rates of 706 and 713 litres/cow/year, respectively. This study's findings correspond with those of Tegemeo (2021), who calculated that the average milk output of Friesian crosses in Bungoma is 7.6 litres/day/cow, and the yearly milk production is 2,745 liters/cow/year. As a result, zebu output is expected to be considerably lower.

### c) Value chain maps

Figure 25: Kitinda Value Chain Map

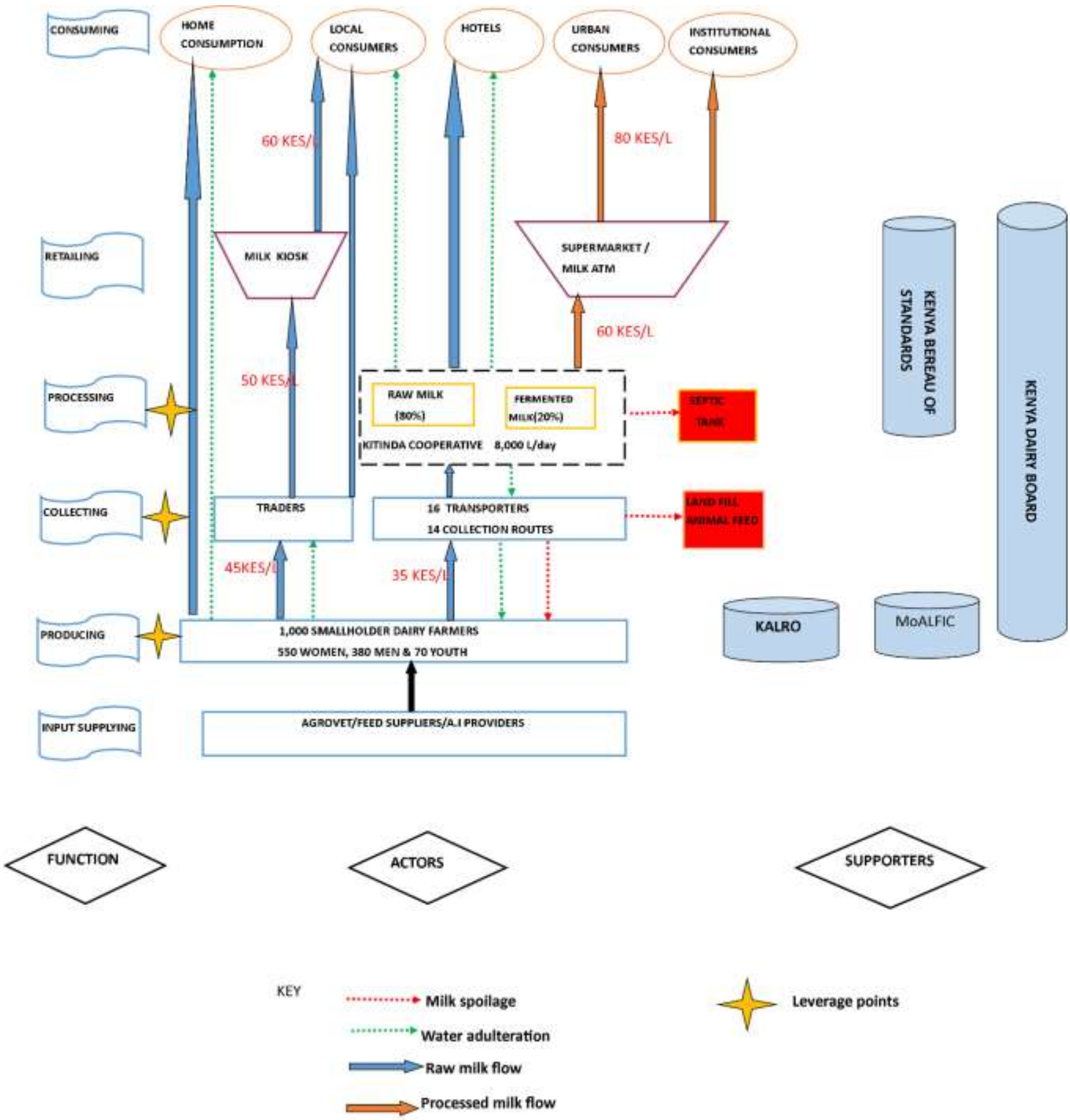
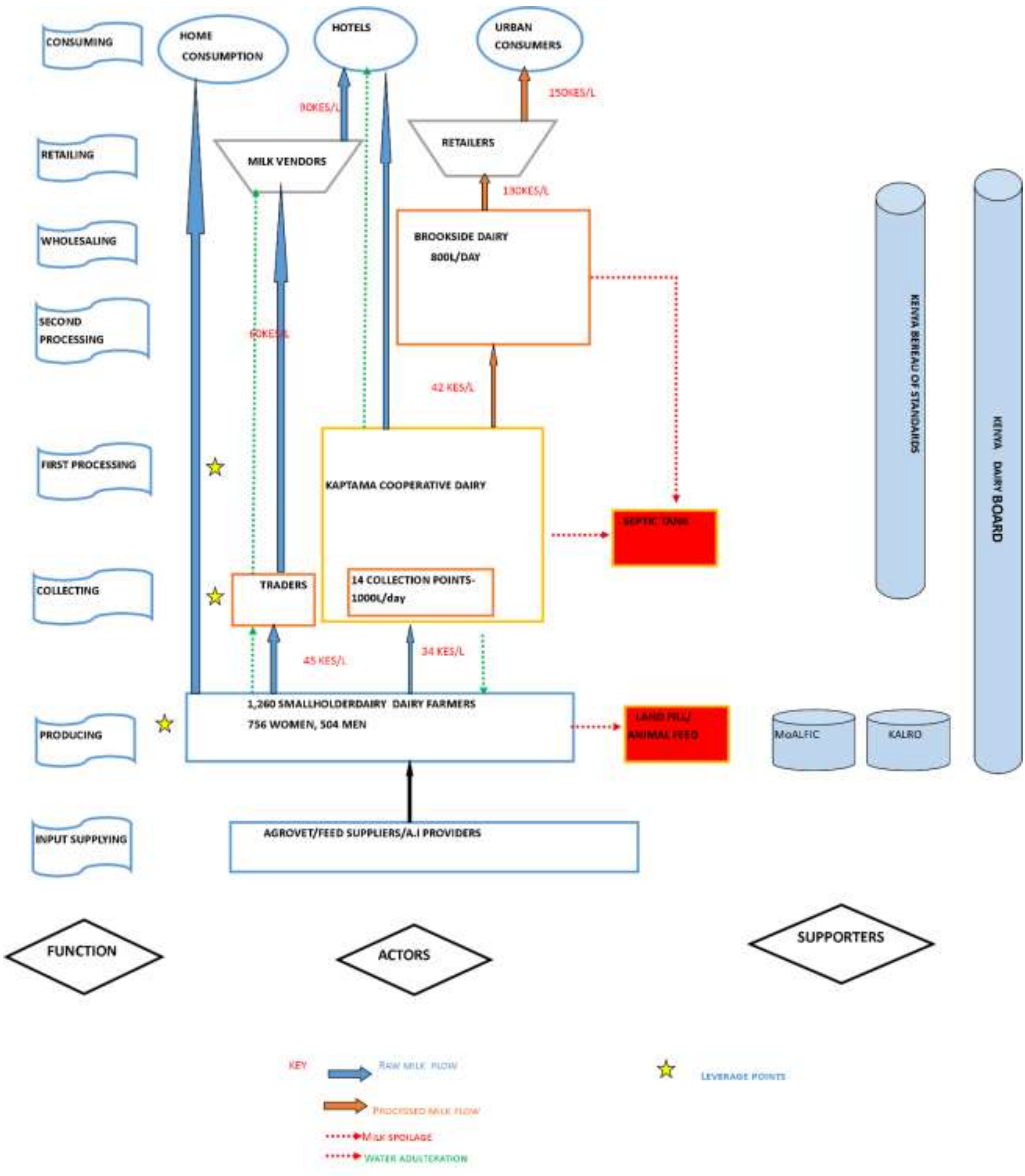


Figure 26: Kaptama Value Chain Map




c) **Food loss share**

Milk loss in Kitinda and Kaptama cooperatives is 71,339 and 17,897 liters/year/HH, respectively, according to key informants. According to respondents (farmers), total milk loss in Kitinda and

Kaptama is 131,400 and 73,120 liters/year/HH, respectively. These two calculations are diametrically opposed. Because of the large sample size of surveyed farmers, farm results are more trustworthy than key informant estimates.

The highest losses in the Kitinda milk shed occur at the cooperative level, accounting for around 130,000 litres of the overall loss, or 60%, while losses at the processing and production levels are 60,000 and 25,000 litres, or 12% and 28% each year, respectively (table 19). Losses were linked to spillage (7%), milk spoilage (49%), and water adulteration (44%) (figure 16). Kaptama milk shed loses 76,860 (73%) litres per year at the cooperative/collection level and 4,8000 (5%) litres at the processing level (Table 20). Losses were attributed to spillage (12%), milk spoilage (41%), and water adulteration (47%) (figure 16)

The cooperative level suffers the biggest losses in both milk sheds. This is in line with the findings of Omondi et al. (2020), who observed that losses at cooperatives exceed production in Nandi and Kakamega counties. Milk rejection is responsible for the majority of milk lost during the collection and cooperation phases. The most common reasons for milk rejection are spoilage and water adulteration.

The wet seasons caused more losses than the dry seasons. This discovery was previously highlighted by Muriuki (2011). Farmers mixing morning and evening milk, inadequate hygiene, mastitis, inaccessible roads, and longer hours of milk delivery may have led to rejection during the wet season. This was comparable to the findings of Munyori et al. (2019) and Odongo et al. (2017).

Furthermore, processors that raise quality standards during the wet season reduce milk to manageable levels due to a large supply of milk over demand, as observed in the Kaptama cooperative. This might be linked to contract agreement with cooperative and processor on the amount of milk to be supplied. This causes processor to increase quality standards requirements during the wet season to regulate milk supply and lowers quality standards requirements during the dry season to break even.

During the dry season, farmers and milk transporters were observed purposefully adding water to milk in order to increase milk volume and so earn more money, similar to Rekha et al., 2018. However, during dry seasons, milk rejection was lower in both cooperatives, which might be explained by limited supply and high demand. On the contrary, there were considerable disparities in milk rejection owing to spoilage, with Kitinda suffering more than Kaptama cooperative. This is most likely owing to Kaptama's highland location, which implies colder temperatures.

Furthermore, both cooperatives transported milk in plastic cans (figure 12). Plastics are typically notorious to clean, which might be contributing to milk losses at the production and cooperative levels. A prior discovery that the use of plastic containers contributes to milk losses verified this (Orregård, 2013; Mogotu et al. 2020).

Purchasing milk cans for both cooperatives can help minimise milk loss as aluminium milk cans are easier to clean and can help reduce milk loss. This can only be accomplished by collaborative partnership with financial institutions such as the Equity Bank of Kenya to get loans to acquire milk cans and testing equipment for collection stations.

Farmers must also acquire milk cans that have been certified by the KDB. They may be unable to do so, though, because they are members of underprivileged groups. Savings systems like SACCO may be beneficial, and because women outnumber males in both cooperatives. (KNBS,2020). this can truly work, as women are more likely to join in saving schemes like table banking and merry-go-rounds.

Nevertheless, milk losses at the processing stage (table 10) were less prevalent, but they were substantial when they did occur. This might be attributable to infrastructural difficulties such as processing equipment failure, power failures, and poor hygiene. While farmers suffered the fewest losses (table 7), spillage and spoilage were the most prevalent. Spoilage was mostly driven by a lack of evening milk markets and inadequate milk handling. While milk spillage was associated with spills caused by moving milk from one container to another, or milk being accidentally pushed down by a cat, dog, or cow. As result of high milk spoilage due lack market of evening milk. Cooperatives can take this role and start buying evening.

### 5.2 Milk loss economic impact

Kitinda milk shed suffers the most losses at the cooperative, accounting for approximately 130,000 litres of total loss and a mean price of 45KES/L, amounting to a total loss of 5.9 million, while losses at the processing and production levels are 60,000 and 25,000 litres (12%) and 28% per year, respectively, with mean prices of 80KES/L and 34KES/L, representing a total loss of KES10.5 million/year

Whereas the Kaptama milk shed had a total loss of 73% with a mean price of 45KES/L, amounting to a total loss of 3.5 million at the cooperative level, losses at the processing and production levels are 4,800 and 22,680 litres/year (22% and 5% per year, respectively, with mean prices of 80KES/L and 34KES/L, equating to a total loss of KES 4.7 million/year. This comparable the findings of Omondi et al. (2020), who discovered that post-harvest milk loss at the production stage alone would be more than 22 million litres per year, costing KES 813 million.

Furthermore, unlike Kaptama, Kitinda has the largest losses at the processing level. This is probable because Kitinda processes their own milk and milk quality requirements are not adhered to, despite the fact that they should have better quality standards owing to self-processing. While Kaptama has fewer processing losses since its milk are processed by Kenya's largest processor, which exports milk globally,

### 5.3 Impact of Milk Loss on Carbon Footprint

According to FAO and NZAGRC (2019), Kenya's average carbon footprint is 12.3 million tonnes of CO2 eq. each year. Kitinda and Kaptama provide CF of 230,809 and 112,010 CO2 eq./kg FPCM, and 231 and 112 CO2 eq./ton FPCM, respectively. If this is extended to national CF, both cooperatives provide 0.001% of national CF. When this is compared to the 14 cooperative dairy farmers in Bungoma county, where the average Cf is 172 CO2 eq./ton FPCM/cooperative, the overall contribution of CF of all cooperatives in Bungoma is (16*172), which is 2,752 CO2 eq./ton FPCM, and its contribution to national CF is 0.02%.

### 5.4 Destination of Rejected Milk At MCC/Cooperative/Processing

Findings reveal that a large percentage of rejected milk owing to water adulteration during production is sold locally, either to neighbors or hotels. If they are rejected owing to milk spoilage, they are either given to animals, sold to pig owners, or fermented milk is made from them. Milk that is rejected at the cooperative because of water adulteration is resold to the informal sector, whereas milk that is rejected by spoilage is disposed of in the septic tank. In addition, any milk that is abandoned during the processing step is disposed of in a septic tank.

Milk adulteration does not appear to be an issue among cooperatives now, except if they market to large processors like Brookside, which accept milk based on their quality requirements. This is because, even if milk is adulterated, it will still make its way to the market or be consumed at home; the issue at stake is the quality of the water added to the milk. Is it healthy for human consumption? Furthermore, the irony is that water-adulterated milk is offered at the same price as quality milk rather than at a cheaper price.

Milk spoilage, on the other hand, tends to be most sold to pig farms, fermented milk, or fed to dogs and cats, until rejected at the cooperative and disposed of in a septic tank. The main rejection criteria, however, appear to be based on an alcohol milk gun test, which might be an indicator of mastitis, antibiotic residues, or bacterial contamination and would require confirmation by another test. As a result, the primary concerns are food safety and health.

As a result, purchasing advanced testing equipment such as Lactoscan and antibiotic testing kits is critical. It appears to be a better strategy to protect the health and safety of customers. However, it appears that, except for spilt milk, most of the rejected milk are merely losses to the cooperative rather than losses to the food system

### 5.5 Current Milk Loss Reduction Strategies

In Kitinda and Kaptama, smallholder dairy producers have adopted milk loss reduction methods such as proper milk container cleaning, hygiene during milking and transportation. According to Ogolla et al. (2017), maintaining cleanliness lowers milk losses. However, milk loss remains a production issue. Smallholder farmers are probably aware of mitigating techniques but are hesitant to implement them.

Cooperatives and processors, on the other hand, claim to be training farmers and staff on clean milk production and handling as one of their goals, as well as strategies for chilling milk within three hours of it being produced. This was revealed by Kaindi et al., 2011, who indicated that chilling is one method of collecting and cooperation to prevent milk loss. However, this seems not to be the case in all cooperatives as there is always a delay in milk delivery to the cooperative. In addition, most processing facilities are not functional because it is not economical to run them due to low milk supply.

### 5.6 Milk Loss Reduction Obstacles

Farmers raise concerns about low milk prices as an obstacle to decreasing milk loss, despite the fact that, as previously stated, this might be connected to cost price (Tegemeo, 2021) Between 2014 and 2019, the total cost of producing a litre of milk surged by 73% to KES 22.51. In addition, there are insufficient financial resources among cooperatives.

Furthermore, cooperatives require adequate financial resources to purchase sufficient milk equipment such as milk testing kits and transport/storage milk cans at the collection centres or cooperatives. In addition, both cooperatives are facing shortfalls in infrastructure such as road networks, equipment, electricity, cooling, and processing facilities, as well as the adoption of ICT. Partnerships with financial can enable cooperative acquire loans to improve infrastructure, purchasing milk cans would help as the main obstacle in booth cooperatives insufficient resources.

Most of the roads become inaccessible during the dry season, causing milk delivery delays. However, despite cooperatives' having processing equipment, most of them are of a larger capacity than the milk supply they collect, making their usage uneconomical. Besides that, the electricity supply is not reliable most of the time, hampering chilling or processing, and there is a low level of adoption of new technology such as ICT, which can aid in pinpointing the cause of milk losses and minimising them.

### 5.7 Governance

According to key informants, Kitinda's cooperative connection between actors is weak. For cooperative to be efficient, there should be positive relations between actors, which builds confidence within the chain. Unlike Kitinda, Kaptama has solid relationships with its farmers since practically all farmers give their milk to the cooperative. Transporters in Kaptama are likewise recruited through cooperatives, therefore their purpose is limited to collecting, whereas Kitinda transporters are referred to as "middlemen" who also own the product.

Furthermore, when compared to Kaptama, Kitinda's cooperative has weak market institutions. For example, while there are quality standards in place, milk quality laws may not be rigorously followed, and milk adulteration seems not to be a problem. Furthermore, farmers no longer have a commitment to the cooperative; they believe management owns the cooperative. There are no contracts in place that bind farmers to the cooperative.

## 5.8 Limitations and Research Contribution

**Limitation**

The researcher was incapable of analyzing the exact loss measurement of milk loss in both cooperatives due to the short time and had to depend on average estimations. Furthermore, most responders and interviewers who had never met the researcher were unwilling to offer accurate information because they suspected the researcher was a government spy.

**Contribution of research**

This study adds to our understanding of the economic effect, carbon footprint emissions, and societal losses. Milk losses must be assessed before solutions can be developed. Milk rejection and spills reduce profits while increasing the carbon footprint. Consumption of rejected milk, on the other hand, has an influence on food safety and health. This reflects the loss, imbalance, and ruin of food systems. Milk loss reduction appears to be a top goal for improving food system sustainability. Previous research has revealed this (Benyam et al. 2021; El Bilali et al. 2019**).**

## 5.9 Reflection

This is a look back at the research study and a discussion of the results. The research was conducted in two cooperatives in Bungoma county, western Kenya (Kitinda and Kaptama). This study was carried out as part of the FORQLAB project, which focused on two food chains: avocado and dairy. This research was centered on food loss inventories in the dairy value chain, comparing milk losses in kitinda and Kaptama cooperatives.

Purposive sampling was used to choose the sample or samples. Survey forms, semi-structured interviews, and focus group discussions (FDGs) were used to collect quantitative and qualitative data. Questionnaires were filled out one-on-one with respondents to accommodate individuals who couldn't write or read. I am satisfied with my research methods since I was able to triangulate facts from several angles.

It enabled the verification of both individual household responses and group discussion responses. The results of survey questionnaires were also cross-checked with information from key informant interviews and secondary sources. I believe are reliable and valid as they are comparable to past studies

However, I suspect that my position as a researcher had some impact on my results. During my first interview, I saw that key informants were hesitant to provide genuine information because they were concerned about how their data would be used. Some important informants were cautious about what they said and even refused to be recorded. I had to respect their privacy because I didn't want my study to jeopardise people out of jobs or relationships with their employers.

If I was to do the research again, farmers prefer having FGDs with all stakeholders in the chain instead of farmers’ FGDs only to understand the picture of losses and challenges from all aspects. I would also wish to be in study a month before to familiarize myself with the respondents and the area where the research will take place.

## CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

## 6.1 Conclusions

### 6.1.1 Food loss share

It was found that the milk shed in Kitinda suffers the biggest losses at the cooperative, accounting for around 130,000 litres with a total loss of KES11.5 million per year, including processing and production losses. At the cooperative level, the Kaptama milk shed lost 3.5 million, with overall losses including production and processing amounting to KES 4.7 million every year.

This is most likely related to the use of plastic cans by farmers and cooperatives, which are notoriously difficult to clean. Milk loss will be avoided at a greater rate if both cooperatives can obtain milk cans for farmers and themselves. Farmers also reported marketing their evening milk to milk bars, traders, and direct customers.

The most of kitinda farmers market their milk to traders, whereas 70% of kaptama farmers market to customers directly (hotels, neighbors). However, at the production level, the most significant milk spoil losses were generated by mixing morning and milk, meaning that not all evening milk was sold. This would be an excellent opportunity to start collecting evening milk and delivering fresh, chilled milk to hotels and clients.

Procurement of KDB certified milk cans by cooperative would greatly reduce the milk rejection at the cooperative through partnership with financial institutions, creation of saving schemes SACCOS to enable buy themselves milk cans through loans or savings.

### 6.1.2 Economic Food Loss Share

Kitinda experiences a total of milk loss of 215,000 annually costing KES11.5Millionn with KES 0.9(7%) Million at production, KES 5.9million (51%) at cooperative, and KES 4.8 million (42%) at the processing level. While Kaptama milk shed a total of KES 104,340 milk losses worth KES4.7Million (17%) with 0.8M(17%) at production, KES 3.5 million (75%) at cooperative, and 0.4Million (8%) at the processing

Kitinda incurred higher losses in both processing and cooperative, but Kaptama sustained more losses in cooperative and output. This is most likely due to Kitinda doing self-processing while Kaptama distributes it to Brookside. As a result, Kitinda should collaborate with Brookside, while Kaptama should help farmers produce quality milk.

### 6.2.3 Milk loss contribution to carbon footprint

Kitinda and Kaptama have CF of 230,809 and 112,010 $CO_2$ eq./kg FPCM, respectively, and 231 and 112 $CO_2$ eq./ton FPCM. Both cooperatives provide 0.001% of the country's total CF. In comparison, the whole contribution of CF of all cooperatives in Bungoma is (16*172), which is 2,752 $CO_2$ eq./ton FPCM, and its contribution to national CF is 0.02%. This clearly shows that milk loss adds a negligible amount of carbon impact to the yearly carbon footprint.

### 6.2.4 Destination of Rejected Milk at Collection/Cooperative

Nonetheless, with the exception of the lost milk, it appears that all losses experienced along the dairy chain are merely losses to the cooperative rather than losses to the food system as the product (milk) rejected is eventually sold or given to animals.

### 6.2.5 Current Milk Loss Reduction Strategies

Furthermore, current strategies used to reduce milk loss identified along the Kitinda and Kaptama dairy value chains include keeping milk clean, separating morning and evening milk, and correctly storing milk. Training is also offered, as is the ability to cool milk. However, the key obstacles are high milk production costs, limited financial resources, and infrastructure gaps.

### 6.2.6 Governance

Kaptama is considered to have a solid governance structure in terms of chain robustness, dependability, and resilience. Kitinda, on the other hand, has weak chain links, market institutions, chain coordination, and farmer organisations. The viability of Kaptama's cooperation with Brookside may be linked to its excellent governance. Brookside's private partnership might strengthen governance. It would be beneficial to the cooperative if Kitinda began supplying milk to Brookside

## 6.2 Recommendations for Kitinda and Kaptama Cooperatives

More recommendations may have been given to the cooperatives, but owing to feasibility and importance, only a handful were chosen.

### 6.2.1 Main Interventions for Both Cooperatives

Table 14: Main interventions for both Cooperatives

| | Description of intervention | Accountable stakeholder | Output | | Impact |
|---|---|---|---|---|---|
| 1. | Partnership with financial institution such Equity bank for procurement of 16 milk cans for collection centres testing equipment from Jan 2023 | Cooperative And bank | a) | Acquisition of loans to buy milking cans and testing equipment<br>Provide a grace period to pay back loans | improved milk quality |
| 2. | Start collect evening milk and selling hotels and milk vendors from Dec 2022 | Cooperative | a) | Create market for evening milk | 80% reduction in spoilage |
| 2. | Starting Savings and Credit Cooperative Organization (SACCO) from Jan 2023 | Cooperative with partnership farmers | a).<br>b)<br><br>c). | Members start saving<br>Members can borrow loans to buy milk cans<br>Farmers to have shares in the cooperatives as commitment | Access of credit facilities |

### 6.2.2 Specific intervention Kitinda and kaptama cooperative

*Table 15: Intervention for Kitinda*

| | Description of intervention | Accountable stakeholder | | Output | Impact |
|---|---|---|---|---|---|
| 1. | Create partnership with the Brookside firm to market their milk from Jan 2023 | Cooperative and Brookside | a)<br>b)<br>c) | Organize stakeholder meeting with Brookside to buy their milk<br>Organize multi stakeholder meeting with strengthening relationship to rebuild with trust producers.<br>Create contracts with their farmers to increase commitment to cooperative | Improved governance For chain sustainability |

Table 16: Intervention for Kaptama

| | Description of intervention | Accountable stakeholder | | Output | Impact |
|---|---|---|---|---|---|
| 1. | Strengthen farmers to deliver quality milk by October 2023 | Cooperative partnership with KDB | a)<br>b)<br>c) | Provision of extension roles to transporters and collection to train on production of clean milk.<br>Provision of quality manual to farmers on how<br>Provide financial incentive for farmers delivering quality milk<br>Provision of quality manual to farmers on how to produce clean milk at farm level | 100% reduction of milk rejection |

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## APPENDICES

Annex 1: Questionnaire

**Questionnaire on assessment of food loss along the dairy value chain: A case study of Kitinda and kaptama dairy farmers cooperative society, Bungoma county – Kenya**

Dear respondent,

I am a master's student in Agricultural Production Chain Management (APCM) -Livestock chains at Van Hall University of Applied sciences, the Netherlands. I am conducting a survey on Food Loss assessment in the Milk Value Chain in Bungoma county. I will appreciate your participation in providing your responses to the questions below. The responses will be treated with high level of confidentiality and solely used for research purposes.

TIME: 10-20 minutes

**Section A: personal Data**

Name of **respondent**………………………………………………

Name of your Cooperative ……………………………………Name of Sub- County……………..

1. What is your age set below 35 years 36-55years Over 56 years?

2. Gender
   - Female Male

3. Highest Level of education

A level O level Tertiary/university

**Section B: Milk production**

1. **Land ownership?**

a) Own land …………………. c) Others specify……………………

2. **What is the total land area under livestock in HA?** ……………………….

3. What type of dairy Breed do you have?

Zebu ☐ Zebu crosses ☐ pure breeds (Friesian, Ayrshire ) ☐

6. What is your herd size?

| Composition | Lactating | Heifers | Oxen/bulls | Female | Male | Dry | Total |
|---|---|---|---|---|---|---|---|

| of herd size | cows | | | calves | calves | cows | herd size |
|---|---|---|---|---|---|---|---|
| Number | | | | | | | |

7. What is the time difference (Months) from the first calf to the second calf (first calving to next calving)?................

**SECTION C: WET SEASON**

8. what is the average highest production per day per cow during wet season?

| Milk production /wet season | Maximum production/day/wet season. | Total number of milking cows | Total milk production /day/dry season | Milk for home use | Milk for feeding Calves | Milk for sale(ltrs) |
|---|---|---|---|---|---|---|
| Morning mlk(lts) | | | | | | |
| Evening milk (lts) | | | | | | |
| Total | | | | | | |

9. what is the lactation period for your dairy cow? (150-210) days (211-270) days above 271 days
10. Have you ever had milk returns from the milk collection center during the wet season? Yes No
    I. If yes, how often in a week? once twice more never
    II. What were the reasons for milk returns?
    …………………………………………………………………………………………….

    ……………………………………………………………………………………………
11. How do you use the returned milk?

Make other milk products sell to other consumers home use feeding calves other use

If other use, mention………………………………………

| Season | Loss | Amount of milk lost (ltrs) | Number of times per week | Total milk lost(litres) | Location; production, coop/collection/ |
|---|---|---|---|---|---|
| Wet | spoilage | | | | |
| | spillage | | | | |
| Dry | Spoilage | | | | |
| | spillage | | | | |

**SECTION D: DRY SEASON**

12. what is the average milk production per day per cow during the dry season?

| Milk production /dry season | Maximum production /day/dry season | Total number of milking cows | Total milk production/day/ dry season | Milk for home use | Milk for feeding calves | Milk for sale (ltrs) |
|---|---|---|---|---|---|---|
| Morning milk | | | | | | |
| Evening milk | | | | | | |
| Total | | | | | | |

13. what is the lactation period for your dairy cows?

(150-210) days (211-270) days above 271 days

14.Have you ever had milk returns from the milk collection center during the dry season? Yes No

I. If yes, how often in a week? once twice more never

II. What was the reasons for milk returns?

……………………………………………………………………………………….

……………………………………………………………………………………….

15. How do you use the returned milk?

Make other milk product sell to other consumers home use feeding calves other use

If other use, mention……………………………………….

16. Besides milk returns, have you ever experienced any other milk losses?

| Season | Loss | Amount of milk lost (ltrs) | Number of times per week | Total milk lost(litres) | Location; production, coop/collection/ |
|---|---|---|---|---|---|
| Wet | spoilage | | | | |
| | spillage | | | | |
| Dry | Spoilage | | | | |
| | spillage | | | | |

**SECTION E: General questions**

16. At what time do you milk your cows?

o Time for Morning milking …………………AM Time for evening milking ..............PM

o Time for other milking if any ……………………….

17. How long does it take you to deliver milk the collection center?

Less than an hour after milking more than two hours after milking

18. How far is the milk collection centre from your farm?

Less than 2km more than 2km

19. How do you deliver your milk to the collection center?

Motorcycle Walking Cycling others………..

if others mention………………..

20.Do sell all your milk to the cooperative? Yes No

If yes, where else do sell your milk besides the cooperative?

| Market(milk) | Direct to consumers | Hawkers | Milk bars | Processors | Others |
|---|---|---|---|---|---|
| Volume (ltrs) | | | | | |
| Price (ltrs) | | | | | |

18. What is the milk price per Litre at the MCC? dry season............... wet season…………
19. What is the milk storage equipment do you use?
    - Plastic can/buckets ……………….
    - KDB Certified containers (Aluminum cans/buckets) ……………

20. Please specify the obstacles do you face in reducing milk loss reduction; using a scale of 1-5

| **Problem** | **1-Strongly disagree, 2-Disagree,3- Neutral, 4-Agree, 5-Strongly agree** |
|---|---|
| Long-distance from farm to collection | |
| Poor infrastructure (roads, milking equipment, | |
| Lack of knowledge in milk loss reduction | |
| Lack of market | |
| Lack of collection service for evening milk | |
| Lack of cooling at farm | |
| Poor handling practices | |

| | |
|---|---|
| Mixing morning and evening milk | |

**End of questionnaire.**

**THANK YOU**

**GUIDANCE FOR FOCUS GROUP DISCUSSION**

**Tools for guiding discussion**

**Chain map, photographs, Drawings**

- How many litres of milk do you produce per day?
- Where do you sell your milk?
- Means of transporting milk from farm gate to collection hub?
- How far are milk collection hubs from dairy producers?
- What exactly is milk loss?
- What is the quantity of milk lost?
- Which is the main milk loss experienced among rejection, spillage, and spoilage?
- Which months have you suffered the most losses?
- What is the quantity of milk rejected?
- What happens to milk rejected?
- What strategies do you employ to reduce milk loss?
- What are obstacles hindering milk loss reduction?
- What is the current value chain?
- Where does milk loss occur in the value chain?
- Where can be the key leverage points in the value chain

**KEY INFORMANT CHECKLIST**

**Actors' checklist (**Collectors, Transporters, Traders and Processors)

- What is your role in the value chain?
- What mode of milk transportation do you employ?
- Have you encountered milk loss?
- How much milk have you lost in a year?
- What is purchasing price?
- What is the amount of milk received/month/day?
- What are the variable costs associated with milk value addition?
- Which of the following is the most common source of milk loss for you: rejection, spillage, and spoilage?
- If milk is rejected, how many litres of milk is rejected out of the total collected?
- What happens to the milk that is rejected?
- What strategies do you use to reduce milk loss?

1. What is the amount of milk received/month/day in wet season?

| Amount of milk received/month | Amount of milk received/month Wet season | Amount of milk sold per month (wet season | Amount of milk rejected/month (Wet season) |
|---|---|---|---|
| Amount milk | | | |

2 **What is the amount of milk received/month/day in dry season?**

| Amount of milk received/month | Amount of milk received/month (dry season) | Amount of milk sold per month (dry season) | Amount of milk rejected/month (dry season) |
|---|---|---|---|
| Amount milk | | | |

**21. What other damage have you ever experienced in dry season? (Score between 1-5 with 5 being the highest)**

| **Damage** | **Score** | | | | | **Total** | **Rank** |
|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | | |
| **Rejection** | | | | | | | |
| **Spoilage** | | | | | | | |
| **spillage** | | | | | | | |

**22. What other damage have you ever experienced in wet season?**

**(score 1-5 and 5 is the highest)**

| **Damage** | **Score** | | | | | **Total** | **Rank** |
|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | | |
| **Rejected** | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **spoilage** | | | | | | | |
| **spillage** | | | | | | | |

1. **What happens to rejected milk?**

   ………………………………………………………………………………………………………………………

2. **What ways do you employ to reduce milk losses?**
   ………………………………………………………………………………………………………………………
3. **Please specify the obstacles do you face in reducing milk loss?**

   ………………………………………………………………………………………………………………………

**Key supporters' checklist (**Livestock officer, extension officers, NGO official, KALRO, KDB Official, Egerton university)

- What value of milk is lost annually in the county?
- What are the contributing factors of the county's high rate of milk loss?
- Where do you think rejected milk ends up?
- What are your firm's existing milk reduction strategies?
- What are the contributing factors of the county's high rate of milk loss?
- What value of milk is lost annually in the county?
- What strategies do you recommend for reducing milk loss in each level?
- What do you think are the main obstacles in reducing milk loss?

## Annex 2

Respondent characteristics

**Age**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Below 35 | 11 | 27.5 | 27.5 | 27.5 |
| | 36-55 | 20 | 50.0 | 50.0 | 77.5 |
| | 0ver 55 | 9 | 22.5 | 22.5 | 100.0 |
| | Total | 40 | 100.0 | 100.0 | |

**Education**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Valid | O level | 10 | 25.0 | 25.0 | 25.0 |
| | A level | 24 | 60.0 | 60.0 | 85.0 |
| | Tertiary/University | 6 | 15.0 | 15.0 | 100.0 |
| | Total | 40 | 100.0 | 100.0 | |

**Gender**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Male | 17 | 42.5 | 42.5 | 42.5 |
| | Female | 23 | 57.5 | 57.5 | 100.0 |
| | Total | 40 | 100.0 | 100.0 | |

a) **Production parameters**

**Group Statistics**

| | Cooperative | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Land | Kitinda | 20 | 1.20 | .410 | .092 |
| | Kaptama | 20 | 1.05 | .224 | .050 |
| acres | Kitinda | 20 | .6125 | .74989 | .16768 |
| | Kaptama | 20 | 1.4875 | 2.26744 | .50701 |
| Herd | Kitinda | 20 | 4.5000 | 3.25253 | .72729 |
| | Kaptama | 20 | 4.3500 | 2.51888 | .56324 |
| Milking cows | Kitinda | 20 | 1.7000 | 1.03110 | .23056 |
| | Kaptama | 20 | 1.5000 | .68825 | .15390 |
| Average milk(wet) | Kitinda | 20 | 4.5500 | 3.60153 | .80533 |
| | Kaptama | 20 | 5.4050 | 10.69508 | 2.39149 |
| Average milk(dry) | Kitinda | 20 | 2.8500 | 1.73281 | .38747 |
| | Kaptama | 20 | 2.7350 | 3.38406 | .75670 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| Land | Equal variances assumed | 10.012 | .003 | 1.435 | 38 | .159 | .150 | .105 | -.062 | .362 |
| | Equal variances not assumed | | | 1.435 | 29.368 | .162 | .150 | .105 | -.064 | .364 |
| acres | Equal variances assumed | 5.421 | .025 | -1.639 | 38 | .110 | -.87500 | .53402 | -1.95607 | .20607 |
| | Equal variances not assumed | | | -1.639 | 23.107 | .115 | -.87500 | .53402 | -1.97943 | .22943 |
| Herd | Equal variances assumed | .586 | .449 | .163 | 38 | .871 | .15000 | .91988 | -1.71221 | 2.01221 |
| | Equal variances not assumed | | | .163 | 35.761 | .871 | .15000 | .91988 | -1.71604 | 2.01604 |
| Milkingcows | Equal variances assumed | 1.083 | .305 | .721 | 38 | .475 | .20000 | .27720 | -.36117 | .76117 |
| | Equal variances not assumed | | | .721 | 33.126 | .476 | .20000 | .27720 | -.36389 | .76389 |
| Wetmilk | Equal variances assumed | .862 | .359 | -.339 | 38 | .737 | -.85500 | 2.52345 | -5.96345 | 4.25345 |
| | Equal variances not assumed | | | -.339 | 23.254 | .738 | -.85500 | 2.52345 | -6.07199 | 4.36199 |
| Drymilk | Equal variances assumed | .638 | .430 | .135 | 38 | .893 | .11500 | .85013 | -1.60600 | 1.83600 |
| | Equal variances not assumed | | | .135 | 28.323 | .893 | .11500 | .85013 | -1.62552 | 1.85552 |

**Milk consumption**

**Group Statistics**

| | Cooperative | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Milk consumed wet | Kitinda | 20 | 1.7500 | .99340 | .22213 |
| | Kaptama | 20 | 1.8750 | 1.48568 | .33221 |
| Milk fed calves | Kitinda | 20 | 1.2250 | .57297 | .12812 |
| | Kaptama | 20 | .9250 | .81556 | .18236 |
| Milk sold (wet) | Kitinda | 20 | 2.1750 | .96348 | .21544 |
| | Kaptama | 20 | 2.1250 | 1.25525 | .28068 |
| Milk consumed (dry) | Kitinda | 20 | 1.4500 | .90175 | .20164 |
| | Kaptama | 20 | 1.6500 | .98809 | .22094 |

| | | | | | |
|---|---|---|---|---|---|
| Milk fed to calves Wet | Kitinda | 20 | 1.0500 | .27625 | .06177 |
| | Kaptama | 20 | .9500 | .32036 | .07164 |
| Milk sold (Dry ) | Kitinda | 20 | 1.2900 | 1.28878 | .28818 |
| | Kaptama | 20 | 1.3900 | .86444 | .19330 |

**Group Statistics**

| | Cooperative | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Milk consumed wet | Kitinda | 20 | 1.7500 | .99340 | .22213 |
| | Kaptama | 20 | 1.8750 | 1.48568 | .33221 |
| Milk fed calves | Kitinda | 20 | 1.2250 | .57297 | .12812 |
| | Kaptama | 20 | .9250 | .81556 | .18236 |
| Milk sold (wet) | Kitinda | 20 | 2.1750 | .96348 | .21544 |
| | Kaptama | 20 | 2.1250 | 1.25525 | .28068 |
| Milk consumed (dry) | Kitinda | 20 | 1.4500 | .90175 | .20164 |
| | Kaptama | 20 | 1.6500 | .98809 | .22094 |
| Milk fed to calves Wet | Kitinda | 20 | 1.0500 | .27625 | .06177 |
| | Kaptama | 20 | .9500 | .32036 | .07164 |
| Milk sold (Dry ) | Kitinda | 20 | 1.2900 | 1.28878 | .28818 |
| | Kaptama | 20 | 1.3900 | .86444 | .19330 |

## Group Statistics

| | Cooperative | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Wetconsumed | Kitinda | 20 | 1.7500 | .99340 | .22213 |
| | Kaptama | 20 | 1.8750 | 1.48568 | .33221 |
| Dryconsumed | Kitinda | 20 | 1.4500 | .90175 | .20164 |
| | Kaptama | 20 | 1.6500 | .98809 | .22094 |
| Wetcalves | Kitinda | 20 | 1.2250 | .57297 | .12812 |
| | Kaptama | 20 | .9250 | .81556 | .18236 |
| Wetsold | Kitinda | 20 | 2.1750 | .96348 | .21544 |
| | Kaptama | 20 | 2.1250 | 1.25525 | .28068 |
| Drycalves | Kitinda | 20 | 1.0500 | .27625 | .06177 |
| | Kaptama | 20 | .9500 | .32036 | .07164 |
| Drysold | Kitinda | 20 | 1.2900 | 1.28878 | .28818 |
| | Kaptama | 20 | 1.3900 | .86444 | .19330 |

**Group Statistics**

| | Cooperative | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Milk consumed wet | Kitinda | 20 | 1.7500 | .99340 | .22213 |
| | Kaptama | 20 | 1.8750 | 1.48568 | .33221 |
| Milk fed calves | Kitinda | 20 | 1.2250 | .57297 | .12812 |
| | Kaptama | 20 | .9250 | .81556 | .18236 |
| Milk sold (wet) | Kitinda | 20 | 2.1750 | .96348 | .21544 |
| | Kaptama | 20 | 2.1250 | 1.25525 | .28068 |
| Milk consumed (dry) | Kitinda | 20 | 1.4500 | .90175 | .20164 |
| | Kaptama | 20 | 1.6500 | .98809 | .22094 |
| Milk fed to calves Wet | Kitinda | 20 | 1.0500 | .27625 | .06177 |
| | Kaptama | 20 | .9500 | .32036 | .07164 |
| Milk sold (Dry ) | Kitinda | 20 | 1.2900 | 1.28878 | .28818 |
| | Kaptama | 20 | 1.3900 | .86444 | .19330 |

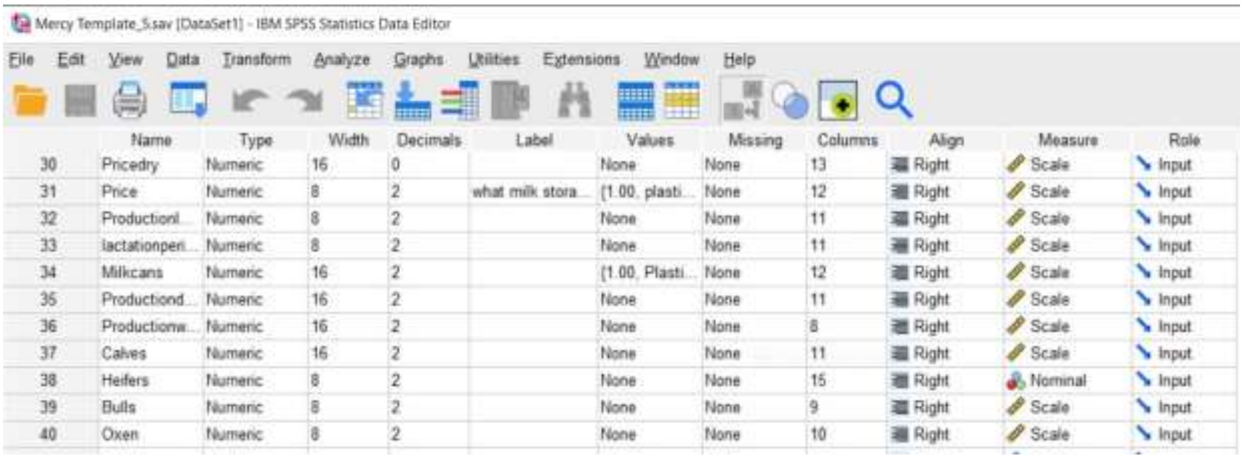
## ANNEX 3: RAW DATA

Mercy Template_5.sav [DataSet1] - IBM SPSS Statistics Data Editor

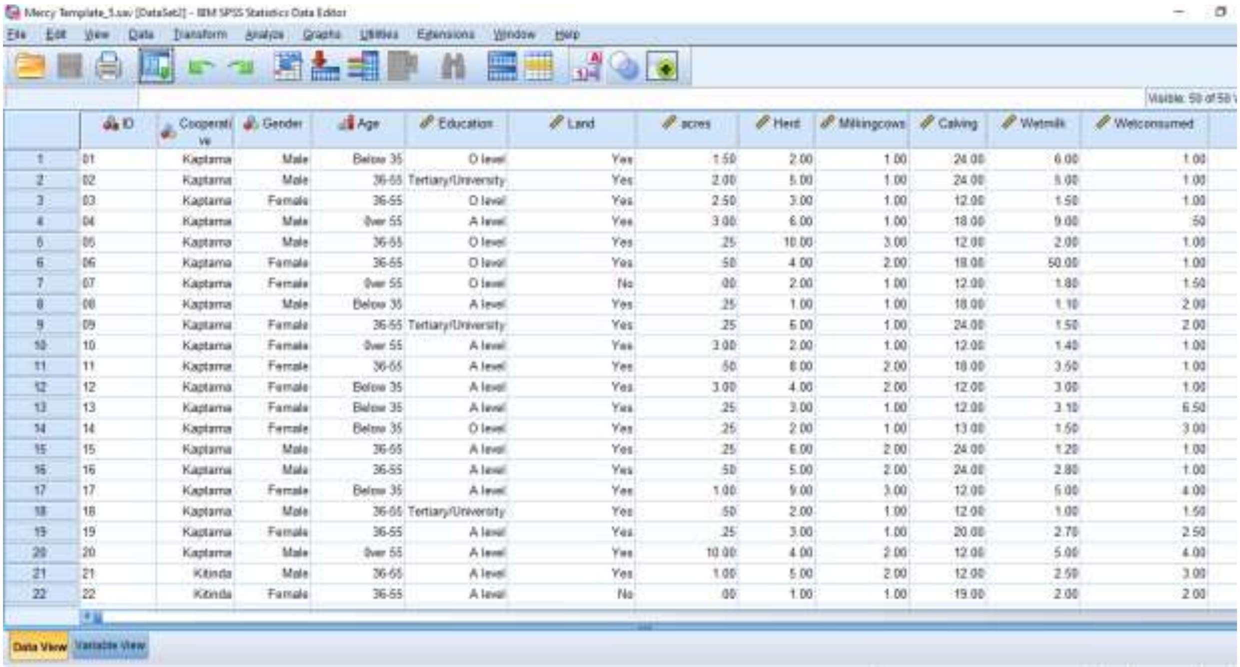
File Edit View Data Transform Analyze Graphs Utilities Extensions Window Help

| | Name | Type | Width | Decimals | Label | Values | Missing | Columns | Align | Measure | Role |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ID | String | 8 | 0 | | None | None | 8 | Left | Nominal | Input |
| 2 | Cooperative | Numeric | 8 | 2 | | {1.00, Kitind... | None | 8 | Right | Nominal | Input |
| 3 | Gender | Numeric | 8 | 2 | | {1.00, Male}... | None | 8 | Right | Nominal | Input |
| 4 | Age | Numeric | 8 | 2 | | {1.00, Belo... | None | 10 | Right | Ordinal | Input |
| 5 | Education | Numeric | 8 | 2 | | {1.00, O lev... | None | 11 | Right | Scale | Input |
| 6 | Land | Numeric | 16 | 0 | | {1, Yes}... | None | 14 | Right | Scale | Input |
| 7 | acres | Numeric | 8 | 2 | | None | None | 11 | Right | Scale | Input |
| 8 | Herd | Numeric | 8 | 2 | | None | None | 8 | Right | Scale | Input |
| 9 | Milkingcows | Numeric | 8 | 2 | | None | None | 10 | Right | Scale | Input |
| 10 | Calving | Numeric | 8 | 2 | | None | None | 8 | Right | Scale | Input |
| 11 | Wetmilk | Numeric | 8 | 2 | | None | None | 10 | Right | Scale | Input |
| 12 | Wetconsum... | Numeric | 16 | 2 | | None | None | 14 | Right | Scale | Input |
| 13 | Wetcalves | Numeric | 8 | 2 | | None | None | 15 | Right | Scale | Input |
| 14 | Wetsold | Numeric | 8 | 2 | | None | None | 8 | Right | Scale | Input |
| 15 | Wetrejected | Numeric | 16 | 2 | | None | None | 8 | Right | Scale | Input |
| 16 | Wetspoilage | Numeric | 8 | 2 | | None | None | 10 | Right | Scale | Input |
| 17 | Wetspillage | Numeric | 8 | 2 | | None | None | 11 | Right | Scale | Input |
| 18 | Drymilk | Numeric | 16 | 2 | | None | None | 15 | Right | Scale | Input |
| 19 | Dryconsumed | Numeric | 8 | 2 | | None | None | 10 | Right | Scale | Input |
| 20 | Drycalves | Numeric | 8 | 2 | | None | None | 20 | Right | Scale | Input |
| 21 | Drysold | Numeric | 8 | 2 | | None | None | 14 | Right | Scale | Input |
| 22 | Dryrejected | Numeric | 8 | 2 | | None | None | 11 | Right | Scale | Input |
| 23 | Dryspillage | Numeric | 8 | 2 | | None | None | 13 | Right | Scale | Input |
| 24 | Dryspoilage | Numeric | 8 | 2 | | None | None | 18 | Right | Scale | Input |
| 25 | Time | Numeric | 8 | 2 | what does it ta... | {1.00, less t... | None | 15 | Right | Nominal | Input |
| 26 | Distance | Numeric | 8 | 2 | | {1.00, less t... | None | 15 | Right | Nominal | Input |
| 27 | Deliverymea... | Numeric | 8 | 2 | | {1.00, walki... | None | 11 | Right | Nominal | Input |
| 28 | Eveningmilk | Numeric | 16 | 2 | | {1.00, Direct... | None | 16 | Right | Nominal | Input |
| 29 | Rejecteduse | Numeric | 8 | 2 | | {1.00, Disca... | None | 11 | Right | Scale | Input |

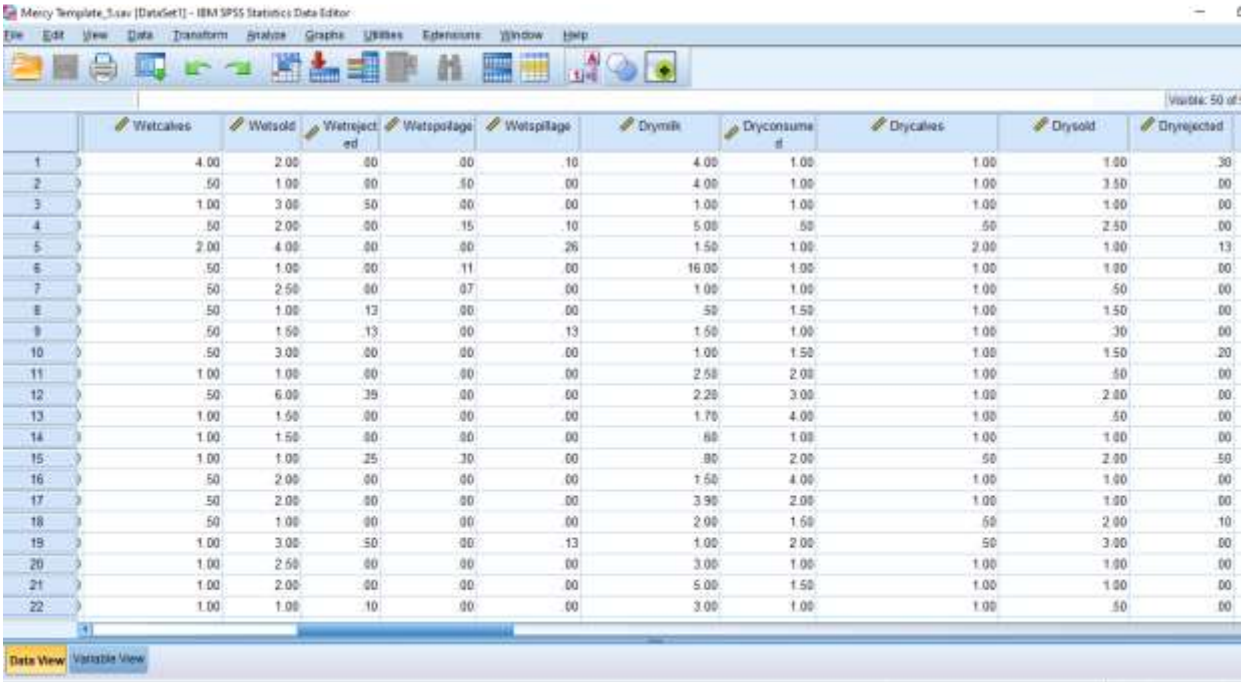
Data View | Variable View



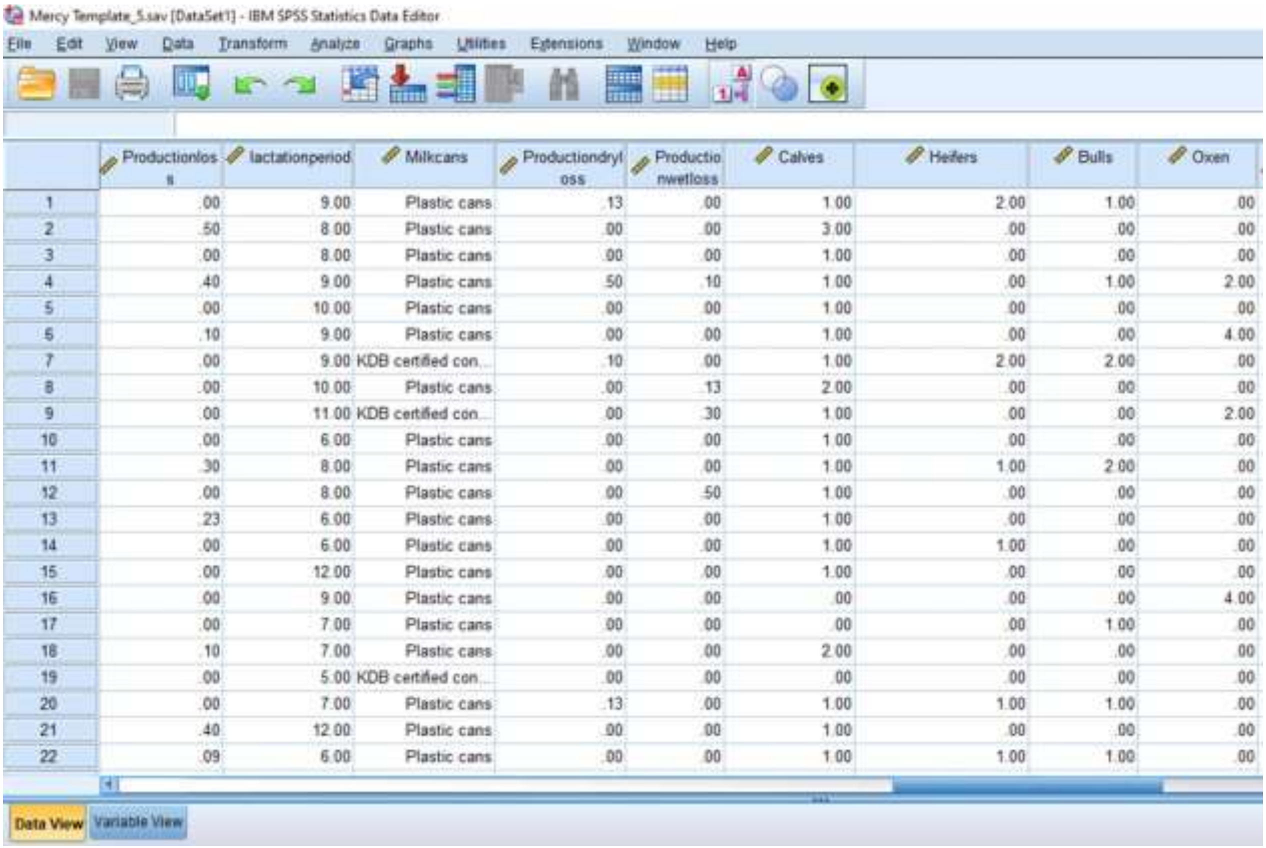

| | Name | Type | Width | Decimals | Label | Values | Missing | Columns | Align | Measure | Role |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | Pricedry | Numeric | 16 | 0 | | None | None | 13 | Right | Scale | Input |
| 31 | Price | Numeric | 8 | 2 | what milk stora... | {1.00, plasti... | None | 12 | Right | Scale | Input |
| 32 | Productionl... | Numeric | 8 | 2 | | None | None | 11 | Right | Scale | Input |
| 33 | lactationperi... | Numeric | 8 | 2 | | None | None | 11 | Right | Scale | Input |
| 34 | Milkcans | Numeric | 16 | 2 | | {1.00, Plasti... | None | 12 | Right | Scale | Input |
| 35 | Productiond... | Numeric | 16 | 2 | | None | None | 11 | Right | Scale | Input |
| 36 | Productionw... | Numeric | 16 | 2 | | None | None | 8 | Right | Scale | Input |
| 37 | Calves | Numeric | 16 | 2 | | None | None | 11 | Right | Scale | Input |
| 38 | Heifers | Numeric | 8 | 2 | | None | None | 15 | Right | Nominal | Input |
| 39 | Bulls | Numeric | 8 | 2 | | None | None | 9 | Right | Scale | Input |
| 40 | Oxen | Numeric | 8 | 2 | | None | None | 10 | Right | Scale | Input |




| | ID | Cooperative | Gender | Age | Education | Land | acres | Herd | Milkingcows | Calving | Wetmilk | Wetconsumed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 01 | Kaptama | Male | Below 35 | O level | Yes | 1.50 | 2.00 | 1.00 | 24.00 | 6.00 | 1.00 |
| 2 | 02 | Kaptama | Male | 36-55 | Tertiary/University | Yes | 2.00 | 5.00 | 1.00 | 24.00 | 5.00 | 1.00 |
| 3 | 03 | Kaptama | Female | 36-55 | O level | Yes | 2.50 | 3.00 | 1.00 | 12.00 | 1.50 | 1.00 |
| 4 | 04 | Kaptama | Male | Over 55 | A level | Yes | 3.00 | 6.00 | 1.00 | 18.00 | 9.00 | .50 |
| 5 | 05 | Kaptama | Male | 36-55 | O level | Yes | .25 | 10.00 | 3.00 | 12.00 | 2.00 | 1.00 |
| 6 | 06 | Kaptama | Female | 36-55 | O level | Yes | .50 | 4.00 | 2.00 | 18.00 | 50.00 | 1.00 |
| 7 | 07 | Kaptama | Female | Over 55 | O level | No | .00 | 2.00 | 1.00 | 12.00 | 1.80 | 1.50 |
| 8 | 08 | Kaptama | Male | Below 35 | A level | Yes | .25 | 1.00 | 1.00 | 18.00 | 1.10 | 2.00 |
| 9 | 09 | Kaptama | Female | 36-55 | Tertiary/University | Yes | .25 | 6.00 | 1.00 | 24.00 | 1.50 | 2.00 |
| 10 | 10 | Kaptama | Female | Over 55 | A level | Yes | 3.00 | 2.00 | 1.00 | 12.00 | 1.40 | 1.00 |
| 11 | 11 | Kaptama | Female | 36-55 | A level | Yes | .50 | 8.00 | 2.00 | 18.00 | 3.50 | 1.00 |
| 12 | 12 | Kaptama | Female | Below 35 | A level | Yes | 3.00 | 4.00 | 2.00 | 12.00 | 3.00 | 1.00 |
| 13 | 13 | Kaptama | Female | Below 35 | A level | Yes | .25 | 3.00 | 1.00 | 12.00 | 3.10 | 6.50 |
| 14 | 14 | Kaptama | Female | Below 35 | O level | Yes | .25 | 2.00 | 1.00 | 13.00 | 1.50 | 3.00 |
| 15 | 15 | Kaptama | Male | 36-55 | A level | Yes | .25 | 6.00 | 2.00 | 24.00 | 1.20 | 1.00 |
| 16 | 16 | Kaptama | Male | 36-55 | A level | Yes | .50 | 5.00 | 2.00 | 24.00 | 2.80 | 1.00 |
| 17 | 17 | Kaptama | Female | Below 35 | A level | Yes | 1.00 | 9.00 | 3.00 | 12.00 | 5.00 | 4.00 |
| 18 | 18 | Kaptama | Male | 36-55 | Tertiary/University | Yes | .50 | 2.00 | 1.00 | 12.00 | 1.00 | 1.50 |
| 19 | 19 | Kaptama | Female | 36-55 | A level | Yes | .25 | 3.00 | 1.00 | 20.00 | 2.70 | 2.50 |
| 20 | 20 | Kaptama | Male | Over 55 | A level | Yes | 10.00 | 4.00 | 2.00 | 12.00 | 5.00 | 4.00 |
| 21 | 21 | Kitinda | Male | 36-55 | A level | Yes | 1.00 | 5.00 | 2.00 | 12.00 | 2.50 | 3.00 |
| 22 | 22 | Kitinda | Female | 36-55 | A level | No | .00 | 1.00 | 1.00 | 19.00 | 2.00 | 2.00 |

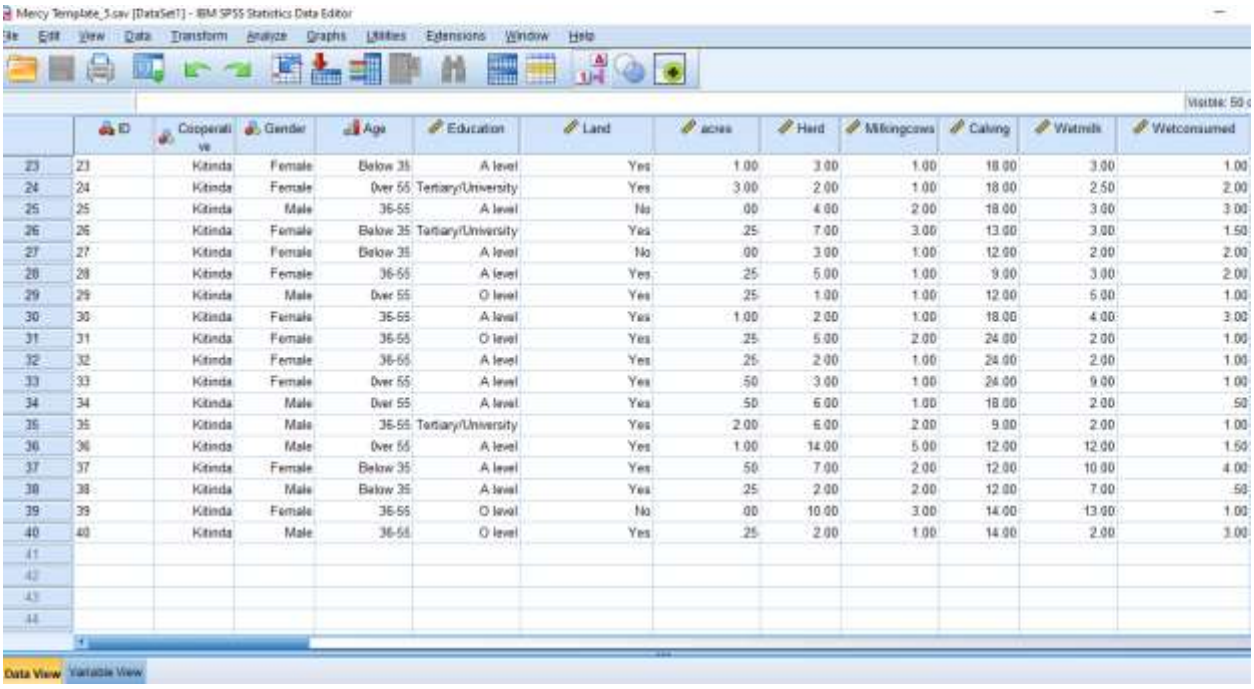



| | Wetcalves | Wetsold | Wetrejected | Wetspoilage | Wetspillage | Drymilk | Dryconsumed | Drycalves | Drysold | Dryrejected |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.00 | 2.00 | .00 | .00 | .10 | 4.00 | 1.00 | 1.00 | 1.00 | .30 |
| 2 | .50 | 1.00 | .00 | .50 | .00 | 4.00 | 1.00 | 1.00 | 3.50 | .00 |
| 3 | 1.00 | 3.00 | .50 | .00 | .00 | 1.00 | 1.00 | 1.00 | 1.00 | .00 |
| 4 | .50 | 2.00 | .00 | .15 | .10 | 5.00 | .50 | .50 | 2.50 | .00 |
| 5 | 2.00 | 4.00 | .00 | .00 | .26 | 1.50 | 1.00 | 2.00 | 1.00 | .13 |
| 6 | .50 | 1.00 | .00 | .11 | .00 | 16.00 | 1.00 | 1.00 | 1.00 | .00 |
| 7 | .50 | 2.50 | .00 | .07 | .00 | 1.00 | 1.00 | 1.00 | .50 | .00 |
| 8 | .50 | 1.00 | .13 | .00 | .00 | .50 | 1.50 | 1.00 | 1.50 | .00 |
| 9 | .50 | 1.50 | .13 | .00 | .13 | 1.50 | 1.00 | 1.00 | .30 | .00 |
| 10 | .50 | 3.00 | .00 | .00 | .00 | 1.00 | 1.50 | 1.00 | 1.50 | .20 |
| 11 | 1.00 | 1.00 | .00 | .00 | .00 | 2.50 | 2.00 | 1.00 | .50 | .00 |
| 12 | .50 | 6.00 | .39 | .00 | .00 | 2.20 | 3.00 | 1.00 | 2.00 | .00 |
| 13 | 1.00 | 1.50 | .00 | .00 | .00 | 1.70 | 4.00 | 1.00 | .50 | .00 |
| 14 | 1.00 | 1.50 | .00 | .00 | .00 | .60 | 1.00 | 1.00 | 1.00 | .00 |
| 15 | 1.00 | 1.00 | .25 | .30 | .00 | .80 | 2.00 | .50 | 2.00 | .50 |
| 16 | .50 | 2.00 | .00 | .00 | .00 | 1.50 | 4.00 | 1.00 | 1.00 | .00 |
| 17 | .50 | 2.00 | .00 | .00 | .00 | 3.90 | 2.00 | 1.00 | 1.00 | .00 |
| 18 | .50 | 1.00 | .00 | .00 | .00 | 2.00 | 1.50 | .50 | 2.00 | .10 |
| 19 | 1.00 | 3.00 | .50 | .00 | .13 | 1.00 | 2.00 | .50 | 3.00 | .00 |
| 20 | 1.00 | 2.50 | .00 | .00 | .00 | 3.00 | 1.00 | 1.00 | 1.00 | .00 |
| 21 | 1.00 | 2.00 | .00 | .00 | .00 | 5.00 | 1.50 | 1.00 | 1.00 | .00 |
| 22 | 1.00 | 1.00 | .10 | .00 | .00 | 3.00 | 1.00 | 1.00 | .50 | .00 |



Mercy Template_5.sav [DataSet1] - IBM SPSS Statistics Data Editor

| | Productionloss | lactationperiod | Milkcans | Productiondryloss | Productionwetloss | Calves | Heifers | Bulls | Oxen |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .00 | 9.00 | Plastic cans | .13 | .00 | 1.00 | 2.00 | 1.00 | .00 |
| 2 | .50 | 8.00 | Plastic cans | .00 | .00 | 3.00 | .00 | .00 | .00 |
| 3 | .00 | 8.00 | Plastic cans | .00 | .00 | 1.00 | .00 | .00 | .00 |
| 4 | .40 | 9.00 | Plastic cans | .50 | .10 | 1.00 | .00 | 1.00 | 2.00 |
| 5 | .00 | 10.00 | Plastic cans | .00 | .00 | 1.00 | .00 | .00 | .00 |
| 6 | .10 | 9.00 | Plastic cans | .00 | .00 | 1.00 | .00 | .00 | 4.00 |
| 7 | .00 | 9.00 | KDB certified con... | .10 | .00 | 1.00 | 2.00 | 2.00 | .00 |
| 8 | .00 | 10.00 | Plastic cans | .00 | .13 | 2.00 | .00 | .00 | .00 |
| 9 | .00 | 11.00 | KDB certified con... | .00 | .30 | 1.00 | .00 | .00 | 2.00 |
| 10 | .00 | 6.00 | Plastic cans | .00 | .00 | 1.00 | .00 | .00 | .00 |
| 11 | .30 | 8.00 | Plastic cans | .00 | .00 | 1.00 | 1.00 | 2.00 | .00 |
| 12 | .00 | 8.00 | Plastic cans | .00 | .50 | 1.00 | .00 | .00 | .00 |
| 13 | .23 | 6.00 | Plastic cans | .00 | .00 | 1.00 | .00 | .00 | .00 |
| 14 | .00 | 6.00 | Plastic cans | .00 | .00 | 1.00 | 1.00 | .00 | .00 |
| 15 | .00 | 12.00 | Plastic cans | .00 | .00 | 1.00 | .00 | .00 | .00 |
| 16 | .00 | 9.00 | Plastic cans | .00 | .00 | .00 | .00 | .00 | 4.00 |
| 17 | .00 | 7.00 | Plastic cans | .00 | .00 | .00 | .00 | 1.00 | .00 |
| 18 | .10 | 7.00 | Plastic cans | .00 | .00 | 2.00 | .00 | .00 | .00 |
| 19 | .00 | 5.00 | KDB certified con... | .00 | .00 | .00 | .00 | .00 | .00 |
| 20 | .00 | 7.00 | Plastic cans | .13 | .00 | 1.00 | 1.00 | 1.00 | .00 |
| 21 | .40 | 12.00 | Plastic cans | .00 | .00 | 1.00 | .00 | .00 | .00 |
| 22 | .09 | 6.00 | Plastic cans | .00 | .00 | 1.00 | 1.00 | 1.00 | .00 |



Mercy Template_5.sav [DataSet1] - IBM SPSS Statistics Data Editor

| | ID | Cooperative | Gender | Age | Education | Land | acres | Herd | Milkingcows | Calving | Wetmilk | Wetconsumed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | 23 | Kitinda | Female | Below 35 | A level | Yes | 1.00 | 3.00 | 1.00 | 18.00 | 3.00 | 1.00 |
| 24 | 24 | Kitinda | Female | Over 55 | Tertiary/University | Yes | 3.00 | 2.00 | 1.00 | 18.00 | 2.50 | 2.00 |
| 25 | 25 | Kitinda | Male | 36-55 | A level | No | .00 | 4.00 | 2.00 | 18.00 | 3.00 | 3.00 |
| 26 | 26 | Kitinda | Female | Below 35 | Tertiary/University | Yes | .25 | 7.00 | 3.00 | 13.00 | 3.00 | 1.50 |
| 27 | 27 | Kitinda | Female | Below 35 | A level | No | .00 | 3.00 | 1.00 | 12.00 | 2.00 | 2.00 |
| 28 | 28 | Kitinda | Female | 36-55 | A level | Yes | .25 | 5.00 | 1.00 | 9.00 | 3.00 | 2.00 |
| 29 | 29 | Kitinda | Male | Over 55 | O level | Yes | .25 | 1.00 | 1.00 | 12.00 | 6.00 | 1.00 |
| 30 | 30 | Kitinda | Female | 36-55 | A level | Yes | 1.00 | 2.00 | 1.00 | 18.00 | 4.00 | 3.00 |
| 31 | 31 | Kitinda | Female | 36-55 | O level | Yes | .25 | 5.00 | 2.00 | 24.00 | 2.00 | 1.00 |
| 32 | 32 | Kitinda | Female | 36-55 | A level | Yes | .25 | 2.00 | 1.00 | 24.00 | 2.00 | 1.00 |
| 33 | 33 | Kitinda | Female | Over 55 | A level | Yes | .50 | 3.00 | 1.00 | 24.00 | 9.00 | 1.00 |
| 34 | 34 | Kitinda | Male | Over 55 | A level | Yes | .50 | 6.00 | 1.00 | 18.00 | 2.00 | .50 |
| 35 | 35 | Kitinda | Male | 36-55 | Tertiary/University | Yes | 2.00 | 6.00 | 2.00 | 9.00 | 2.00 | 1.00 |
| 36 | 36 | Kitinda | Male | Over 55 | A level | Yes | 1.00 | 14.00 | 5.00 | 12.00 | 12.00 | 1.50 |
| 37 | 37 | Kitinda | Female | Below 35 | A level | Yes | .50 | 7.00 | 2.00 | 12.00 | 10.00 | 4.00 |
| 38 | 38 | Kitinda | Male | Below 35 | A level | Yes | .25 | 2.00 | 2.00 | 12.00 | 7.00 | .50 |
| 39 | 39 | Kitinda | Female | 36-55 | O level | No | .00 | 10.00 | 3.00 | 14.00 | 13.00 | 1.00 |
| 40 | 40 | Kitinda | Male | 36-55 | O level | Yes | .25 | 2.00 | 1.00 | 14.00 | 2.00 | 3.00 |
| 41 | | | | | | | | | | | | |
| 42 | | | | | | | | | | | | |
| 43 | | | | | | | | | | | | |
| 44 | | | | | | | | | | | | |

Mercy Template_5.sav [DataSet1] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Graphs Utilities Extensions Window Help

Visible: 50

| | Wetcalves | Wetsold | Wetrejected | Wetspoilage | Wetspillage | Drymilk | Dryconsumed | Drycalves | Drysold | Dryrejected |
|---|---|---|---|---|---|---|---|---|---|---|
| 23 | .50 | 3.50 | .00 | .00 | .00 | 2.50 | 1.00 | .50 | 2.00 | .00 |
| 24 | 3.00 | 2.00 | .00 | .00 | .00 | 2.00 | 1.50 | 2.00 | .00 | .13 |
| 25 | 1.00 | 3.50 | .26 | .00 | .00 | 1.00 | 2.00 | 1.00 | .50 | .00 |
| 26 | 1.00 | 2.00 | .00 | .00 | .08 | 2.00 | 1.00 | 1.00 | 1.00 | .13 |
| 27 | 2.00 | .50 | .53 | .53 | .00 | 1.50 | 2.00 | 1.00 | 1.00 | .00 |
| 28 | 1.00 | 3.50 | .66 | .66 | .27 | 3.00 | 1.00 | 1.00 | .30 | .00 |
| 29 | 1.00 | 3.00 | .00 | .00 | .00 | 3.00 | 1.00 | 1.00 | .50 | .39 |
| 30 | 1.00 | 2.00 | .00 | .00 | .00 | 2.00 | .50 | 1.00 | .50 | .00 |
| 31 | 1.00 | 1.00 | .39 | .70 | .13 | 2.00 | 1.00 | 1.00 | 1.00 | .00 |
| 32 | 1.00 | 1.00 | .00 | .00 | .00 | 5.00 | 1.00 | 1.00 | .50 | .00 |
| 33 | 1.00 | 3.50 | .13 | .00 | .00 | 1.00 | 2.50 | 1.00 | 2.00 | .09 |
| 34 | 1.00 | 3.00 | .50 | .00 | .13 | 1.00 | 2.00 | 1.00 | 2.50 | .00 |
| 35 | 1.00 | 2.00 | .00 | .50 | .00 | 6.00 | .50 | 1.00 | 1.00 | .00 |
| 36 | 2.00 | 3.00 | .20 | .52 | .00 | 5.00 | 1.00 | 1.00 | 1.50 | .30 |
| 37 | 1.00 | 2.00 | .53 | .00 | .00 | 4.00 | 4.00 | 1.00 | 1.00 | .00 |
| 38 | 1.00 | 2.00 | .13 | .00 | .00 | 6.00 | .50 | 1.00 | 1.00 | .00 |
| 39 | 2.00 | 2.00 | .16 | .00 | .00 | 1.00 | 1.00 | 1.50 | 2.00 | .00 |
| 40 | 1.00 | 1.00 | .00 | .00 | .00 | 1.00 | 3.00 | 1.00 | 6.00 | .10 |
| 41 | | | | | | | | | | |
| 42 | | | | | | | | | | |
| 43 | | | | | | | | | | |
| 44 | | | | | | | | | | |

Data View Variable View

Mercy Template_5.sav [DataSet1] - IBM SPSS Statistics Data Editor

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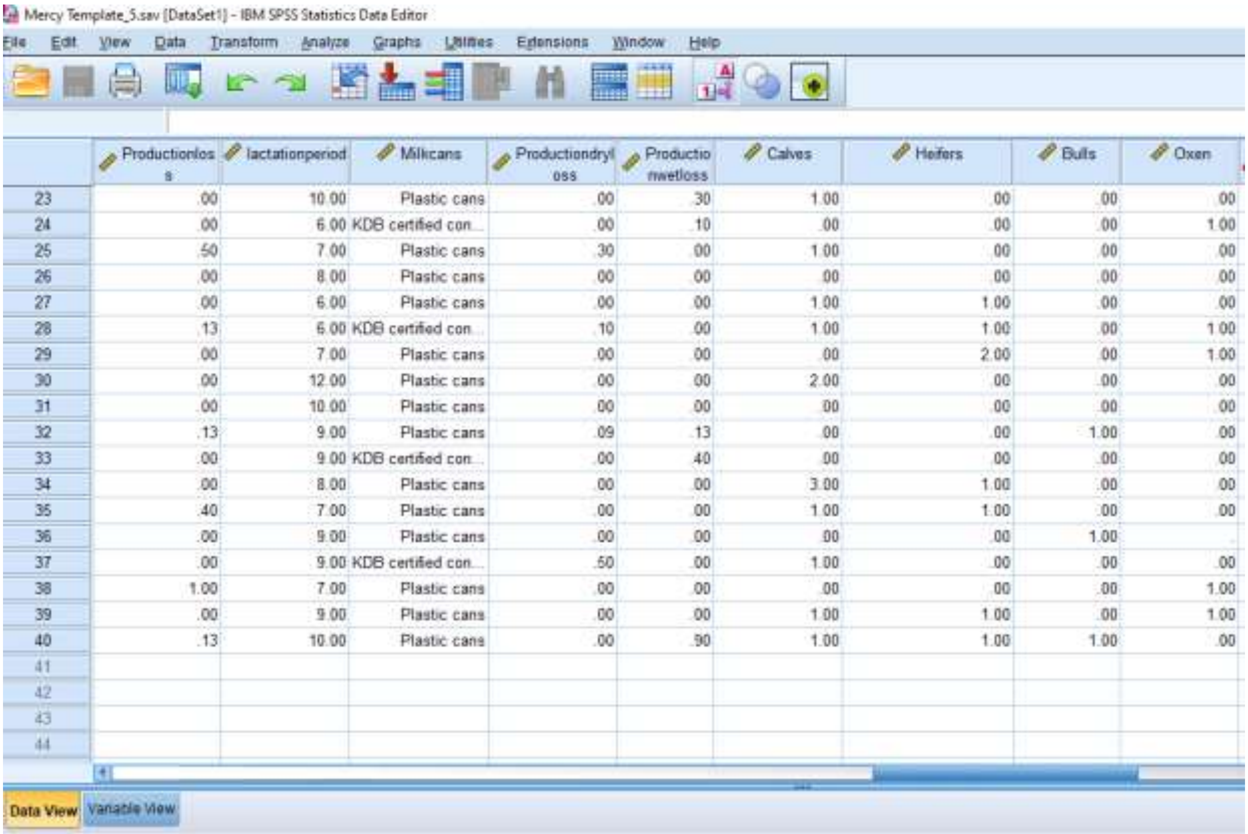
Visible: 50 of

| | Dryspillage | Dryspoilage | Time | Distance | Deliverymeans | Eveningmilk | Rejecteduse | Pricedry | Price |
|---|---|---|---|---|---|---|---|---|---|
| 23 | .00 | .00 | more than 1hour | morethan 1km | walking | Traders | sale locally | 36 | 34.00 |
| 24 | .00 | .00 | less than 1hour | less than 1km | walking | Traders | Home use | 36 | 34.00 |
| 25 | .00 | 1.25 | less than 1hour | less than 1km | walking | Traders | Discarded | 36 | 34.00 |
| 26 | .00 | .00 | less than 1hour | less than 1km | walking | Direct to consumers | Home use | 35 | 34.00 |
| 27 | .00 | .00 | less than 1hour | less than 1km | walking | Traders | sale locally | 36 | 34.00 |
| 28 | .00 | .00 | more than 1hour | morethan 1km | walking | Direct to consumers | sale locally | 36 | 34.00 |
| 29 | .13 | .39 | less than 1hour | less than 1km | walking | Direct to consumers | sale locally | 35 | 34.00 |
| 30 | .00 | .00 | more than 1hour | less than 1km | walking | Traders | Discarded | 35 | 34.00 |
| 31 | .00 | .66 | less than 1hour | less than 1km | walking | Direct to consumers | sale locally | 36 | 34.00 |
| 32 | .00 | .00 | less than 1hour | less than 1km | walking | Traders | sale locally | 36 | 34.00 |
| 33 | .00 | .36 | less than 1hour | less than 1km | walking | Direct to consumers | Home use | 36 | 34.00 |
| 34 | .19 | .00 | more than 1hour | less than 1km | walking | Traders | sale locally | 35 | 34.00 |
| 35 | .00 | .13 | less than 1hour | morethan 1km | walking | Milk bars | sale locally | 36 | 34.00 |
| 36 | .00 | .39 | less than 1hour | morethan 1km | walking | Traders | sale locally | 35 | 34.00 |
| 37 | .00 | .00 | less than 1hour | less than 1km | walking | Traders | sale locally | 36 | 34.00 |
| 38 | .00 | .00 | more than 1hour | less than 1km | walking | Direct to consumers | Home use | 35 | 34.00 |
| 39 | .05 | .66 | more than 1hour | morethan 1km | walking | Milk bars | Home use | 36 | 34.00 |
| 40 | .00 | .50 | less than 1hour | less than 1km | walking | Traders | Discarded | 36 | 34.00 |
| 41 | | | | | | | | | |
| 42 | | | | | | | | | |
| 43 | | | | | | | | | |
| 44 | | | | | | | | | |

Data View Variable View


Mercy Template_5.sav [DataSet1] - IBM SPSS Statistics Data Editor

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| | Productionloss | lactationperiod | Milkcans | Productiondryloss | Productionwetloss | Calves | Heifers | Bulls | Oxen |
|---|---|---|---|---|---|---|---|---|---|
| 23 | .00 | 10.00 | Plastic cans | .00 | .30 | 1.00 | .00 | .00 | .00 |
| 24 | .00 | 6.00 | KDB certified con... | .00 | .10 | .00 | .00 | .00 | 1.00 |
| 25 | .50 | 7.00 | Plastic cans | .30 | .00 | 1.00 | .00 | .00 | .00 |
| 26 | .00 | 8.00 | Plastic cans | .00 | .00 | .00 | .00 | .00 | .00 |
| 27 | .00 | 6.00 | Plastic cans | .00 | .00 | 1.00 | 1.00 | .00 | .00 |
| 28 | .13 | 6.00 | KDB certified con... | .10 | .00 | 1.00 | 1.00 | .00 | 1.00 |
| 29 | .00 | 7.00 | Plastic cans | .00 | .00 | .00 | 2.00 | .00 | 1.00 |
| 30 | .00 | 12.00 | Plastic cans | .00 | .00 | 2.00 | .00 | .00 | .00 |
| 31 | .00 | 10.00 | Plastic cans | .00 | .00 | .00 | .00 | .00 | .00 |
| 32 | .13 | 9.00 | Plastic cans | .09 | .13 | .00 | .00 | 1.00 | .00 |
| 33 | .00 | 9.00 | KDB certified con... | .00 | .40 | .00 | .00 | .00 | .00 |
| 34 | .00 | 8.00 | Plastic cans | .00 | .00 | 3.00 | 1.00 | .00 | .00 |
| 35 | .40 | 7.00 | Plastic cans | .00 | .00 | 1.00 | 1.00 | .00 | .00 |
| 36 | .00 | 9.00 | Plastic cans | .00 | .00 | .00 | .00 | 1.00 | . |
| 37 | .00 | 9.00 | KDB certified con... | .50 | .00 | 1.00 | .00 | .00 | .00 |
| 38 | 1.00 | 7.00 | Plastic cans | .00 | .00 | .00 | .00 | .00 | 1.00 |
| 39 | .00 | 9.00 | Plastic cans | .00 | .00 | 1.00 | 1.00 | .00 | 1.00 |
| 40 | .13 | 10.00 | Plastic cans | .00 | .90 | 1.00 | 1.00 | 1.00 | .00 |
| 41 | | | | | | | | | |
| 42 | | | | | | | | | |
| 43 | | | | | | | | | |
| 44 | | | | | | | | | |

Data View Variable View