# ANALYSIS OF THE SUSTAINABILITY OF LIVESTOCK FOOD SYSTEM IN KENYA: A CASE OF CAMEL MILK VALUE CHAIN IN ISIOLO COUNTY

**BY**

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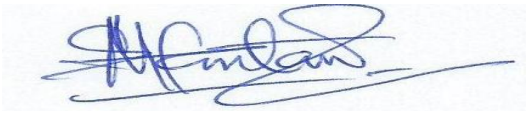
## DECLARATION

This Thesis is my original work and has not been presented for a degree in any other University.



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## DEDICATION

This Dissertation is dedicated to my beloved family.

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## ABSTRACT

The pastoral communities of Isiolo County in Kenya are mainly dependent on camel milk value chain as a primary source of livelihood. The system experience challenges in sustenance due to production, quality control, and safety measures. These and other related risks and stressors such as environmental degradation accruing from climate change and poor land uses are major threats to this livelihood system. In this study I analyzed the drivers and processes influencing the sustenance of camel milk value chain in Isiolo County. The specific objectives of the study were to: (i) characterize the camel milk value chain and its players (ii) examine the environmental factors influencing the system (iii) evaluate the efficacy of the regulatory frameworks, and (iv) develop a model for an enhanced system. I adopted a mixed methods approach in the case study and I collected primary data from 284 households selected through simple random technique, using a survey questionnaire, and interview guides for focus group discussions (FGD) and key informant interviews (KII). I obtained secondary data from the literature review from research publications and existing reports from relevant public and private institutions. I used analysis of variance (ANOVA) to test for inter-annual variations in quantities of camel milk supplied by producers to bulking centers. I also carried out regression analysis between fresh and value-added milk products against prices and cross tabulations to assess the variations and associations between the variables presented. I analyzed the data using statistical package for social sciences (SPSS) for Windows Version 23 as the statistical software tool. The main findings of the study show firstly, a characteristic three categories of actors, namely, the micro actors, the support services providers, and the policy makers who are not-well connected; secondly, the result indicates high variations in supply of camel milk delivered to the bulking and processing centers due to changes in seasonality; thirdly, inadequate capacities and weak institutional coordination mechanisms among the chain actors and support institutions and fourthly, I present a model for a sustainable camel milk value chain system for Isiolo County. I conclude that the current system is not sustainable due to unstable quantities of milk supplied to processing centers predisposed by seasonality and climatic variability. The current milk produced by producers is also of low quality and poor hygienic standards. There is also inadequate connectivity among the camel milk value chain actors and weak implementation of the existing policies supporting the system. I recommend a well-regulated camel milk value chain to improve on the current informal marketing system through establishing a camel policy in the county with a structured institutional arrangement for sustenance. This will enhance capacity building of the value chain actors for adoption of sustainable land uses and natural resources management in order to stabilize the camel milk value chain for Isiolo County.



Keywords: Camel Milk, Value Chain, Regulatory Framework, Environment, Northern Kenya

## LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| AEZ | Agro-ecological zone |
| AfDB | African Development Bank |
| AIT | Animal Identification and Traceability |
| ANOVA | Analysis of Variance |
| ASAL | Arid and Semi-Arid Lands |
| CAADP | Comprehensive African Agriculture Development Programme |
| CAC | Customer Acquisition Cost |
| CASELAP | Centre for Advanced Studies in Environmental Law and Policy |
| CIDP | County Integrated Development Plan |
| COMESA | Common Markets for Eastern and Central Africa |
| DA | Development agency |
| DRM | Drought risk management |
| EAC | East African Community |
| EDE | Ending Drought Emergency |
| ENSO | EL-Nino southern oscillation |
| FAO | Food and Agriculture Organization |
| FGD | Focused Group Discussion |
| GDP | Gross Domestic Product |
| GOK | Government of Kenya |
| HACCP | Hazard Analysis Critical Control Point |
| IGAD | Intergovernmental Authority on Development |
| IPCC | Inter-governmental panel on climate change |
| ITCZ | Inter-tropical convergence zone |
| KEBS | Kenya Bureau of Standards |
| KII | Key informant interview |
| KLMC | Kenya Livestock Marketing Council |
| KMC | Kenya Meat Commission |
| KMS | Kenya meteorological services |

| | |
|---|---|
| KNBS | Kenya National Bureau of Statistics |
| LFS | Livestock Food System |
| LSD | Least standard deviation |
| MID-P | Merti-integrated development project |
| MoAL&F | Ministry of Agriculture, Livestock and Fisheries |
| MTP | Medium Term Plan |
| NDMA | National Drought Management Authority |
| NDVI | Normalized Difference Vegetation Index |
| NEMA | National environment management authority |
| NGO | Non-Governmental Organization |
| NRM | Natural Resources Management |
| OIE | World Organisation for Animal Health |
| RUA | Resource user association |
| SDG | Sustainable Development Goal |
| SES | Socio-ecological system |
| SFVC | Sustainable food value chain |
| SPSS | Statistical Package for Social Scientists |
| UAE | United Arab Emirates |
| UNFCCC | United Nations Framework Convention on Climate Change |
| USA | United States of America |
| USAID | United States Agency for International Development |
| VC | Value chain |
| VCA | Value Chain Actor |
| VCI | Vegetation cover index |
| WPC | Ward planning committee |
| WRMA | Water resource management authority |
| WTO | World trade organization |
| WTO-SPS | WTO – Sanitary and phytosanitary |

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# CHAPTER ONE
# INTRODUCTION

## 1.1 Background to the study

Globally, the livestock food system supports the livelihoods of about one fifth of the population, mainly pastoralist communities, and accounts for over 40% of the world's agricultural gross domestic product (GDP) (Reay et al., 2020; Thornton *et al.,* 2013). Recent studies indicate that most of world's pastoralists mainly derive their livelihoods from livestock and livestock-based products (Ndiritu, 2020; Noor et al., 2013; Downie, 2011). The foundation of a successful livestock food system is anchored on the development of the promising value chains. A sustainable value chain is considered as one that provides quality and healthy foods in sufficient quantities while maintaining healthy ecosystems that will also be able to provide food for future generations (Colonna et al, 2014; McGinnis, 2014).

Among these, camel production is critical in supporting pastoral livelihoods in the arid and semi-arid lands (ASAL) of the world, with an estimated world's total camel population standing at 35 million (Odongo, 2016). Specifically, 82.5% of these camels are found in sub-Saharan Africa, where they are kept mainly for milk production and transport purposes (Nato et al., 2018). The studies further show that the world will continue to see a shift away from traditional staple food crops towards a corresponding increase in the consumption of livestock products particularly dairy and meat products (Colonna et al, 2014; FAO, 2008). This phenomenon will be driven by rapid rural migrations, subsequent urbanization, and anticipated increases in the world's human population that is estimated at 9 billion by the year 2050 (Willet et al., 2019). Further, the United Nations Framework Convention on Climate Change (UNFCCC) established during the Rio Earth Summit (1992) and the recent Paris Agreement on Climate change (2015) also provides universal and legally binding policy options to reducing vulnerability towards the adverse effects of climate change and environmental risks. These UN agreements together encourage partnerships and networking among all stakeholders to take action towards the impact of climate change and other environmental stressors that affect sustainable systems. These have therefore, stimulated global, regional and national attention towards the need for policy interventions and implementation of sustainable livestock food system especially in fragile ecosystems of the arid and semi-arid regions of the world.

Neven (2014) shows that a value chain is considered "sustainable" when it provides the full range of services and their successive coordinated value-adding activities (input supply, production, bulking, processing transportation, and marketing), and that does not compromise environmental integrity. A study conducted by McGinnis (2014), also shows that a sustainable value chain is considered as one that provides quality and healthy foods in sufficient quantities while maintaining healthy ecosystems that will also be able to provide food for future generations. The indicators include minimal negative impacts on environment, promotion of local production and distribution, availability of nutritious foods which are also accessible and affordable both in quantity and quality required and has systems approaches and regulatory mechanisms in place that safeguard the interests of all actors while upholding the environmental integrity. However, although the camel is an important source of livelihoods to some 820 million people living in the arid and semi-arid regions of the world, it has not solved the food insecurity and extreme poverty levels persistent in these regions (Willet, 2019).

In sub-Saharan Africa, the major value chain which form the backbone of livelihoods of the pastoral communities is the camel, which is also considered the most resilient to the extreme climatic conditions and survive drought episodes. Today, Eastern Africa is considered home to 60 per cent of the world's camel population, and the popularity of camel products in Kenya, Somalia, Sudan and Ethiopia has rapidly increased in recent years with milk not just consumed by pastoralists but being increasingly sold in urban areas (Odhiambo, 2006). Camels are a source of food, incomes and also provide significant cultural functions to pastoral communities in the ASALs (Guliye et al., 2007).

In Kenya, livestock sub-sector contributes 17% of the country's gross domestic products (GDP) and supports over 30% (14 million) of the population, and a corresponding camel population of 3 million (GOK, 2017). For Isiolo County, the estimated camel population is 148,858 with an average annual milk production of 486 million liters (KNBS, 2020). However, although there is high potential for camel milk value chain to boost the county revenue base and cushioning household demands through sale of milk and milk products, there are barriers to its sustenance. These are due to undeveloped camel milk value chain, increasing climate anomalies and other environmental risks influencing the productivity of the system. In order to boost the productivity of the camel milk value chain, the County Government of Isiolo has planned for the need to

undertake critical understanding of a viable and sustainable value chain system, through the 2018-2022 County Integrated Development Plan (CIDP).

This will consider the identification of possible policies and opportunities that focus on sustainable production, marketing systems, and natural resources management mechanisms commensurate with the existing national, regional, and global food system frameworks. Among these frameworks, the most relevant is the sustainable development goals (SDG's) No. 12 and 17 that promote "responsible production and consumption" and development of "regional and global partnerships" respectively.

The challenge is that, although over 80 per cent of the pastoral households in Isiolo County derive their source of livelihood from camel production, and there are also significant support institutions interested in the system, the sustainability of the camel milk value chain in the county is not well understood in relation to marketing networks and reliable control mechanisms. The persistent food insecurity standing at 77% and increasing poverty levels at 72% against the national level of 56% anticipated to have been caused by undeveloped value chain system is a great challenge. The purpose of this study, therefore, was to investigate the drivers and processes that influence the viability of the camel milk value chain in Isiolo County. The results are analyzed according to the specific objectives of the study and the outcomes used to develop an alternative modernized camel milk value chain system with a well-regulated framework for Isiolo County.

### 1.2 Statement of the research problem

Isiolo County holds 9% of the total estimated camel population in Kenya, with the camel milk value chain supporting over 80% of the pastoral household demands (Machan et al., 2022). The value chain attracts diverse actors e.g. 18 local bulking centers feeding three cooperative societies involved in processing and marketing camel milk. There are also many support institutions such as the county departments of livestock and veterinary services, and other non-governmental development agencies that are involved in the development of the camel milk value chain.

Despite these efforts, the system experiences low control mechanisms in quality and safety of the fresh milk marketed, predisposing an unsustainable value chain. This may be due to the socio-cultural practices of the value chain micro actors and the high dependence of the system on the prevailing climatic and weather conditions. Presently, there are challenges due to high post-harvest losses and low value addition due to low capacities among the micro producers and the processing

centers. Also, there are weak interconnectivity among the value chain actors and inadequate institutional arrangements to enhance a sustainable system.

The study focuses on finding possible solutions towards resolving these anomalies through critical analysis and mapping of the value chain system and address the existing threats, in order to enhance a sustainable camel milk value chain with strong regulatory frameworks and connectivity among the actors. This study undertakes a clear understanding and analysis of the existing camel milk value chain system, critical environmental risks that limit sustenance, and evaluation of the existing policies and legislations governing the system. Finally, the study was to develop a modernized model for a sustainable camel milk value chain system. This will generate knowledge necessary to inform policy makers and enhance a viable and sustainable camel milk value chain system for Isiolo County.

### 1.3 Research Questions

The main research question for the study is how is the camel milk value chain system structured and governed in Isiolo County?

The sub-questions are:

(i) How is the camel milk value chain characterized in Isiolo County?

(ii) What environmental risks face the sustenance of camel milk value chain in the County?

(iii) What is the efficacy of the regulatory frameworks that govern the camel milk value chain in the County?

(iv) How can the camel milk value chain be modernized to enhance a sustainable system in Isiolo County?

### 1.4 Objective of the study

The main objective of the study was to analyze the camel milk value chain system and the control mechanisms that influence the sustenance of the system in Isiolo County. The specific objectives of the study were to:

(i) Characterize camel milk value chain in Isiolo County

(ii) Examine the environmental factors influencing the sustainability of camel milk value chain in the County.

(iii) Evaluate the efficacy of the regulatory frameworks that govern the camel milk value chain in the County

(iv) Develop a modernized camel milk value chain model to ensure a sustainable system in Isiolo County

**1.5 Justification of the study**

The Sustainable Development Goals (SDG's) and the world trade organization (WTO) agendas seek to ensure that livestock sub-sector plays core part in boosting the economy, improve livelihoods of the livestock dependent pastoral communities, and promote sustainable livestock development in livestock prone areas (WTO, 2016). The most relevant SDG to this study is goal No. 12 which advocates for ensuring sustainable consumption and production patterns of livestock subsector through sustainable utilization and management of the natural resources. This has stimulated attention towards the need for national and county specific policy interventions in order to achieve implementation of the established global SDG's and national livestock food system frameworks.

Towards attaining these, the Constitution of Kenya (2010), Article 185, stipulates that the county governments are constitutionally mandated to formulate their own policies and strategies in line with the national policies. Further, Article 6(1) to (3) and the Fourth Schedule of the Constitution stipulate for the devolvement of the livestock sub-sector through enhancing livestock and livestock-based products markets and their respective value chains developments. Chapter four of the Constitution on the "Bill of Rights" provides for economic and social rights for every person and the right to clean and healthy environment. Specifically, Article 43(c) of the Constitution advocates for the economic and social rights which include freedom from hunger and to have adequate food of acceptable quality. Part two of Chapter five of the Constitution, under Article 69 (1) stipulates the obligations to respect for the environment and states in particular to (i) ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources and ensure the equitable sharing of the accruing benefits (b) have obligations relating to the environment fulfilled under Article 70 that pertains to enforcement of environmental regulations and rights.

The purpose of national livestock policy (2008) together with the newly revised version (2017) and the national policy for the sustainable development of northern Kenya and other arid lands (2011) was to provide coherent and practical regulatory and legislative frameworks for the sustainable development of livestock-subsector in ASAL regions of Kenya. The key objectives were to

develop alternative approaches to service delivery, governance, and strengthening climate resilient opportunities to ensure sustainable livelihoods. The Isiolo 2017-2022 County Integrated Development Plan (CIDP) also brings out that the current camel milk value chain is based on traditional production systems with informal marketing practices and highly dependent on fragile climatic conditions. This phenomenon is a big challenge to a sustainable value chain in the county since the system have not been assessed in terms of sustainability. These indicators make it necessary to carry out studies essential for clear understanding of the dynamics of a sustainable value chains system with feasible coordination frameworks for sustenance.

Hence, this study is triggered by the fact that, no studies have been conducted aimed at a well-regulated camel milk value chain to enhance a viable and sustainable system in a pastoral community such as Isiolo County. It's important to note that, previous studies on camel milk value chain, have only investigated the links in the milk marketing systems without understanding the overall efficacy of the regulatory frameworks in the value chain system. The aim of this study, therefore, is to provide adequate information on a modernized camel milk value chain system, not only for the actors in Isiolo County, but also to pastoralist communities practicing camel milk value chain in similar regions. Such information would be useful for initiating policy planning to enhance a sustainable camel milk value chain system.

### 1.6 Significance of the study

The Isiolo County Government is anticipated to support and develop strong partnerships and networks among the camel milk value chain actors in order to improve the performance and productivity of the sub-sector, through the CIDP 2022-2027. The overall goal is to upscale the camel milk industry to increase the county revenue base and also improve the pastoral livelihoods. Many researchers had also shown results indicating high post-harvest losses during bulking and delivery of raw milk to processing centers. This is associated with poor milk handling techniques, weak regulatory frameworks, and lack of strong connectivity among value chain actors to ensure a sustainable system.

The importance of this study was mainly the completion of a Doctoral Dissertation at the University of Nairobi, in order to come up with a modernized camel milk value chain model that ensure an efficient and effective regulatory mechanism to enhance a sustainable system in Isiolo

County. The study generates an informed knowledge towards transformation (production, processing, distribution, transportation and consumption), through improved regulatory framework with strong connectivity among the value chain actors. The study will also inform the policy makers on the need to develop a board and legislations anchored on the proposed camel milk policy for the county.

More important, the study has generated two scientific journal papers that can be accessed online, showing the findings of this study and this will broaden the knowledge of other researchers to investigate further the areas recommended for further research in this study.

### 1.7 Scope and limitations of the study

The study covered the whole of Isiolo County which include Isiolo central, Garbatulla and Merti sub-counties. The information collected included household demographic information's, analysis of most important value chains and environmental risks that affect the sustainability of the camel milk value chain in Isiolo County. The study limitations include vastness of the study area coupled with poor infrastructure, varied stakeholders with diverse interests and behaviours. Other limitations also included inadequate livestock population statistics and data for livestock and livestock products by the County departments of livestock and veterinary services. The data on livestock populations were mainly projections which may not have been very accurate.

### 1. 8 Operational definitions of terms

**Food system:** Food systems can be defined as the full range of activities required to bring a livestock product to final consumers through the different phases of production, transportation processing, distribution and consumption (FAO, 2014). Ingram et al. (2005) also show that food system comprises activities, resources, stakeholders, and infrastructure that collectively determine food availability, food access, and food utilization.

**Value Chain:** Value chain is a set of linked activities that work to add value to a product; it consists of actors and actions that improve a product while linking commodity producers to processors and markets

**Value Chain Actor:** These are those individuals or groups that are actually directly involved in value chain activities. In real sense it involves individuals, groups or organizations along the value chain.

**Value Chain Organization:** These are category of value chain actors undertaking similar activities that come together for a common purpose. This could be common interest groups, value chain groups, marketing federations, producer association, association of input suppliers etc.

**Environmental risk:** Actual or potential threats or exposures that induce harmful responses to both biological and the physical environment. The exposures can be in the form of effluents, emissions, resources depletion, land degradation, wastes etc.

**Environmental risk assessment:** To evaluate the effects of environmental exposures, awareness, vulnerability, preparedness and response in managing emerging and unforeseen pollution risks. These risks cause environmental liability with the potential to negatively impact the environment.

# CHAPTER TWO
# LITERATURE REVIEW

## 2.1 Introduction

This chapter analyses the literature review in relation to the specific objectives of the study. It considers studies conducted and observations by other researchers in relations to overall livestock food system and livestock-based value chains, challenges to sustainability, as well as existing regulatory frameworks for livestock food system.

## 2.2 Understanding the context of the global livestock food system frameworks

The contextual understanding of a sustainable food system involves the clear analysis of products and their market systems, the participation of different actors and their networks, and critical constraints that either limit or enhance the growth from production to final consumption stage (Kumar et al., 2011). Hence, the system involves many value chain actors which have significant roles in characterizing complex networks in the production and marketing of a given value chain system. It is imperative to note that the world food prices of 2007, 2008, and 2010 generated increased interests in the analysis of food systems and related value chains by many policy makers (Ericksen, 2008a; McGinnis & Ostrom, 2014). A recent study shows that about 820 million people, mainly from arid and semi-arid regions of the world, have insufficient food arising from undeveloped value chains (Willet et al, 2019). McGinnis & Ostrom 2014 also indicated that "food system crisis" is a result of poor understanding and practices in sustainable value chains developments that culminate to persistent food insecurity, increasing environmental degradation, and poverty levels in the dry lands of sub-Saharan Africa.

The Africa region frameworks for the development of livestock sub-sector and agricultural sector strongly advocates for supporting commercialization of the livestock and livestock-based products. However, these frameworks (EAC, COMESA, CAADP, IGAD) have failed to meet the objectives which include the development of sustainable livestock food system with the aim to improving market access, reducing tariff and non-tariff barriers, and enhancing effective market information as well as maintaining environmental integrity (IGAD, 2016). Also, although there are about 532 million livestock in Africa, the development of livestock food system lags behinds not because of lack of livestock and livestock-based products but due to inadequate leadership or political will and lack of pastoral community's capacities in the commercialization of the livestock sub-sector

(IGAD, 2014). For example, the enhancement of transboundary animal diseases important for regional and international trade entirely depends on developed policies and "political will" for enforcement of agreed legislations. The major gap has been the lack of comprehensive control mechanisms for quality, standards and safety measures for sustainable trade. This requires that all the actors in the livestock food system and respective value chains have to be provided with adequate skills and capacities to comply with the established global and regional policies and legislations in order to undertake sustainable trade.

### 2.3 Review of the global environmental related challenges towards sustainable livestock value chains development

The global Intergovernmental Panel on Climate Change (IPCC) has indicated that the major challenges that affect the sustenance of reliable and potential livestock value chains in the ASAL regions, accrue from environmental risks that include; changes in rainfall patterns, floods, droughts, a reduction in biodiversity, and increases in resource use conflicts (Johns et al., 2013; Koech and Mundia, 2020; McMichael, 2011; Sabala, 2013; Wossen, 2013). Today, warnings of these disaster-related scenarios are most evident all over the world. There is also growing evidence that the frequency and extent of droughts have increased as a result of climatic variations and overall global warming (Omoyo et al., 2015). A global analysis also shows that changes in climate change impact the overall productivity and environmental services that support pastoral livelihoods, therefore, complicating the pastoral production systems (Harison et al., 2017). This is evidenced by abrupt changes in weather conditions necessitating unreliable weather patterns that have strong negative impacts on livestock production, vegetation index cover, and natural resources management (Ostron, 2009). Sub-Saharan Africa (SSA) is among these regions in the world where the effects of climate change and climatic variability are being felt hard (Gaur and Squires, 2018); Miller et al., 2013). These environmental challenges are likely to affect more of the pastoralist communities whose main livelihoods are dependent on livestock production (Okoba et al., 2011; McPeak and Barrett, 2001). These constraints are anticipated to affect the viability of the camel milk value chain in the region. Hence, although there is potential for the camel milk value chain in the arid and semi-arid regions of Africa, particularly the drylands of the Sahel and Horn of Africa, there are barriers to its sustenance. The major threats are realized in camel milk production and market channels due to climate change and climatic variability that affect the overall livestock production systems (Herrero and Thornton, 2013). Other studies also indicate that climate change

and climatic variability predispose frequent droughts that exacerbate inappropriate land-use systems (Harison et al., 2017; Li, et al., 2013; Davidson, 2011; Connelly, 2007). These inappropriate land-use systems further exacerbate a pastoral migratory pattern that ultimately threatens the system and contributes to low productivity and high environmental degradation, resulting in weak value chain products to meet global market standards (IGAD, 2014).

Studies also indicate that changes related to increasing climate variability coupled with the oscillating socio-economic situations have led to a need to enhance adaptation by building the resilience of local food systems, including economic diversification, and the sustainable management of natural resources (Thornton et al., 2014). In these aspects, understanding of a These diversifications, both internal and external, will stimulate changes in policy matters needed to support rational camel milk production, market access, and income generation without compromising environmental integrity. Although nomadic pastoralism and traditional camel keeping practices are anticipated to provide a significant contribution of the revenue—not only to the County Government of Isiolo but also to the overall national economic development—there are no sustainable natural resources management measures that are put in place to support a resilient pastoralist's livelihood (Machan et al., 2022). It is, therefore, important to conceptualize that nomadic pastoralism has come increasingly under pressure in a downward spiral of resource depletion and diminishing resilience against climate and non-climate changes, thus negatively influencing its sustenance.

### 2.4 Environmental policies and legislation influencing the camel milk value chain in Isiolo County

There are various policies and legislations that influence the sustainability of camel milk value chain in the county. These include the Kenya National Climate Change Policy (2014) which gives a focus for finding out the mitigation measures of the consequences implicated with climate change. The policy stipulates for support for the coherent development of an integrated institutional frameworks between the National and County levels in matters concerning natural resources management and climate related disasters. The overall implication is that the present situation with weak coordination mechanisms will seriously challenge the livestock production and marketing systems. Hence, there is need for scientific understanding and finding options for a resilient and sustainable framework for increased productivity of the livestock-based value chains,

such as the camel milk value chain, to meet the requirements for both domestic and external markets (County Government of Isiolo, 2018). The main concern, therefore, is that the system currently faces challenges of resilience to existing environmental stressors affecting the system. The ten-year plan Kenya Compact for the Ending Drought Emergency (EDE) linked to the UN Sendai Framework for climate actions (2015–2030), which intends to end extreme climate anomalies, such as drought emergencies, by 2022 recognizes that environmental risks are driven by climate change and climatic variability and the socio-cultural practices leading to land degradation and reduced livelihood performance (GOK, 2012). This framework stipulates the need to build capacities in the pastoral communities towards the resilience of livelihoods in the arid and semi-arid regions. The framework emphasizes enhancing the productive potential of the livestock value chains and the need for development of a multi-sectoral and multidisciplinary approach to enhance effective risk management for sustainable livestock value chains such as camel milk (GOK, 2018). I, therefore, attempt to fill this gap by analyzing the environmental factors influencing the sustenance of the camel milk value chain along the various processes in the chain and provide recommendations for an enhanced system.

In Isiolo County, the livestock food system regulatory mechanisms are anchored in the departments of livestock production, veterinary services (disease control and certification), public health (health and sanitary requirements), Kenya bureau of standards (KEBS) for quality and standardization of traded products and national environmental management and authority (NEMA) for waste management and environmental concerns under EMCA, 2019 Act. However, the Isiolo CIDP (2016) points out that all these bodies or departments from the National to County levels work in isolations or without any proper coordination mechanism. The livestock department and the veterinary services department are also not coordinated. It also states that although some of them are under the same ministerial governance system, they experience conflicting roles and responsibilities in the enforcement of the existing legislations. This is evident in the recently developed Isiolo County Livestock Sales Yard Act, 2016. This is the first legislation in the County related to food system development. The Act covers a number of items, namely: establishment of livestock sale yards regulations for the same, and establishment of management committees for livestock-based products. The challenge is that the livestock sales yard Act (2016) did not capture the linkages between the national and county government roles to enhance a sustainable system.

Instead, it shows a system where the county will work in isolation or exclusive management and this will affect the sustainability of the system.

**2.5 Analyses of camel milk value chain system**

Research analyses of the livestock value chains, such as camel milk, shows that there is increasing demand for these products but there are challenges to meet the requirements to attain wider markets due to low quality products and inadequate marketing systems that limit the ability for sustenance (Dandesa, 2017; FAO, 2014). Although camel production is an important source of livelihood to pastoralist communities in northern Kenya, there are no studies conducted to enhance an enabling environment for a sustainable system. A study conducted by Farmer & Mbikwa (2012) has also indicated that the failure of the overall sustainability of livestock-based food systems, in arid and semi-arid regions of sub-Saharan Africa, is due to lack of comprehensive analysis and understanding of potential value chains. However, Colonna et al., 2014 cited recommendations to remedy the situation through multidisciplinary approaches in order to attain development of potential value chains. A study conducted in Garissa County reveal that there are low levels of camel milk production, collection, processing and marketing, and these stages are also not well developed as a result of weak marketing infrastructure (Mwanyumba, 2014). Studies done in southern Ethiopia, Somalia, and Saudi Arabia also show that the interconnectedness of the camel milk value chain actors is weak and that institutional arrangements are poorly coordinated (Anastasiadis & Poole, 2015).

Many researchers had conducted studies in analyzing camel milk value chains in different regions, such as Saudi Arabia, Kenya and eastern Ethiopia, mainly targeting the production and marketing of camel milk (Yilma & Yonas, 2017). The studies have focused mainly on challenges influencing husbandry practices and, to a lesser degree, on the hygienic practices and microbial loads in traditional camel milk production (Ndiritu, 2020; Yilma, & Yonas, 2017). Therefore, this study has identified the gap that no studies have been conducted on the need for an enabling environment or regulatory frameworks that are critical in enhancing a sustainable value chain system. Specifically, studies conducted in Isiolo County and other parts of northern Kenya among pastoralists communities, on the analyses of the camel milk value chain, reveal that income from the sale of camel milk exceeds other livestock income sources (Hussein, 2015; Noor et al., 2013). These studies have been argued that even resource-poor households are involved in the value chain, despite having fewer animals. Despite these, milk is consumed either in fresh form or as fermented

milk regardless of whether the milk was spoiled (Nato et al. 2018). It is revealed that such traditional milk production methods contribute to increased bacterial loads due to low hygiene practices that subject the product to poor quality and safety standards for marketing purposes.

This study addresses this problem through analyses of the value chain system, environmental factors influencing the system, and the existing regulatory frameworks providing an enabling environment. In addressing the gaps, the study provides developing recommendations for appropriate institutional arrangements and coordination frameworks that can enhance a sustainable system. This will generate knowledge to build the capacities of the value chain actors for resilience. The outcome of these will be development of an organized marketing channels and the strengthening of processes that add value to milk to enable camel milk micro actors earn more from their products. The study recognizes that camel milk is a strong boost for pastoralist communities in Isiolo County and, therefore, attempt to provide explicit options to counteract the current fluctuating camel milk prices due to an unstable market infrastructure. The reason for the lack of an organized marketing system in the county is likely due to a lack of awareness of the prevailing national, regional, and global regulatory frameworks, and environmental policy matters. The study fast tracks recommendations by Ericksen (2008a) which indicates that unless local food systems and their underlying value chains are well-structured and well-regulated, then sustainability may not be possible in the policy-making process.

### 2.6 Research gaps identified

The global food system regulations in relation to policy matters have traditionally been on the conditions of access to markets with little considerations for regulatory frameworks and upholding environmental integrity geared towards sustainable production and consumption practices. Literature review indicates that there are challenges in control mechanisms to implement, enforce, and to strengthen compliance of local livestock value chains with the wider market requirements for sustenance. The studies conducted by various researchers have dealt widely with livestock food system processes, activities and outcomes, without taking serious consideration of the governance structure (regulatory environment) as the main driver for sustenance.

Literature review on Isiolo County policies and legislation governing livestock sub-sector show that, although there are many public and other private development agencies interested in camel

milk value chain, the system is unstructured due to weak coordination and institutional arrangements. The Isiolo CIDP 2018-2022 highlights that the high levels of food insecurity and poverty are due to undeveloped livestock-based value chains. The critical question this study is addressing, therefore, is firstly, "how can the Isiolo County camel milk value chain be structured and coordinated to fit to the global and national standards for sustainable food system"? and secondly, what knowledge is required to build the capacities of various value chain actors to expand their market opportunities for sustenance. It is important to note, therefore, that "without a strong societal understanding of market-oriented livestock value chains system, then the concept of sustainability will ever remain a big challenge.

## 2.7 Analytical Framework for Camel Milk Value Chain

### 2.7.1 Theoretical framework

The theoretical framework of this study is built on the Sustainable Food Value Chains (SFVCs) approach adopted by FAO, 2014. This involves complex systems which include all activities related to the production and distribution of food in a given region. The underlying principles is the creation of a conceptual grouping of actors, their activities, and constraints required in providing a required service. These services were conceptualized as linkages between the practices of the value chain actors and market organizations for a given product (Reardon and Timmer, 2012). The limitations of this approach are that, when applied to a food system, it does not comprehend all the connections and relationships among the food supply and distribution system, including the negative externalities and intrinsic complexities.

Specifically, FAO (2014) used this approach as a dynamic system that involves the identification of actors' behavior within a value chain. This concept is not only central to identifying the stages involved in the value chain, but also preparing stages and interventions to be adopted for socio-economic development (Neven, 2014; Bowersox et al., 2013; Donovan et al., 2013). However, the limitation of this approach is that it targets market's efficiency and dynamism. In this framework, the enabling environment mainly influenced by policies for sustainability are not well-considered. This study modifies the SFVS model to include the governance system, environmental concerns, and the direct interventions for an enhanced system. The theory also assumes that the societies depend upon the environment and the services provided by its ecosystems for sustenance (Connelly, 2007).

In this scenario for the development of a sustainable camel milk value chain for Isiolo County, the concept undertakes the understanding of the value chain activities (production, bulking, transportation, processing and marketing), support services providers, and the enabling environment as a contested concept for sustainability. The role of the community through social networks is crucial to enhance the adoption of new management practices (Li, 2013; Barrett, 2012). The SFVC framework approach used by this study has also been used by other researchers considering sustainable food system along the three dimensions of sustainability. These are social, economic and environmental dimensions.

In using this approach, the framework assumes that sustainability is determined by the behavior of diverse actors in the value chain system that influences the flow of food products from point of production to consumption. The framework also recognizes the society's dependence on the natural resources and prevailing ecosystem services for their livelihood. The economic dimension considers that a value chain, or food system at large, is considered sustainable if the activity conducted by each actor is commercially or fiscally viable. The assumption is that these activities should generate economic benefits. Comparatively, the environmental dimension assumes sustenance if the impacts of the system activities are contained or not detrimental to environmental integrity e.g. destruction of biodiversity, water resources degradation, health and reduced toxicity levels for livestock products consumed. Several researchers have based the governance of resource system (ecological conditions) and resource units (the value chains) as the major parameters for consideration to the sustenance of a viable value chain system (Donovan and Poole 2014; McGinnins and Ostrom, 2014; Ericksen, 2008).

This study finds that although SFVC framework is built on the assumption that sustainability is a key factor in food system or respective value chain (e.g. processing, packaging & distribution) to meet consumer demands, there is limitation in regulatory mechanisms required for a sustainable system. However, the framework has a strength in that it provides the possibility to diagnose the complex challenges among the value chain actors and the enabling environment for sustainable food system. In summary, the modified version (Figure 2.7.2) of the conceptual framework model for this study has included the enabling environment for an enhanced system. The outcome of this

framework is focused to attain an equilibrium between the socio-economic and environmental concerns influencing the sustenance of the camel milk value chain in Isiolo County.

**2.7.2 Conceptual framework for sustainable camel milk value chain in Isiolo County.**

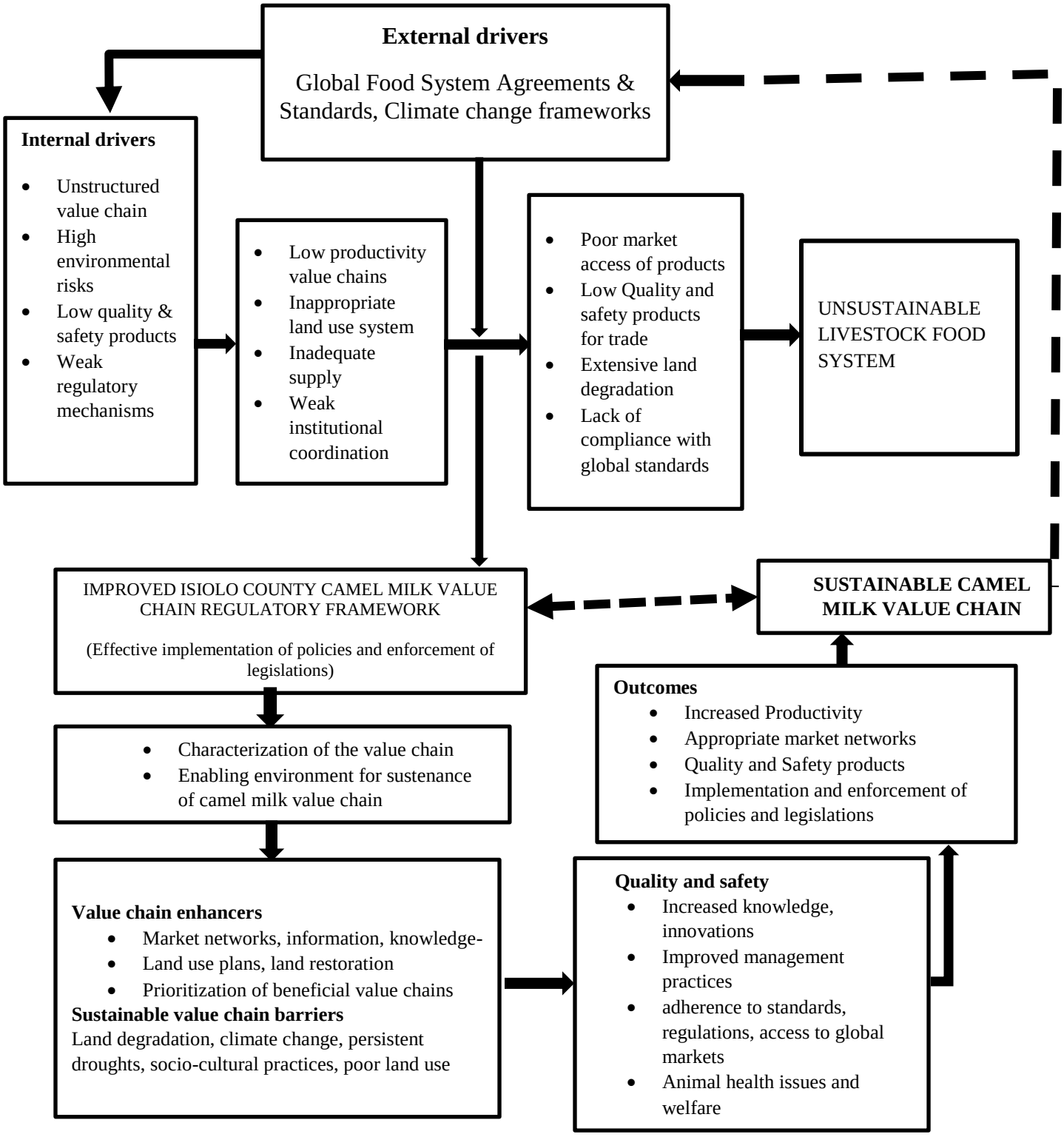


**Figure 1: Conceptual framework showing interrelationship between external and internal factors influencing the system: Source: Field study, 2019**

# CHAPTER THREE
# STUDY AREA AND METHODOLOGY

## 3.1 Introduction

This section describes the study area and the methodology adopted in research design and execution. Specifically, it focuses on the study sites, data collection and methodology, sampling frame and sampling procedure, data analysis and interpretation respectively. I also discuss the research design and methods carried out during the study based on the objective of the study. This approach was used to ensure quality and reliable data to enable suitable data analysis in order to achieve appropriate results for the underlying research specific objectives.

## 3.2 Background of the Study Area

### 3.2.1 Administrative units and population size

The study area, Isiolo County, has a land area of 25,350.6 $km^2$ and a population of 268,002 persons (KNBS, 2020). Figure 2 below, shows the position of the study area in Kenya. Administratively, the county is divided into three sub-counties: Isiolo, central, Garbatulla, and Merti. According to the 2019 population census, Isiolo central had the highest population, with 121,066 persons, Garbatulla had 99,730 persons, and Merti had the lowest population with 47,206 persons.

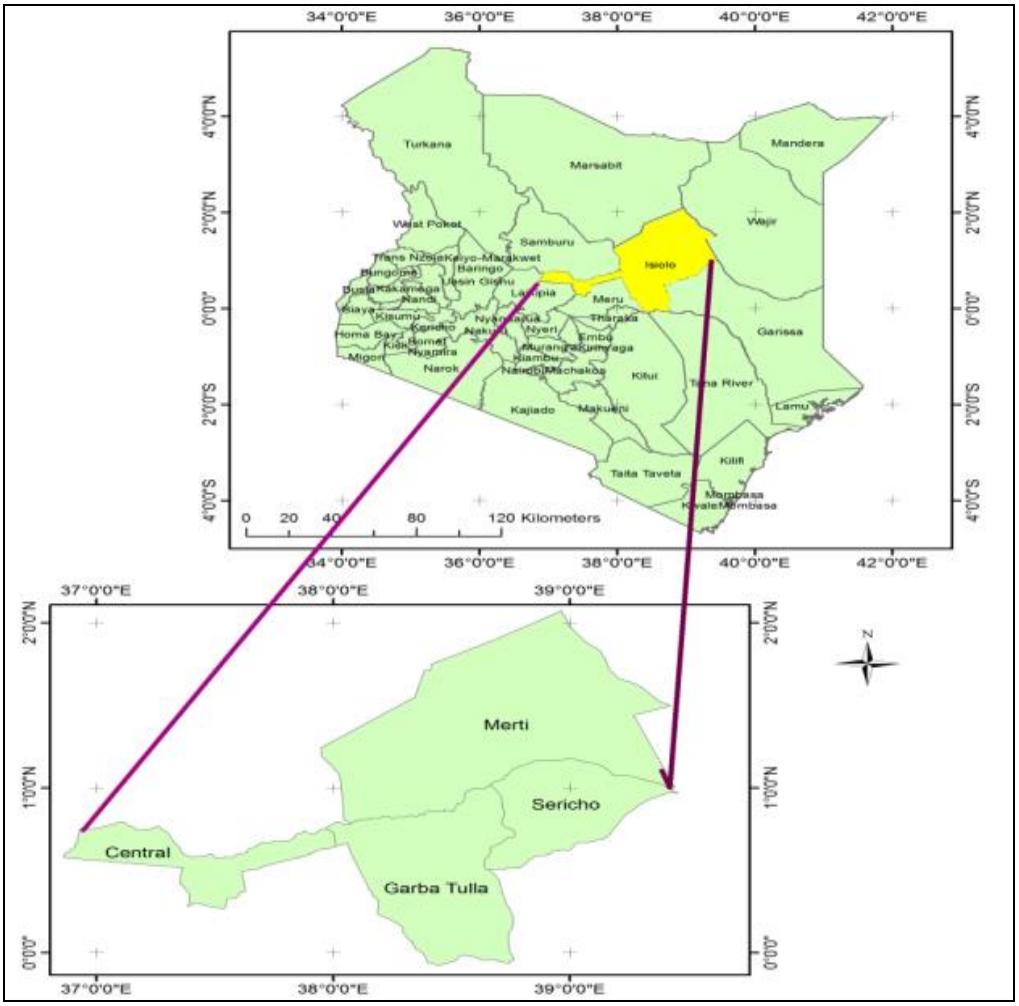



**Figure 2: The location of the study area in Isiolo County, Kenya**

### 3.2.2 Rainfall and temperature

In terms of climate, Isiolo County is a typical arid and semi-arid region with a bimodal rainfall pattern, characterized by long rains from March to May and short rains from October to December (Noor et al, 2013). Generally, the rainfall is highly unreliable and unevenly distributed. About 95% of the county is classified as arid or very arid, while only 5% is semi-arid, generally receiving an average annual rainfall below 300 mm (12 inches), which is also unevenly distributed (NDMA, 2019). The rainfall regime in the County is influenced by Inter-Tropical Convergence Zone (ITCZ), the EL Nino Southern Oscillation (ENSO), and the altitude effects of the neighboring Mt. Kenya and Nyambene Hills (CIDP 2018-2022). These factors cause rainfall variability across the county with the eastern regions and northern parts of the county receiving less than 250mm of rainfall per annum. Thus, the rainfall in the county is often characterized by high inter-annual

variability which directly affects hydrological, ecological, and biochemical processes that have an eventual influence on the climate of Isiolo County (CIDP, 2017).

The temperatures are high throughout the year, ranging from a mean minimum of 27$^{o}$C and a maximum of 30$^{o}$C, in almost all parts of the county (Nato et al., 2018). The average temperature is about 29$^{o}$C. This is mainly influenced by variation in altitude which rises from 200m to 300m at Merti plateau with the highest peak or region rising up to 1,100 m above sea level in Isiolo central (KMS, 2018). The topography of the landscape influences the amount of rainfall received and temperature regimes in the area.

### 3.2.3 Socio-economic activities

Livestock keeping is considered the main source of livelihood for over 80% of the citizens who are mainly pastoralists with only a few practicing ago-pastoralists. The main sources for livelihoods are derived from cattle, camels, sheep and goats, in terms of milk, meat, and incomes from sale of live animals. Other livestock-based byproducts include hides and skins. Among the livestock-based value chains in the county, camel milk is the most common enterprise. The value chain also attracts the most vulnerable groups, such as women and youth, into the system. However, there is still high persistence of poverty and food insecurity levels in the county, standing at 70% and 77% respectively (CIDP, 2018).

### 3.2.4 Land use system

Isiolo County is categorized into three agro-ecological zones (AEZ's) namely arid (95%), semi-arid (5%) and very arid thus favoring livestock production as the predominant use for land use system. Generally, this type of climatology supports grassland, dry land trees, and shrubs. This vegetation type makes it more conducive for livestock keeping than crop farming. Due to the browse nature of the vegetation, camel keeping is the most preferred in the area. The soils in the County are mostly sandy and saline with low productivity for crop farming. Hence, the main land use system practiced in the area is nomadic pastoralism. Majority of the land is communally owned (80%); public land and wildlife conservancies and sanctuaries account for 19%, and only 1% of the land is under private ownership (County Government of Isiolo, 2018). In summary, the land does not support productive crop farming, unless under irrigated agriculture, and therefore

offers exclusive opportunity for livestock keeping. Currently, minimal irrigated agriculture is practices along the Bisan Adhi river in Kinna and Ewaso Nyiro river basin.

### 3.3 Study design

The study adopted the field survey design method used by Simiyu (2012) for acquiring representative samples from the geographical areas of interest that happen to be large. It involves mixed methods (quantitative and qualitative) approaches that strive to find information that can be subjected to statistical analysis. The study focused on camel milk value chain actors within Isiolo central, Garbatulla, and Merti sub-counties. The main purpose was to fully understand the socio-economic characteristics of camel milk value chain actors, the environmental factors influencing the sustainability of the system, and the regulatory frameworks affecting the sustenance. This research design was also used by Kothari (2004).

The study used primary and secondary data from the value chain actors, the support service providers and enabling environment influencing the sustenance of the system. The primary data included household information on socio-economic and environmental concerns, the present activities carried out in the chain function (input supply, production, processing, transportation and consumption) and focus group discussions while the secondary data was used to collect information on existing literature concerning the policies and legislations governing camel milk value chain in Isiolo County. This involved review of the existing literature (policy documents, legislations, publications from researchers, departmental reports and relevant information from internet sources) and in-depth analysis of the available records on camel milk sales by the primary actors. The study mainly involved the entire camel milk business environment and the regulatory aspects influencing the sustainability of the camel milk value chain in the county.

### 3.4 Research methods

The methodology undertaken in this research aimed to capture the data required for the study which includes data types and sources, methods used in data collection, the sampling frame and sample size, sampling procedures, data analysis and presentation of the data.

### 3.4.1 Sampling frame and sample size procedure

The sampling frame of the study is derived from the population of Isiolo County estimated at 164,949 by 2022. This population was divided into three sub-counties namely Isiolo central, Garbatulla and Merti sub-counties derived from the administrative and geographical distribution thereby forming non-overlapping representative strata. Each stratum was then subjected to simple random sampling method and 284 respondents were selected with Isiolo central 152 respondents, Garbatulla 82 respondents and Merti 48 respondents respectively. The system allows possibility of each member of the population selected to have equal chance for selection for the study.

The sample size for the study was determined using the formula adopted from Simiyu (2012) and Kothari (2004).

$$n = \frac{NC_V^{\,2}}{(C_V^{\,2} + (N-1)\,e^2)}$$

N= Population n= Sample size Cv = Coefficient of variation (taken as 0.5)

e= Tolerance of desired level of confidence, take 0.05% at 95% confidence level

A total of 284 respondents were selected randomly for interviews.

### 3.4.2 Data needs, types and sources

#### 3.4.2.1 Data needs

The data needs, types and sources are driven based on the research objectives of this study. The types of data required involved social, economic and environmental issues. These included both primary and secondary data collected from the field survey and desk study respectively. The combination of these data types was necessary to complement one another so as to reduce the biases and weaknesses in both quantitative (primary) and qualitative (secondary) methods. The following is the narrative of data needs, types and sources of information based on the research objectives:

Objective one of the study is to investigate how camel milk value chain is characterized in Isiolo County. In order to acquire reliable and quality information's, the study required the collection of quantitative data such as households' information's on socio-economic activities or incomes through using the value chain analysis approach which included mapping of the value chain actors,

the support services providers, and the enabling environment of a sustainable camel milk value chain for Isiolo County. This analysis enables identification of constraints and gaps in the chain and the opportunities possible to enhance a sustainable system. The primary data was obtained through questionnaires, field observation, interviews of the key informants and focus group discussions (FGD). The questionnaires seek to establish actual data such as types of activities involved by value chain actors throughout the system. The secondary data such as literature review and departmental reports from the relevant institutions (Livestock department, Veterinary department, Public Health, relevant Development Agencies (DA's) was collected to add value to statistical analysis and reduce biasness. Field observations and focus group discussion (FGD) were used to provide information's useful for ground truthing and for researcher's triangulation.

The second objective was to analyze the environmental risks that affect the sustainability of the camel milk value chain in the county. The primary data was collected through investigations on whether there were variations in quantities of milk sold between and within seasons among the value chain micro actors. These information's were mainly collected from the three main camel milk cooperative societies in the county which included Anolei, Tawakal and Isiolo dairy cooperative societies. The secondary data was obtained from key institutions such as county department of livestock production, National Drought Management Authority (NDMA), National Environment Management Authority (NEMA) and other traditional key informants that have historical experiences on traditional grazing practices and past land use systems. Information for drought trends and vegetation cover index (VCI) was gathered from the Kenya meteorological services (KMS) and NDMA Isiolo office and information on VCI trends from 2001-2007 summarized. The projection for the seasonality specifically for Isiolo County was determined using the PRECIS tool. This tool uses the NDVI model to evaluate the severity of drought for the last few decades. The model is based on three months analysis for the availability of grazing resources such as vegetation and other forage for livestock production. The National Drought Management Authority (NDMA) provided summary on the information on the analysis of VCI trends from 2001-2007.

The third objective involves analysis of the regulatory frameworks influencing the sustainability of the camel milk value chain in Isiolo County. This involved investigating existing institutional arrangements, operational county livestock-based policies and legislation influencing the system.

The study further investigated the level of enforcement and compliance of the laid down policies and legislations.

Finally, the fourth objective involved the development of a model for sustainable came milk value chain for Isiolo County. This also included use of the researcher's triangulation for the acquired primary and secondary data information collected. These were used to complement one another and compensate biases or weaknesses from either primary or secondary data collected. This gave an in-depth understanding of the sustainability of camel milk value chain and the potential threats to its sustainability hence provided appropriate opportunity to develop a modernized camel milk value chain framework for its sustenance.

#### 3.4.2.2 Types of data and data sources

The types of data needed in the study involved the use of primary and secondary data during information gathering. This enabled application of reliable data and information collection techniques useful when analysing of livestock food system in Isiolo County. The sources of data can be broadly classified as primary and secondary data. The primary data was obtained using a semi-structured questionnaire (n=284), field observations and interview schedules for the resource persons and key informants in Isiolo Cental(152), Garbatulla (82) and Merti (48) sub-counties respectively. The semi-structured questionnaires were used for household surveys while the interview schedules were directed to institutions' resource persons and formal groups operating livestock food system activities in the area. This information from groups was collected in form of focus group discussions (FGD's). While the primary data collected from the household survey was based on simple random sampling method the one for the key informants and focus group discussions (FDG's) was based on purposive sampling method. The latter was useful in order to obtain the dynamics of livestock food system and historical information concerning socio-cultural practices and land use patterns.

These resource persons inter alia included the County directors of the departments of livestock and veterinary services, Public health, Water and NEMA; Government parastatals such as National Drought Management Authority (NDMA), Kenya Meteorological Services (KMS), Water Resources Management Authority (WRMA), Kenya Forestry Services (KFS), Regional Pastoral Livelihood Resilience Project (RPLRP), Non-Governmental organizations involved in livestock food system in the county such as REGAL-AG, Resource Advocacy Programme (RAP0 in

Garbatulla, Merti Integrated Development Project (MID-P) and focus groups which included the five Livestock Markets Associations (LMA's), Camel milk Cooperative Societies (Anolei and Tawakal group societies), Resource Users Associations' (e.g. in Merti sub-county), Ward climate change adaptation committees (WAPC's) and the traditional (Borana) land use committee "deedha" in Garbatulla sub-county. During primary data collection the research gave equal opportunity for male and female household heads in answering the questionnaires without any biasness.

The secondary data was obtained from the qualitative data or existing literature from relevant institutions in the County. Some of these information's' included the livestock population dynamics, bio-physical data from the livestock department, County Integrated Development Plan (CIDP) and Kenya Meteorological Services respectively, traditional land use system from Resource Advocacy Programme in Garbatulla sub-county and the historical information and experiences regarding drought episodes. This information was analysed from annual reports (relevant departments), monthly/annual records and publications. Information was also sourced from Internet sources and other research publications relevant to the study.

### 3.4.3 Methods of data collection

This study involved multiple methods of data collection. Both primary and secondary were collected using quantitative and qualitative research methods from camel milk value chain actors. Specifically, surveys, observations, key informant interviews, and desk reviews were conducted. Qualitative data collected from households selected for interviews were conducted using a questionnaire. About 284 semi-structured questionnaires were developed and administered for the households selected for information collection. The design of the questionnaire was closed and open ended to answer the research questions for the study. The survey was carried out in the three sub-counties of Isiolo County (Isiolo Central. Garbatulla, and Merti) between January and December 2018.

In order to assess the suitability in obtaining the required information, the questionnaires were initially pre-tested and refined for adoption. Interview schedules were also developed and conducted for the key institutions (e.g. County departments of livestock and veterinary, public health, National Environmental Management Authority, National Drought Management Authority,

relevant International and local non-governmental organizations) and selected focus group discussions such as the cooperative societies for the camel milk value chain in the County. The study used face-to-face interviews and also telephone for clarification of certain information during field data collection. The interviews were conducted at village level for selected households and the household heads were considered to take part in the interview if the individual was 18 years and above.

To gather information on the quantity of milk supplied, milk processed, and milk marketed, interviews were conducted at the camel milk bulking and processing centers in the county. These included; Anolei, Tawakal and Isiolo dairy cooperatives respectively. Data on the studied camel milk value chain included socio-demographic and socio-economic characteristics of the value chain players. The information collected involved sex of the household heads in the value chain, their level of education, and quantities of milk supplied along the value chain system. Primary data collected including field observations, KII's and FGD's gave the insights on the efficacy of the regulatory frameworks influencing the system. Records on the quantities of milk supplied to bulking centers and processing units were obtained from the two active cooperative societies (Anolei and Tawakal). During the study, we used different interview guides for each category of actors, for example, in the case of input suppliers, information was collected on the kind of services they offered to support the system. In the case of producers, the study sort information on the amount of milk produced at the household level and surplus for sale or delivery to bulking centers. For the case of processors and marketers, information on quantities of milk supplied and processed for sale were collected. Specifically, the types and numbers of value chain actors interviewed included: input suppliers (31), producers (110), local bulking centers (18), processors (104), marketers (39), and consumers (50).

In terms of processes influencing the sustainability of the camel milk value chain, information gathered included levels of awareness on the exiting camel milk regulatory frameworks. In addition, desk reviews were used to collect qualitative data on past records from public institutions, such as the livestock department, veterinary department, public health, and other development agencies, to add value to the statistical analysis and to check for bias. Trained local enumerators who spoke the language of the respondents administered the questionnaires during the survey. Pre-testing of the questionnaire was done to remove errors and to assure data quality.

Through appropriate data collection methods, the researcher was able to do triangulation which enabled to give informed comparisons between the results of descriptive statics and the information collected from key informants, focus group discussions and field observations.

#### 3.4.3.1 Questionnaires

About 284 questionnaires were developed and administered for the households selected for information collection. The design of the questionnaire was closed and open ended used to answer the research questions and the research objectives. These were semi-structured and self – administered household questionnaires. In order to assess the suitability in obtaining the required information, the questionnaire was initially pre-tested and necessary corrections were made. Four field research assistants were recruited and trained in administering the questionnaires.

#### 3.4.3.2 Interviews

Oral and telephone interviews were conducted to gather information from key resource persons among the value chain actors' and other development agencies who were related to the value chain system. These included the input suppliers, producer groups and associations, transporters, processors, traders and their affiliate associations, public and private organizations in the county and other international and community-based organizations. Face to face interviews from key informants were also conducted using a check list containing the required information based on the research questions to be answered or as per the objectives of the study. Telephone calls and use of mobile phones for clarification or validation of specific information's was also carried out during the study.

#### 3.4.3.3 Observations

Observation was also a data collection method using a field note book and photography where applicable. The major issues in field observations were mainly on the aspects of environmental management and conservation, natural resources use and social behaviours, and value chain actors' attitudes towards commercialization of the system. Observations were also made on assessing the networking of the various value chain processes or functions between the micro actors (value chain function), meso actors (extensionists, financial institutions linkages) and mega actors (enabling environment or regulators) in the county. Changes in land use systems, environmental degradation

and livelihood options were also some of the parameters for observation during the study. These observations were put into thematic areas, analysed and included in the Thesis write up.

#### 3.4.3.4 Focus Group Discussion (FGD)

According to Gitau (2013), Focused Group Discussion (FGD) is an in-depth interview with a group of people sharing the same experience and understanding with regard to a situation or event. Focused group discussions were undertaken with the representatives of the various groups such as the Anolei, Tawakal and Isiolo Dairy cooperative societies, livestock markets associations (LMA's) and resource users' associations (RUA's) at county ward levels. These discussions provided in-depth understanding of the existing gaps in camel milk value chain and options for alternative livelihoods. These constraints also provide opportunity options and the potential areas for technological innovations and investments that may lead to a sustainable camel milk value chain in the county.

#### 3.4.3.5 Photography

Photography is a form of data collection preserved in pictorial form. According to Gibson and Brown (2009) images can be used both as data and in presenting the outcomes of the research in visual forms as they provide insight and in-depth understanding that is hard to achieve with text alone. It's important to understand that data images can provide prudent assistance to verify certain phenomenon which may not be clear in a means of written descriptions or narrative. These include photographs for group discussions, landscapes and visual images showing certain identities such as materials used for milking and handling of products like camel milk for the case of this study. Photographic data was collected using digital camera.

### 3.4.4 Data Analysis

Comparative descriptive and inferential statistical analyses were conducted using the IBM SPSS Statistics for Windows version 23.0 (Armonk, 2011). The survey data was coded and entered into a Microsoft Excel Spreadsheet for cleaning and then transferred to SPSS version. The data on the socio-demographic and socio-economic information of the household heads interviewed, quantities of milk supplied, mapping of the camel milk value chain system, were analyzed using the information provided by the respondents of the chin actors. The measures of central tendency (mean) and dispersion (range) were computed to give summary (means and frequencies) for socio-

demographic and economic data. In this case, the simple response variable may add up to 100%. The analysis of variance (ANOVA) was carried out to assess the variations between the wet and dry seasons to test significance difference ($p< 0.05$). In order to differentiate the means, Fisher's LSD test at a 5%level was adopted. Cross tabulations were also done to find out the associations between the potential variables and results presented. The secondary data from the literature review provided supplementary information and support. A combination of these analyses was then used for interpretation and also provided opportunity for researcher's triangulation to develop a modern camel milk value chain regulatory framework for Isiolo County.

# CHAPTER FOUR
# RESULTS AND DISCUSSIONS

## CHARACTERIZATION OF CAMEL MILK VALUE CHAIN ACTORS IN ISIOLO COUNTY

### 4.1 Introduction

This chapter summarizes the research findings based on the objectives of the study. It contains information gathered from the 284 household heads from the three sub-counties (Isiolo central, Garbatulla, and Merti) of Isiolo County that have been selected randomly and interviewed for the study. In depth, the chapter considers the socio-demographic and socio-economic characteristics of the camel milk value chain players, other livestock based economic activities involved by selected households, and compares their contributions with the camel milk value chain in the county. These results have been analyzed using descriptive and inferential statistics and the findings discussed accordingly. The analyses of these results have provided recommendations given in this study.

### 4.2 Socio-demographic and socio-economic characteristics of the respondents

#### 4.2.1 Socio-demographic characteristics

The socio-demographic characteristics of the household surveyed in this study included; the gender characteristics, age brackets, and their educational levels. Likewise, the socio-economic activities considered were the Occupation/employment factors and the reasons for settlement in the present area of the respondents. These variables have adverse implications on the general sustenance of livestock food system in terms of capacities in production and investment opportunities.

##### 4.2.1.1 Response rate of the respondents selected for the study

The results for the response rate indicated that about 53 per cent was constituted by male respondents while the female respondents constituted 47 per cent. Specifically, 136 female-household headed, 49 male-headed, and 99 youth house-hold headed respondents in their different roles in the camel milk value chain were interviewed. The study shows an overall response rate of 94% of the respondents. The variation was mainly influenced by the different gender roles among the respondents.

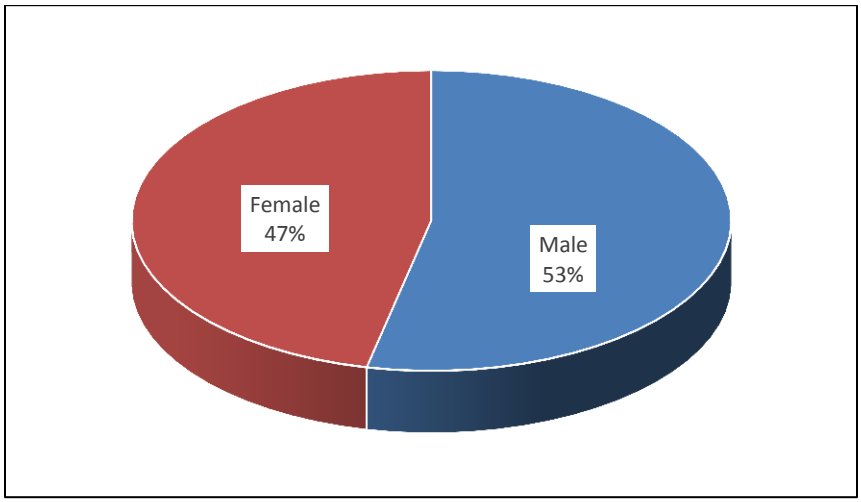



**Figure 3: Overall response rate of the respondents**

#### 4.2.1.2 Age brackets of the households' dependents

The study shows that about 80% of the respondents were youth between 18-35 years age bracket. This indicates that there is opportunity for work force to be tapped from these young population (Table 1).

**Table 1: Age brackets of the households dependents**

| | Count | Column N % |
|---|---|---|
| 18-35 years | 208 | 79.8 |
| 36-43 years | 52 | 10.4 |
| 44-61 years | 40 | 8.0 |
| 62-79 years | 9 | 1.8 |
| Over 80 years | 0 | 0.0 |
| Total | 499 | 100.0 |

#### 4.2.1.3 Educational levels of the respondents in the study

The study investigated five categories of education levels amongst the households surveyed (figure 4). These included primary education, secondary, tertiary, university and those not formally educated. The results indicates that about 62% of the total respondents in all categories had no formal education and none had university education. However, 29.7 per cent have gone through

primary education, 19.3 per cent secondary education, and 2 per cent tertiary education (Table 2). This indicates that there is a slight drop in illiteracy level by 3% per cent compared to the previous rate of 65 per cent in the county (KBS, 2019). The reason is due to access to free primary education and possibly increased number of primary schools in the County during the last decade. Although the access to free primary education should have impacted on the number of persons joining secondary school and thereafter tertiary and university levels it's notable that there is no direct correspondence. The low rate of continuity after primary education is an indication of higher school drop outs after primary level and secondary education hence very few joining tertiary and university education. The study also showed that the female respondents were the most disadvantaged in education, indicating 45% with informal education compared to the male respondents with 17%, 18% with primary education, 6.3% with secondary level education, and none with either tertiary or university education. However, even without much education, the participation of females in the camel milk value chain is instrumental, mainly in the bulking and processing of camel milk products.

**Table 2. Response rate by sex and education of the respondents involved in the camel milk value chain in Isiolo County**

| | Sex of the respondents | | |
|---|---|---|---|
| **Level of education of the respondents** | **Male (n=86) in %** | **Female (n=198) in %** | **Total (n=284)** % |
| No formal education | 48 (17) | 128 (45) | 62% |
| Primary | 21 (7.4) | 52 (18) | 25.4% |
| Secondary | 13 (4.6) | 18 (6.3) | 10.9% |
| Tertiary | 4 (1.4) | 0 (0) | 1.4% |
| University | 0 (0) | 0 (0) | 0 (0) |

The nominal values show the number who responded, while the figures in parentheses show the frequency in the levels of education (%)

### 4.2.2 Socio-economic characteristics of the respondents

#### 4.2.2.1 Occupational/employment categories of the respondents

The analysis of the occupational categories of the respondents shows 85% pastoral production or livestock keeping practices, 6.5% casual labor, 4.7% salaried or employed, 3.4% crop farming and

only 0.9% involved in contractual employment (Figure 4). Therefore, the study show that pastoralism is the dominant economic activity among the respondents.

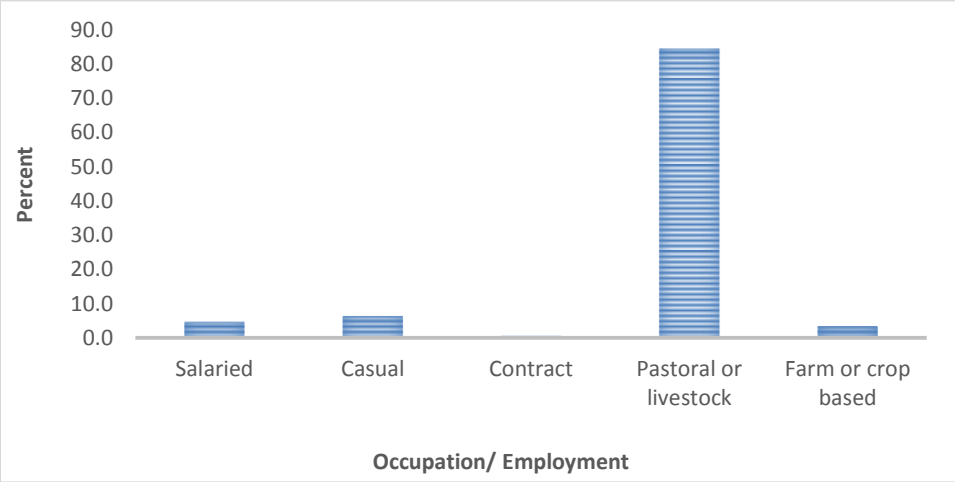



**Figure 4: Analysis of occupational categories of respondents involved in camel milk value chain in Isiolo County**

### 4.2.2.2 Reasons for settlement in the present area

The study investigated for the reason for settlement into present areas of residence (figure 6) and established that about 43.5% have settled in the present residential area because they believe it's their ancestral home. However, 38.2% have settled in the present area due to livestock rearing, 14.5 per cent crop production, 3.1% for commercial purposes while only 0.8% have settled for security reasons.

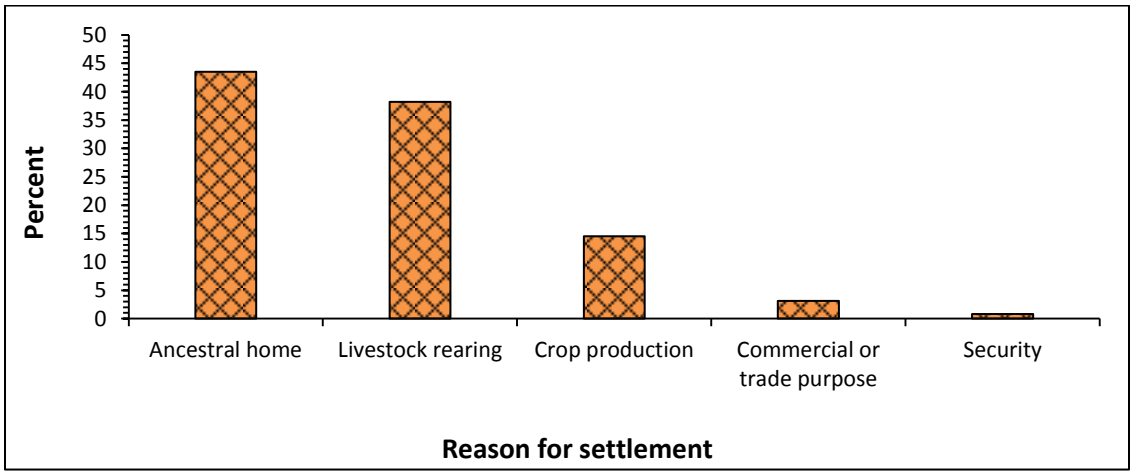



**Figure 5: Reasons for settlement of the households interviewed in the present area of residence**

### 4.3 Characterization of beneficial livestock value chains in Isiolo County

This section considers the characterization of the livestock food system and categorization of value chains products in the County. Food system analysis involves the understanding of the relevant value chains involved in the system. These provides the understanding of the flow of products, their distribution, risks involved and opportunities available for improving the product consumption. This study used the value chain analysis approach for mapping the potential value chains in order to develop a practical framework that show the current chain functions (producers, transporters, processors, distributors and consumers), the chain enablers (input suppliers, extension services, financial institutions) and regulatory frameworks (policies and legislations) influencing the system in the County. The outcome is a development of a process map (value chain map) or flow chart for camel milk value chain which indicated the most beneficial among the livestock value chains analyzed. Value chain mapping is a social study tool that can be used to identify key constraints and opportunities within a livestock production system (from production to consumption) that may influence the sustainability of livestock food system. Hence these projections can be used to create awareness on the future impacts that can affect the societies so as to enable develop early warning systems and mitigation measures. Therefore, value chain mapping acts as a focus for communicating knowledge and can play an important role in risk communication leading to more transparent decision-making process.

In summary the study identified the potential value chains, types of products traded and estimated revenue or value, type of value chain actors (individual, groups and other stakeholders), distribution and consumption points of the products traded. It's also important to understand that value chain analysis describe "how chains actually work and not how they ought to operate" and hence the study involved identifying constraints to sustainability of livestock food system and developed possible options for leverage to deliver compliance through effective regulatory mechanisms for sustainable domestic and external trade in livestock food system.

#### 4.3.1 Contribution of revenue earned from categories of potential livestock-based value chains

The major livestock-based value chains that make up the main revenue base for the county and livelihood of the pastoralist communities in Isiolo County were; camel milk (58.7%), beef (16.7%), goat meat (3.9%), mutton (2.7%) respectively (Table 3). Among these, the camel value

chain products form about 69.4%, while camel milk alone contributes 58.7% of the total county revenue (Table 3). Isiolo central sub-county supplies over a half (53%) of the total milk delivered to milk processing centers, and Garbatulla sub-county (26.5%) and Merti sub-county have the lowest (20.6%) camel milk supplied to the processing centers (Table 3).

This finding indicates that camel milk is the highest revenue earner in all the three sub-counties (Isiolo central, Garbatulla and Merti) contributing almost 60% of the total revenue that accrue from livestock and livestock products (Table 3). However, Isiolo central seems to be the hub for camel milk, beef and small stock (goat and sheep products). Garbatulla has the highest sales for sheep while Merti has complete deficit for camel meat market. Other studies have also pointed out that even the resource poor households are involved in the value chain despite having fewer animals and have earned from sale of milk which they use to pay school fees as well as buying household food among other basic needs (Elhadi et al., 2015; Musinga et al., 2008; Noor et al., 2013).

**Table 3. Summary of total revenue earned from livestock-based value chains in Isiolo County ('000' KES).**

| Value Chain | Isiolo Central | Garbatulla | Merti | Totals |
|---|---|---|---|---|
| Beef | 139,293.2 | 120 | 720 | 140,133.2 |
| Meat goat | 23,940 | 5938 | 3036.4 | 32,914.4 |
| Mutton | 3448 | 14,347 | 4418.4 | 22,213.4 |
| Camel meat | 84,377.6 | 5026.4 | 0 | 89,404.0 |
| Camel milk | 259,200 | 129,600 | 100,800 | 489,600.0 |
| Poultry | 15,205.5 | 13,270.5 | 8318 | 36,794.0 |
| Hides | 1747.2 | 404.8 | 404.8 | 2556.8 |
| Skins | 1898.1 | 9111.5 | 9870.5 | 20,880.1 |
| | | | TOTAL | 834,495.9 |

Source: Isiolo CIDP (2018).

The study also concurs with the findings of Mwaura (2015) that camel milk value chain is the most important economic earner for pastoral households in Isiolo County. It is also true that the chain function accommodates all the vulnerable groups into the system. This has therefore stimulated increasing interests and development in camel milk value chains by many micro actors, stakeholders and development agencies. This study concurs with the County prioritization of camel milk, beef, sheep and goats as the main beneficial value chains in the County envisaged to

increase the economic development, food security and poverty alleviation for pastoral communities. Kumar et al (2011) also found out that in pastoral areas, livestock keeping is considered the major source of livelihood and that traditional livestock production offers good opportunities for the pastoral communities to engage in domestic, regional and global trade. However, the main by-products that contribute to the revenue includes; hides and skins (79.4%), bones and horns (8.7%) and yoghurt/Mala milk (7%) respectively.

### 4.3.2 Mapping of the Camel Milk Value Chain in Isiolo County

This section provides results on the analysis of chain function of the camel milk value chain drivers and processes. The results of the milk data collected from the bulking centres over the six-year period indicate that an average of 1,727,834 litres of milk were generated in the county annually (Table 4). Out of this, 1,465,911 litres (85%) of the milk were delivered on average to the bulking centres annually, and, thereafter, to the local processors. About 261,922 litres (15%) of the milk produced was consumed at the household level. About 293,182 litres (20%) of the milk delivered to processors get spoilt or become wastage. Value addition of milk at the county is low, standing at 74,362 litres (5%) annually. It shows that less than 1% of processed milk access the external markets.

The findings concur with the study conducted by Mwanyumba 2014, which reveals that there are low levels of milk production and processing, exacerbating weak marketing infrastructure, mainly due to low capacities in milk handling and marketing, in the ASAL regions of Kenya. It's also in line with studies conducted by Dandesa (2017) and FAO (2014) which shows that although there are increasing demands for milk products, there is still challenges to meet the requirements to attain required quantities and thus increased incomes due to lack of accessing wider markets. This is an indication, therefore, of an inadequate marketing system that limit the ability for resilience and sustenance of the camel milk value chain in Isiolo County.

**Table 4. Quantities of camel milk produced in the county during 2014-2019.**

| Period (Year) | Quantity of fresh milk produced/litres | Milk consumed at HH level | Milk delivered to bulking centres | Spoilt milk /litres | Processed milk/ yoghurt /litres |
|---|---|---|---|---|---|
| 2014 | 1,687,900 | 286,943 | 1,400,957 | 266,182 | 56,038 |
| 2015 | 1,626,230 | 260,196.8 | 1,366,033.2 | 245,886 | 61,471.5 |
| 2016 | 1,702,912 | 272,465.92 | 1,430,446.08 | 271,789 | 71,523 |
| 2017 | 2,011,924 | 301,788.6 | 1,710,135.4 | 498,223 | 119,709.5 |
| 2018 | 1,619,662 | 226,752.68 | 1,392,909.32 | 222,865.5 | 62,681 |
| 2019 | 1,718,374 | 223,388.62 | 1,494985.38 | 254,147.5 | 74,749 |
| Grand Total | 10,367,002.00 | 1,571,536.00 | 8,795,466 | 1,759,093 | 446,172 |
| **Averages** | **1,727,834** | **261,922** | **1,465,911** | **293,182** | **74,362** |

**Note: The table shows average camel milk data collected among the bulking centers (2014-2019). Source: field survey, 2019**

The results of the milk data collected from the bulking centres over the six-year period indicate that an average of 1,727,834 litres of milk were generated in the county annually (Table 4). were estimated at KES 829,360.3 and processed fresh milk at 100,388.7. This show that when milk is value added, the benefits can be increased by 68%.

**Table 5. Comparison of fresh and processed milk Sales from 2014-2019 ('00' KES). Source: field survey, 2019.**

| Period (year) | Quantity of milk produced (liters) | Farm gate prices per liter ('00' KES). | Total amount ('00' KES). | Processed fresh milk (liters) | Price per liter ('00' KES). | Total amount ('00' KES) | Processed yoghurt (liters) | Price per liter ('00' KES). | Total amount ('00' KES) |
|---|---|---|---|---|---|---|---|---|---|
| 2014 | 1,687,900 | .50 | 843,950 | 1,400,957 | .70 | 980,669.9 | 56,038 | 1.2 | 67,245.6 |
| 2015 | 1,626,230 | .50 | 813,115 | 1,366,033.2 | .70 | 956,223.3 | 61,471.5 | 1.2 | 73.765.8 |
| 2016 | 1,702,912 | .40 | 681,164.8 | 1,430,446.08 | .80 | 1,144,372.9 | 71,523 | 1.3 | 92,979.9 |
| 2017 | 2,011,924 | .40 | 804,796.6 | 1,710,135.4 | .80 | 1,368,108.3 | 119,709.5 | 1.4 | 167,593.3 |
| 2018 | 1,619,662 | .50 | 809,831 | 1,392,909.32 | .90 | 1,253,618.4 | 62,681 | 1.5 | 94,021.5 |
| 2019 | 1,718,374 | .60 | 1,031,024.4 | 1,494,985.38 | .90 | 1,345,486.9 | 74,749 | 1.5 | 112,123.5 |
| Averages | 1,727,834 | .48 | 829,360.3 | 1,465,911 | .80 | 1,172,728.8 | 74,362 | 1.35 | 100,388.7 |

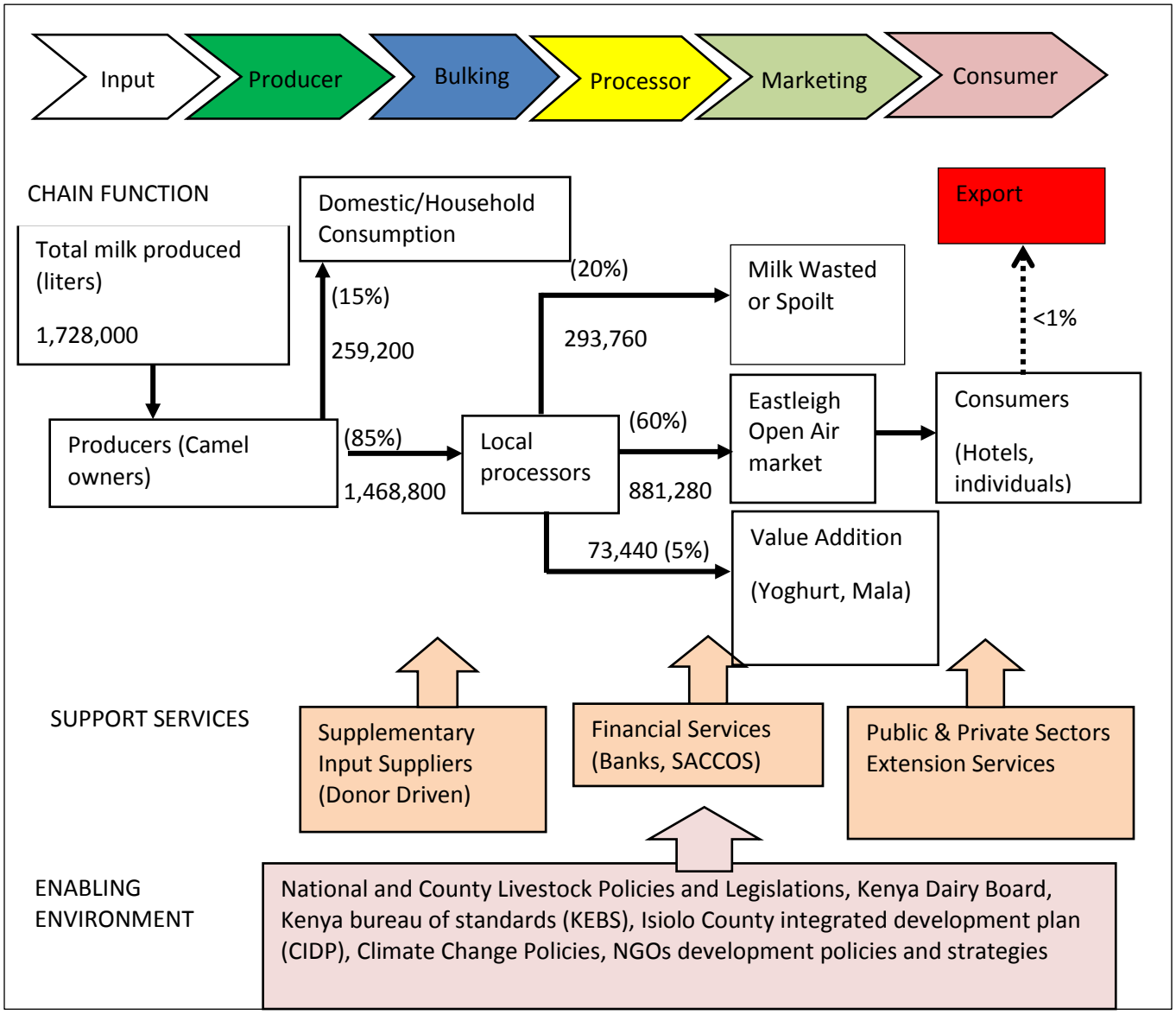
### 4.3.3 A Schematic Presentation of the Analysis of a Typical Camel Milk Value Chain in Isiolo County

This schematic presentation (figure 6) is derived from the results displayed in table 4 and table 5 respectively. The study reveals a distinct camel milk value chain with three categories of actors and compares well with other studies (FAO, 2014; Colonna, 2014). These include the micro-actors involved in daily activities, such as input suppliers, producers, bulking, processors, marketers, and consumers; the support service providers; and those who provide the enabling environment-the policy-makers. The study also shows that 85% of the camel milk is sold in raw form to the bulking and local processing centers, while only 15% is consumed at the household level. This is an indication that there is change from the previous traditional practices, where camels were only kept for milk consumed at the household level, to a commercialized system where camel milk is now traded to generate income and other livelihood options. Milk spoilage (20%) occurs at bulking centers and during transportation and is a major concern for a modern camel milk value chain. This has been associated with the long distances to delivery points and poor road infrastructure, inadequate milk production and handling techniques, and lack of milk cooling apparatus. The milk bulking centers and processors have conveyed their great concern to local milk producers due to challenges pertaining to clean milk production and adherence to milk quality and safety measures. The local producers as well as the majority of milk bulking centers are still resistant to adopting modern milk production methods. There continues to be a broad use of locally fumigated milking containers, or "jerry cans," for milking camels and transporting milk to destination markets. For example, 60% of the milk is sold to milk vendors at the Eastleigh open air market in Nairobi and a few neighboring markets. We also observed that vendors at these markets prefer milk preserved in traditionally fumigated containers due to the tastes and preferences of their final consumers. This has been found to be a big challenge to the sustainability of the system.

There is low (5%) value addition in the camel milk value chain implicating negligible (<1%) access of the milk to national, regional, and international markets. This is due mainly to a lack of skills and knowledge about a modernized camel milk value chain. We show that this is due to weak relationships among the value chain actors, exacerbated by weak regulatory mechanisms in the county. Our observations are in line with studies conducted by Nato et al. (2018) that revealed that such milk production methods contribute to an increased bacterial load in traditional camel milk production due to low compliance with hygiene practices, subjecting the product to poor

quality and safety standards. The other challenge is weak networks among the milk producers and other support institutions. However, our study shows a similar trend in the value chain to that reported by other studies in similar regions of Africa such as Morocco, Djibouti, Mauritania, and Sudan (Idris, 2011), and Ethiopia (Dandesa, 2017). The current production and marketing practices make it difficult to sustain a camel milk value chain in the county.

**Figure 6: A Schematic Presentation of the Analysis of a Typical Camel Milk Value Chain in Isiolo County. Source: Field survey, 2019**




**Note: The arrows indicate the linkages of various actors at different nodes in camel milk value chain in Isiolo County, northern Kenya**

The study is also in line with the findings of Colonna et al. (2014), who indicate that a value chain involves many value chain actors who have significant roles in characterizing complex networks and relationships among actors. Although livestock production and the subsequent value chains offer good opportunities for the pastoral communities, there is a weak relationship between the input suppliers and the producers. Our study also concurs with studies that show weak inter-farm linkages and uncoordinated market strategies in many undeveloped economies (Anastasiadis & Poole, 2015).

#### 4.3.3.1 Input supply node

The input suppliers include the agrovets and other suppliers providing assorted materials and equipment's focusing husbandry practices and animal health. Examples of such local input suppliers were SIDAI and Oasis agro-vet in Isiolo County. There are many of such itinerant agrovet suppliers in the three sub-counties, namely, Isiolo cental, Garbatulla and Merti. The main materials and equipment's supplied included veterinary medicines, mainly antihelminthics, antibiotics and trypanocidal drugs, acaricides, and mineral and vitamins supplements.

#### 4.3.3.2 Production node

The main actors at this node are the camel owners and milkers who are also the herders. They are found mainly at the interior of the grazing areas sometimes as far as 80-120 Kms away from the bulking and processing units. The common milk production areas include Kulamawe, Burat, and Kambi sheikh. The production of milk is highly dependent on the prevailing environmental conditions. Unlike other improved production systems such as zero grazing in dairy cattle, there is low input supply such as supplementary feeds and minerals, breed improvement (e.g. artificial insemination services) in camel production contributing to low productivity in the system. Although camel milk is the major income earner among the beneficial value chains analyzed, the FGD's indicated the performance of the system in terms of production still low than what is expected. This is mainly associated with feeding on dry pastures and forages together with poor supplementation of feeds, minerals, and vitamins to enable increase the milk production which is crucial for increasing productivity. Currently, no attempts have been made to rear camels either for intensive or semi-intensive production system with the aim to increasing milk production, and hence improving on the productivity of the system.

The production system is purely dependent of the extensive and uncontrolled grazing system due to the prevailing land use system which is over 90% communal basis. This scenario predisposes camel rearing to irrational migrations in search for vegetation or grazing resources from as far as 80-120 Km from the main milk bulking centers situated in Isiolo central sub-county. From the field observation and interviews carried out from actors in production node, it is estimated that in many instances it takes about 9hrs to 10 hrs for the milk from the production zones to be delivered to the main bulking and other processing centers. Hence, the major challenge identified at this production node is the inadequate milk handling techniques which is a precursor to milk spoilage. Although long distances to bulking Centre's under hot temperatures is a factor contributing to milk spoilage, lack of skills in clean milk production techniques, low adoption for use of modern equipment's such as milking apparatus and mobile milk cooling systems is a constraint to the sustenance of the camel milk value chain in the County.

Our study also concurs with other findings that indicate that the constraints to milk marketing in Isiolo County are due mainly to poor hygiene practices, low capacities for milk processing and marketing, all of which exacerbate low incomes due to low production and poor quality and safety standards (Nato et al., 2018; Wayua et al., 2012). These constraints to compliance with quality and safety of milk production exacerbates the current low incomes or revenue earned from the value chain system. Evaluation on the capacities in milk processing and marketing during interviews conducted with FGD's and KII's also confirmed that low capacities and skills by various categories of actors in the chain are a threat to the future of the camel milk value chain.

(a) (b)

**Plate 1: Pictorial evidence of traditional milk production by smoking. See (a) above and negligence of using modern milking apparatus (b).**

#### 4.3.3.3 Transportation

The study observed that the mode of transportation of the milk from the production areas was by donkeys, motorbikes, land rovers, and buses depending on the availability. The major challenge is inaccessibility to camel satellite camps, where milk is produced, due to poor road net work systems or feeder roads. These challenges influence timely delivery of milk to the bulking centres and, therefore, exacerbate the high milk spoilage which has been estimated at 20%. For example, milk produced in Kulamawe will reach the Anolei cooperative society for processing by 2.00-3.00 pm. This is almost 9-10 hours from the time when the camels were milked. Anolei cooperative, which is the main bulking and processing centre, will be deliver the processed milk to final consumption points in Nairobi (e.g. Eastleigh) the following day by 12.00 (noon) or 1.00 pm. This surge in untimely delivery of milk to destination areas has a lot of impact on the quality and safety of products.

The major challenge in this node is the traditional milk storage techniques, using local fumigants to increase the shelf-life of milk during transportation. The resultant effect of the "traditional smoked or fumigated milk" is the compromise for the quality and safety of milk to meet standards for external markets. Notably, the influence of socio-cultural practices that milking guards must be smoked is a big challenge in modern commercialization of dairy value chains in pastoral communities. A key informant, Mrs Halima Godana, stated that "it's a taboo for one to milk camels without using a smoked calabash or a wooden guard". This is a major challenge to the sustenance of the system.

#### 4.3.3.4 Bulking

Bulking is the critical value chain node that determines the entire business environment which includes the handling and testing of milk supplied. The bulking centres collect milk from the various itinerant milk vendors, and other mini-collection centres. The major camel milk bulking centres in the county include the existing cooperative societies such as Anolei and Tawakal. However, the field observations have shown that majority of them are trading smoked camel milk and this is also evidenced by a recent study conducted by IIRR (2016) which indicated that in Isiolo County only 10% of milk supplied to the market is non-smoked. This is a big challenge and it's also driven by the fact that the majority of consumers in Nairobi-Eastleigh market prefer "smoked" milk.

This phenomenon has great challenge to the sustenance of the system due to inappropriate control mechanisms for quality and safety standards. This is a clear indication of weak regulatory mechanisms to guide the actors in quality and safety milk production for sustainable business environment. The traditional milk production and preservation method may currently suffice for the domestic market but does not conform to the requirements of the regional and international markets. It is estimated that about 20% of the milk get spoilt at this node due to lack of innovations and techniques in milk handling and storage. Lack of value addition concepts for "Mala" and such innovations like "yoghurt" during excess supply is an indication of low skills and entrepreneurship.

#### 4.3.3.5 Processing

This stage involves milk testing, cooling, and storage. Processing is dependent of the state of milk delivered. The main processors are Anolei and Tawakal cooperative societies. The major challenge is the inability to control quality of milk and the safety standards. Almost all the milk delivered is transported with local "jerrycans" which are smoked or fumigated. This is because most of the milk is delivered by individual members or vendors who may not have adhered well to the requirements for quality, safe and clean milk production. All the milk collected from different sources are finally collectively stored for processing after testing. Over 60 percent of the processed milk is sold as raw to the external markets such as Eastleigh while 10 percent of the raw milk is consumed locally and only 5 per cent of the milk is processed as yoghurt and "Mala". This is attributed to low capacities and knowledge in commercialization of milk products. Hence low diversification of products in the value chain. Majority of the value chain actors involved in processing of the milk are women.

#### 4.3.3.6 Consumption

The results indicate that about 70 per cent of the milk is consumed in Nairobi-Eastleigh market while only 30 per cent is consumed for domestic use and value addition. However, the supply of milk to main bulking centers is not consistent and timely. Perceptions of consumers on the availability of milk indicated that milk is not available at all times due to delays in the delivery to processing centers. They associate these with long distances from production points, poor road networks, variability in seasons (wet and dry) and mode of transportation. The consumers also

observed that the processed milk for domestic consumption is not well-certified. According to Kenya Public Health and Dairy Board regulations, all dealers in milk products are supposed to have requisite licenses and certificates obtained after inspection and approval of their trade practices and subsequent premises. Camel milk value chain actors require capacity building on best practices on handling of milk and hygiene measures, value addition and requirements for processing and manufacturing to attract wide markets for consumption of these products. This should target policy and legislative matters that should govern and control the business environment. Hence there is need for adequate information exchange among the actors both horizontally and vertically.

The concern is that the current legislations governing the dairy sub-sector (Dairy Industry Act, Cap 336) which regulates production and commercialization of dairy products in Kenya do not recognize camel as domestic animal or dairy. In fact, it defines 'milk' as milk from a cow. Currently the camel milk traders are using this legislation for convenience. The County, therefore, needs to develop separate policy for camel or fully integrate it into the dairy industry policy and/or legislations. Hence this study also agrees with the findings according to Kirwan and Maye (2013) that there is need to address the question of how local food systems can be structured and coordinated for sustenance. I also concur with Thornton et al (2011) which points out that there is need of appropriate social, institutional and political support to strengthen the adaptive capacity of community value chains for sustainable local food systems.

# CHAPTER FIVE

# EVALUATION OF ENVIRONMENTAL RISKS AFFECTING SUSTAINABILITY OF CAMEL MILK VALUE CHAIN IN ISIOLO COUNTY

## 5.1 Introduction

In this section, the objective is to analyze the environmental risks that face the sustainability of camel milk value chain in Isiolo County. These include seasonal climatic variability (2014-2017) and its effect on the supply of milk to bulking centers, and drought trends that influence the sustenance of the system. The perceptions on effects of drought episodes, drivers, and coping mechanisms are also discussed in this chapter.

## 5.2 The seasonal variability of camel milk sales in Isiolo County (2014-2017)

The results indicate that the highest sales were realized in 2016 and 2017 respectively (Figure 7). There were minimal variations between other seasons. This suggests that there are variations in milk sales due to seasonality and rainfall patterns.

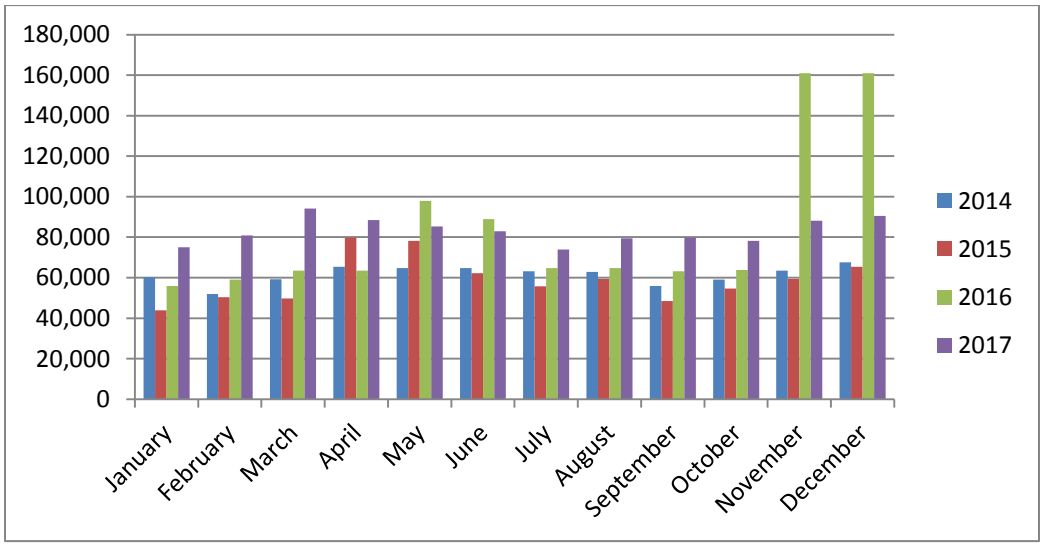



**Figure 7: Variations on camel milk sales between short and long rain seasons (2014-2017).**

These changes influence the sustainability of the system. Hence the study concurs with the findings of Narisma et al., (2007) which concluded that there will be abrupt changes in rainfall patterns likely in arid and semi-arid regions of the world. Other studies also indicate there is growing evidence in the frequency and extent of droughts increases as a result of climatic variations and overall global warming (Dai et al, 2004).

### 5.2.1 Inter-annual variations in quantities of milk sold between 2014-2017

The result shows that there were more quantities of milk sold during the year 2017 (Appendix II). The 2014 and 2016 showed similarity with negligible difference in terms of quantity of milk sold. However, low milk supply was realized during the year 2015 among the others.

**Table 6: Quantity of milk sold by years**

| Year | Quantity sold ± 2728.6 | |
|---|---|---|
| 2017 | 84689 | A |
| 2016 | 70790 | B |
| 2014 | 63130 | Bc |
| 2015 | 60618 | C |

$LSD_{(0.05)} = 7777.1$
$p<0.001$
CV(%) = 13.5

The result also show that the mean quantity of milk sold during the dry season was 65592 litres while that sold during wet season was 74,021 which gave a variation of ± 2570.8 over the four years (Appendix III). The mean of quantity of milk supplied during the wet season was higher than the dry season that concurs with $p_{(0.05)} = 0.025$.

### 5.2.2 Coefficient of variation for quantities of milk sold (2014-2017)

The quantities of milk sold over the 4 years were also compared to determine the coefficient of variation and LSD (Table 9). The Values not sharing the same letter (a, b) are significantly different at $p< 0.05$. There was no significance difference in the years2014, 2015 and 2016 in long and short seasons. The result also indicates that LSD(0.05) = 11703.4 and the coefficient of variation as 13.1 % giving precision and validity of the study. However, there was more quantities of milk sold in 2017, indicating significance difference than the others. There was more milk sold during the short rains than the long rains season. This concludes that the short rains season (OND) is becoming more reliable than the long rains.

**Table 7: Quantity of milk sold by years**

| Year | Quantity of milk (litres) ±3967.3 | |
|---|---|---|
| 2017 | 89620 | A |
| 2016 | 74369 | B |
| 2015 | 66664 | B |
| 2014 | 65432 | B |

$LSD_{(0.05)}$ = 11703.4
$p_{(0.05)}$ = 0.001
CV(%) = 13.1
Note:

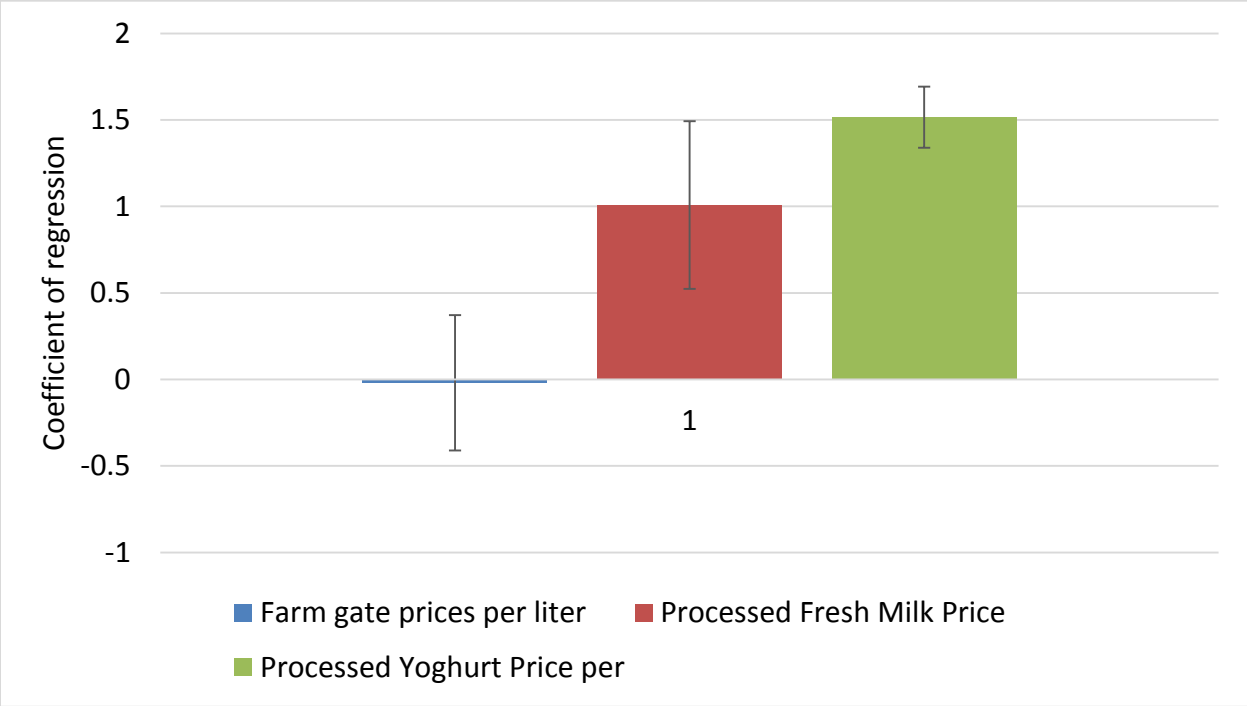
**Table 8: Determining coefficient variation between quantities of fresh and processed camel milk sales from 2014-2019 ('00' KES)**

| Prices_Category | Coeff. | Range | Sig. |
|---|---|---|---|
| Farm gate prices per liter | 863747.625 | 676561.809 | .271 |
| | -.019 | .390 | .963 |
| Processed Fresh Milk Price per liter | -303185.108 | 713308.593 | .693 |
| | 1.008 | .485 | .106 |
| Processed Yoghurt Price per liter | -11452.282 | 13692.772 | .450 |
| | 1.516 | .177 | .001 |

NB: The Independent variable is the predicted amount of milk produced.
The dependent variable are the price categories at farmgate, processed fresh milk and processed yoghurt.

The explanation of this regression analysis is that, at the farmgate prices the coefficient is negative and not significant. This means that for every unit increase in milk production, the price decreases. However, for processed fresh milk and yoghurt, the coefficient is positive and not significant. The interpretation is that for every increase in quantity supplied there's increase of total amount by a coefficient value.

**Figure 8. Regression analysis between value addition of camel milk against prices**




### 5.3 Analyses of drought trends in Isiolo County between 2002-2020

The assessment of drought trends and vegetation condition index reveal that there has been an upsurge of unusual drought episodes over the last few decades (Figure 6). The main cause of drought is due to unreliable and poorly distributed rainfall patterns. It's also important to note that camel milk value chain is highly dependent on rainfall availability and natural vegetation conditions. There is, therefore, the need to assess the vegetation cover index and drought intensities in order to plan for sustainable practices. The result show that the rainfall amounts have increasingly been decreasing over the last few decades, culminating into several failed rainfall seasons summing up into drought episodes. In fact, this scenario is evidenced by the interannual rainfall variability with $\pm$ 2570.8 over the four years (2014-2017) and the coefficient of variation ($\pm$3967.3 at $P_{(0.05)} = 0.001$) for milk supplied, discussed hitherto. This is attributed to conditions of low vegetation regeneration and environmental degradation.

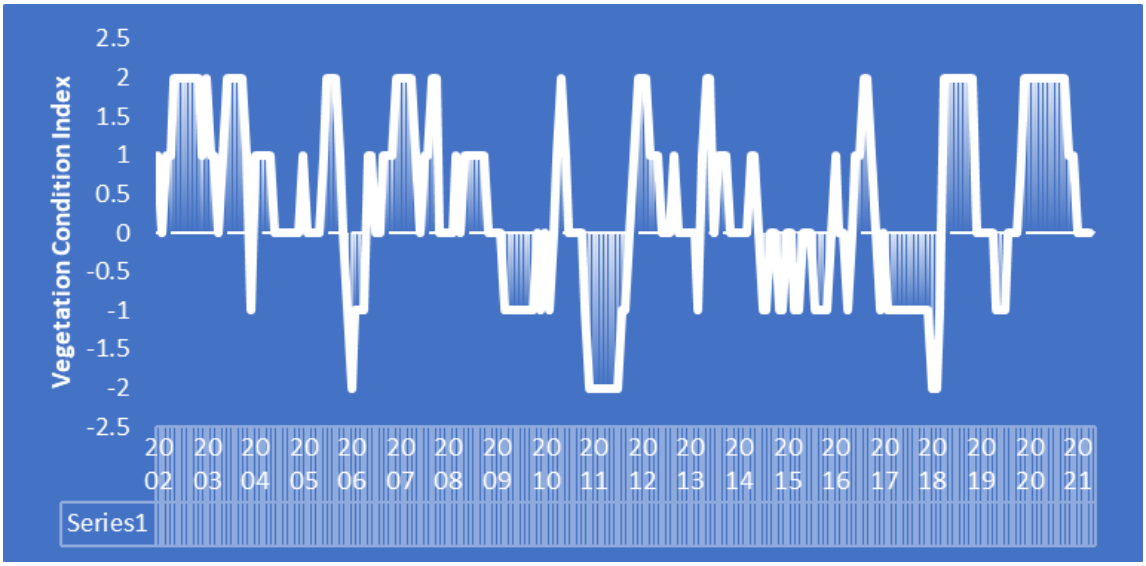



**Figure 9. Vegetation condition index (VCI) indicating drought trends for Isiolo County (2002-2020). Source: NDMA,** 2021.

The scale Zero (0) is considered a duration of normal rainfall. The positive scale 1 (+) is an indication of above normal rainfall while the negative scale (-) is an indication of severe vegetation deficit or drought. This study concurs with other studies that indicated that there is increasing evidence in the frequency and extent of droughts, which are increasing as a result of climatic variations and overall global warming (Koech and Mundia, 2020; McMichael, 2011). The study also agrees with other studies conducted that indicated that drought severity and related climatic extremes have a greater impact on general livestock production, market access, and price stability (Gaur and Squires, 2018; Harison et al., 2017). Drought is the outcome of climate variability, specifically, rainfall and temperatures, which contributes significantly to the increasing instability of production and ecological resilience, hence affecting the market prices of camel milk products. These coupled with uncontrolled land use system, and lack of communal grazing plans or systems, is a threat to a sustainable system. This necessitates competition for scarce resources, thereby, stimulating frequent frictions and conflicts over grazing resources, such as pastures and water, among the camel producers.

Information's collected from the FGD's and KII's also reveal that there are more frequent movements of camels into the territories of Isiolo County, causing influx and exerting more pressure on the existing scarce resources. This coupled with lack of land-use plan in the county can

cause an inadequate enabling environment for the camel milk value chain and other livestock-based products.

### 5.4 Perceptions on effects of frequent drought episodes, drivers and coping strategies

The main long-term effects of droughts as perceived by households (Table 10) included; land degradation and loss of vegetation cover (32.2%), risks involved in migrations to conflict prone areas (22.6), reduction in milk quantities (19%), drying of water sources (13.8%), emergence of invasive species (5.6%), high incidences of camel pests and diseases (4.8%), and camel losses (2%).

The drivers of these drought episodes were identified as; changes in seasonal rainfall patterns (29.7%), poor provision of security measures (28%), weak implementation of land use policies and legislation (23.5%), low veterinary diseases control (15.4%), and livestock influx from other regions causing increasing carrying capacities due to overstocking (3.4%).

The households coping mechanisms used for drought disasters were; milk sales for purchase of foodstuffs (36.1%), sale of male camels for incomes and school fees (24.4% ), retention of female camels for breeding (21.3% ), sourcing of breeding bulls for breed improvement (8.7%), control of dry season grazing areas for dairy camels (7.1%), and migrations to areas with good pastures and water sources (2.4%).

**Table 9: Awareness of households about drought episodes, drivers and their coping strategies**

| **Perceptions on effects of frequent droughts** | **Percent (%)** |
|---|---|
| Land degradation and loss of vegetation cover | 32.2 |
| Risks involved in migration to inaccessible and conflict prone areas | 22.6 |
| Reduction in milk quantities | 19.0 |
| Drying of water sources (rivers, wells and boreholes) | 13.8 |
| Emergence of invasive species | 5.6 |
| High incidences of camel pests and diseases | 4.8 |
| Camel losses or death | 2.0 |
| Total | 100.0 |
| **Drivers of emerging changes** | |
| | Percent |
| Changes in seasonal rainfall patterns | 29.7 |
| Poor provision of security measures | 28.0 |
| Weak implementation of land use policies and legislation | 23.5 |
| Low veterinary diseases control (vaccination and treatment) | 15.4 |
| Livestock influx from other regions causing increasing carrying capacities due to overstocking | 3.4 |
| Total | 100 |
| **Possible options for coping mechanisms of drought disasters** | |
| | Percent |
| Milk sales for purchase of household foodstuffs | 36.1 |
| Sale of male camels for incomes and school fees | 24.4 |
| Retention of female camels for breeding | 21.3 |
| Sourcing of breeding bulls | 8.7 |
| | 7.1 |
| Control of grazing areas for dairy camels | |
| Migrations to areas with good pastures and water sources | 2.4 |
| Total | 100 |

### 5.5 Categories on land use systems and perceptions on county land use policies

The result show that presently only 67% of their previous communal grazing areas are accessible for grazing. About 15.2% of the respondents perceive those parts of the previously communal grazing areas are currently under settlements, crop farming (9.8%), wildlife conservancies and game reserves (9.8%), and community conservancies at 1.8% (Table 11). Also, over ninety per cent of the respondents indicated lack of awareness on Isiolo County policies and legislations. They further reiterated that there is inadequate implementation and enforcement of the County livestock policy and legislations due to lack of effective institutional coordination in place. This is observed through inadequate mechanisms to deal with transboundary dispute resolutions and conflict managements that is prone in the county.

Perceptions on time of use of land between seasons (short and long rains), indicated that only 18.8% of the communal grazing lands are used all year round. About 75% belief that most of the grazing take place during short rains and only 6.2% of the grazing areas are accessible for use during the long rains. Apparently, these indicate there is change in seasonality as the short rains become more reliable and dependable than in the previous years. These challenges combined with socio-cultural practices of the pastoral communities in the County, who mainly practice nomadic pastoralism as their main land use system without any control mechanisms, causes the land use system in the county quite unsustainable. The researcher's triangulation finds that these cultural practices (e.g. traditional livestock production and land use system) can no longer sustain the existing livestock value chains. The major reasons are that: firstly, the production system is challenged with the availability of grazing resources because the county is always on alarm and emergency drought cycles and secondly, there is increasing reduction in rainfall regimes all year round. These affects the consistent supply of camel milk products, and hence the overall sustenance of the livestock food system in the county.

**Table 10: Categories of land uses and perceptions on county land use policies**

| Land use | Responses | |
|---|---|---|
| | N | Percent |
| Grazing | 190 | 67 |
| Settlement | 43 | 15.2 |
| Farming | 28 | 9.8 |
| Wildlife conservation and game reserves | 18 | 6.3 |
| Community conservancies | 5 | 1.8 |
| Total | 284 | 100 |

## 5.6 Perceptions of camel milk micro actors on challenges to sustainable camel milk value chain

The result shows that the main challenges include drought (20%), insecurity (16%), lack of environmental policy (15%), high milk spoilage (14%), high transportation cost (9%), inadequate capital (5%), poor rods (5%), low demand (4%), poor market (3.5%), low business skills (3.5%), illiteracy (3%) and unstable prices (2%) (Figure 9). This study with studies done in southern Ethiopia, Somalia, and Saudi Arabia that show challenges in sustainable value chains due to weak interconnectedness of the camel milk value chain actors and poor coordination or institutional arrangements (Anastasiadis & Poole, 2015).

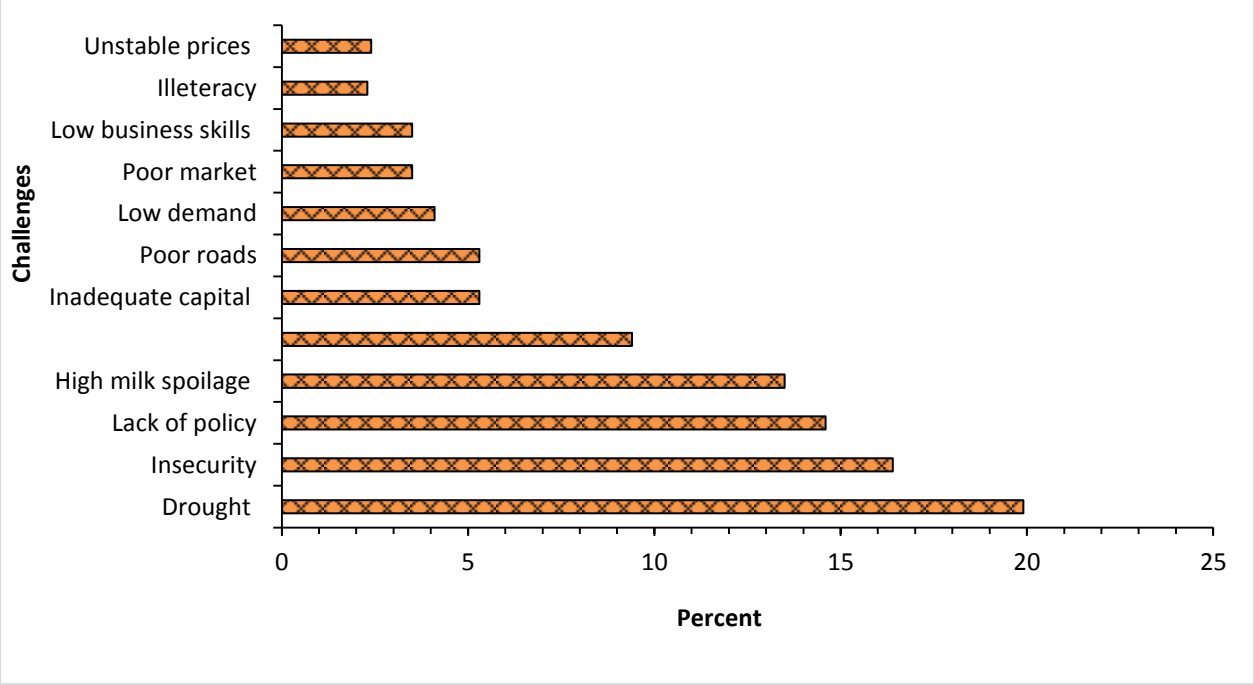



**Figure 10: Perceptions on risks affecting sustainable camel milk value chain in Isiolo County**

It is, therefore, true with the fact that the challenges in the overall camel milk value chain, particularly in the ASAL of the Sahel and Horn of Africa, are characterized by informal marketing systems (FAO, 2014). The high incidences of droughts couples with insecurity and lack of policy in place, is an indication of lack of effective and efficient regulatory frameworks in the county, to create an enabling environment a sustainable value chain system. Thus, the study agree with Colonna (2014), which reveals that inappropriate market regulatory mechanisms have great impact on productivity, market access, and price stability. It's also in line with Ericksen (2008a) indicating that unless local food systems, underlying value chains, and environmental integrity are strengthened, information for designing interventions for sustainable value chains may not be effective in the policy-making process.

### 5.7 Perceived solutions for improving quality and safety of products traded in the County

Over 40 per cent of the respondents indicated that sustainability can be achieved if reliable market infrastructure is put in place, security in the area enhanced, improve roads (transport), stabilize market prices and disease control among others.

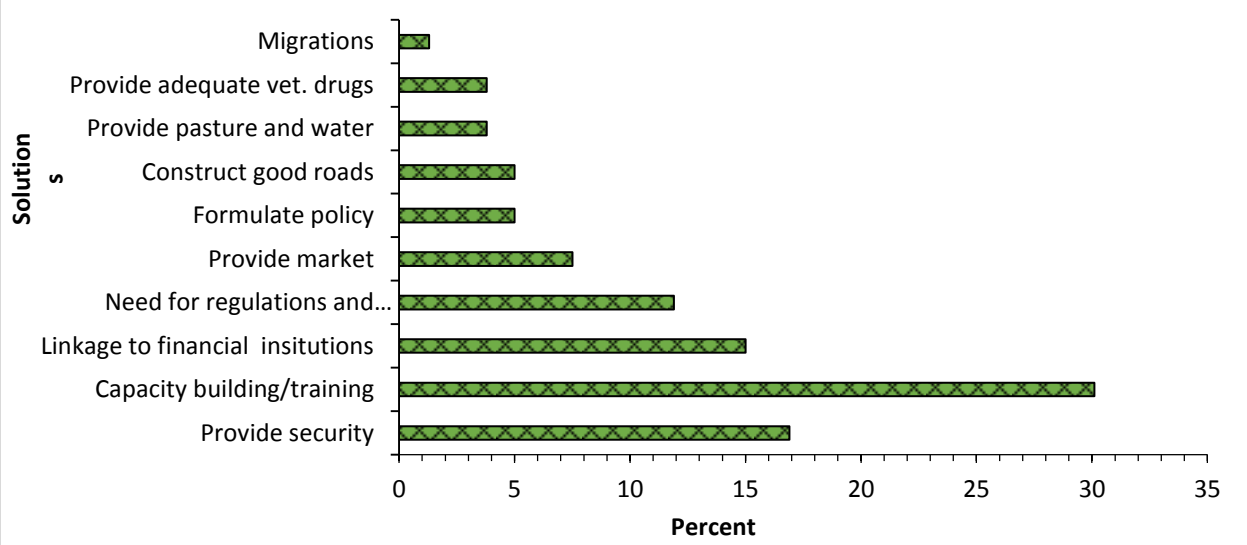



**Figure 11: Perceived solutions to challenges in the camel milk value chain**

# CHAPTER SIX
# EVALUATION OF REGULATORY FRAMEWORKS GOVERNING CAMEL MILK VALUE CHAIN IN ISOLO COUNTY

## 6.1 Introduction

This chapter included analysis of existing global, regional, national policies and legislations that govern the overall livestock food system, mainly the dairy sub-sector. The types of markets with their specifications and other requirements in livestock and livestock products were also included in the analysis. The study established three distinct categories of markets. These include (i) local or domestic market requirements, (ii) regional markets and (iii) international export markets requirements. The local or domestic market takes care of the intra and inter-County trade as well as the national level while the regional market is based on the REC agreements such as the COMESA, IGAD and EAC. The International markets include export markets such as European Union (EU), United States of America (USA) and Middle East markets.

Globally, livestock and livestock products trade requirements are governed by WTO-TBT Agreement (for technical regulations, standards & conformity assessment procedures) and WTO-SPS Agreement for sanitary and phytosanitary requirements i.e. health and safety requirements. The regulations stipulate that the member countries have the pre-requisite mandate to comply with international standards (OIE, CAC) for livestock and livestock products with known animal health status (Animal identification and traceability) with minimal contamination. These products should maintain agreed thresholds or low preference of trade sensitive and zoonotic diseases proven by effective and consistent residue monitoring and control plan (WTO, 2012). The evaluation of the local and national existing food system regulatory mechanisms shows that there's potential for expansion of camel milk value chain at both levels.

## 6.2 Regional and international market requirements for livestock and livestock products export trade

The result indicates that different markets (regional and global) have different requirements for products (Table 12). For example, the external markets such as the European Union (EU), United States of America (USA), and the Middle east markets have almost the same level of requirements and compliance for import products. Food safety certification and residue monitoring plan (RMP) are mandatory. However, the national control of the flow of these products indicates lack of

adherence to these standards. This is an indication of weak regulatory mechanisms both at the national and county levels.

**Table 11: Regional and international market requirements for livestock and livestock products export trade**

| Market | *Criteria* | *Requirement* | *Comment for potential exporting Country* |
|---|---|---|---|
| European Union (EU) | Animal health status | Yes | Must be member of OIE & fulfill health standards + determine BSE status |
| | Food safety certification | Yes | System inspected by EU inspectors + food lab accredited + HACCP |
| | Animal identification and traceability (AIT) | Yes | Comply with OIE standards of AIT |
| | Residue monitoring plan (RMP) | Yes | Must have RMP approved by EU annually |
| United States of America (USA) | Animal health status | Yes | US officially recognizes health status. Must be free from diseases + others |
| | Food System certification | Yes | Supplier to be inspected, audited, verified & approved; food lab must be accredited; upholds WTO standards |
| | (AIT) | Yes | Imported milk must meet labeling / branding requirements |
| | Residue monitoring plan (RMP) | Yes | Must implement RMP equivalent to US *"National Residue Program for dairy products"* |
| | | | |
| Middle East Markets (UAE) | Food safety certification | Yes | System inspected by UEA inspectors + food lab accredited + HACCP |
| | AIT | Yes | Comply with OIE std of AIT |
| | RMP | Yes | Must have RMP approved by UEA annually |
| National | Animal health status | Not known | • Free status from trade sensitive diseases<br>• Screening areas developed and quarantine system imposed<br>• Enforce disease barriers legislations e.g. cross border based |
| | Food safety certification | Not requested or demanded | • System partially aligned with CAC (Certification by Public Health for food products e.g. meat and milk<br>• Need to enforce and align with CAC and HACC standards |
| | AIT | Very limited (Practiced in existing few ranches) | Only movement permits |
| | Residue Monitoring Plan (RMP) | **Does not exist** | Need to be developed and institutionalized |

This study therefore concurs with the recommendations of Kumar (2010) for the need to develop innovative policies and regulatory frameworks that would enhance control of quality and standards for livestock-based products for sustainable commercialization of priority value chains in Isiolo County. It is imperative to understand that the sustainability indicators for sustainable livestock

food system is coined at the center of the dynamics of existing markets, livestock diseases control, management of the natural resources which directly or indirectly affect the production system and the policies in place.

### 6.3 Categories of Support Institutions Involved in the Camel Milk Value Chain in Isiolo County

The research findings indicate that various institutions provide support for the development of camel milk value chains in the County (Figure 11). The International development agencies (39%) and local non-governmental organizations (21%) play a significant role in supporting camel milk value chain, together adding up to 60%. The community (18.8%) and county government (17%) contribute up to 35.8% while the national government play the least role (4.2%).

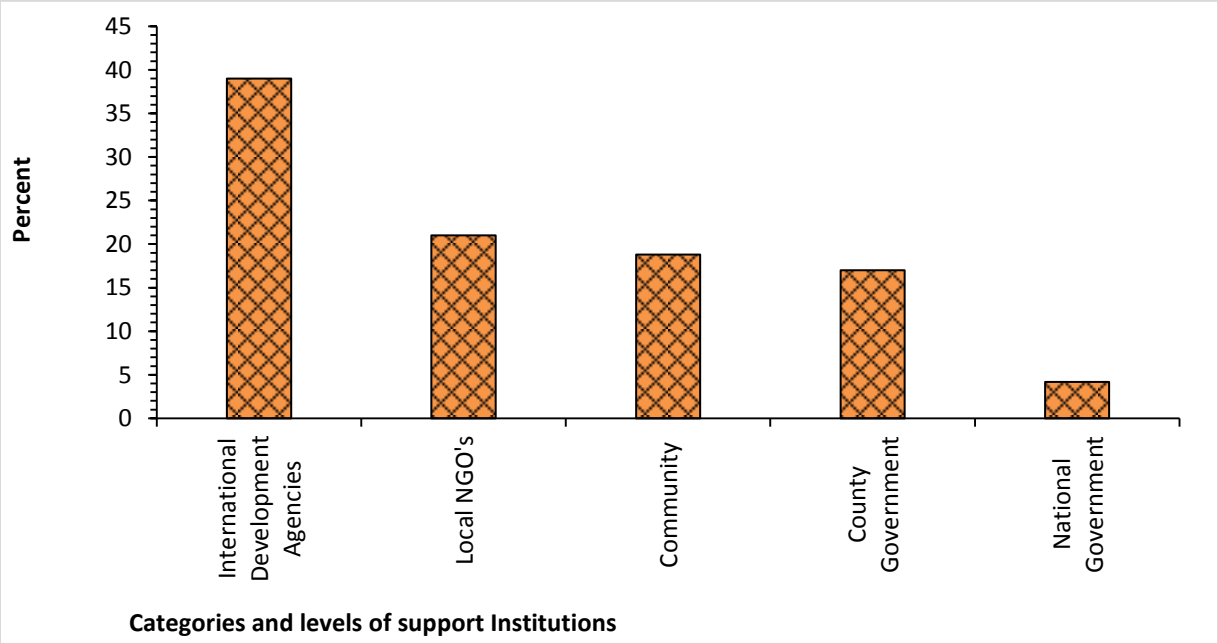



**Figure 12. Categories and levels of support institutions for camel milk value chain in Isiolo County**

Further analysis has indicated that 82.5 per cent of the respondents said that the networking of these organizations in the County is weak and hence poor coordination mechanisms. Only 17.5 per cent of the respondents acknowledge that the existing institutions "somehow work together" meaning they are poorly coordinated. This is also evidenced by poor monitoring and evaluation of value chains activities as observed during the survey. Those who indicated slightly joint working

of the stakeholders associate these when there are opportunities for opening new markets or other workshops conducted by public or private organizations.

### 6.4 The type and role of Institutions that support the development of camel milk value chain in Isiolo County

The results indicate that the major functions of the County Government include revenue collection (44.8%), provision of security (25.2%) and market infrastructure development (28.7%) (Table 13). The national government role includes provision of security (39.2%), market infrastructure development (34.2%) and formulation of policy (26.7%). On the other hand the community role includes enhancing security (58.2%), market management (31.6%) and involvement in the provision of services (buying and selling) at 10.1%. In summary, the critical indicator for the sustenance of livestock food system is security (41%), market developments (31.5%) and policy formulation (9%) and others only sharing 18.5%. The limitation is that the County Government is not associated with the formulation and enforcement of policies and legislations but rather as mainly tax collection.

**Table 12: The type and role of Institutions that support the development of camel milk value chain in Isiolo County**

| **County Govt. Role** | Responses | | Percent of Cases |
|---|---|---|---|
| | N | Percent | |
| Collection of revenue. | 64 | 44.8 | 66.7 |
| Provide security. | 36 | 25.2 | 37.5 |
| Improve infrastructure of current market. | 41 | 28.7 | 42.7 |
| Financial support | 2 | 1.4 | 2.1 |
| Total | 143 | 100 | 149 |
| | Responses | | Percent of Cases |
| **Community role** | N | Percent | |
| Enhance security. | 46 | 58.2 | 60.5 |
| Managing the market, | 25 | 31.6 | 32.9 |
| Buying and selling goods and services. | 8 | 10.1 | 10.5 |
| Total | 79 | 100 | 103.9 |
| | Responses | | Percent of Cases |
| **National Govt. role** | N | Percent | |
| Ensure proper market infrastructure. | 41 | 34.2 | 64.1 |
| Provide security. | 47 | 39.2 | 73.4 |
| Formulate policy. | 32 | 26.7 | 50 |
| Total | 120 | 100 | 187.5 |
| **Local/International** | Responses | | Percent of Cases |
| **Development agencies** | N | Percent | |
| Construction of market | 59 | 77.6 | 83.1 |
| Informing the community about market trends | 9 | 11.8 | 12.7 |
| Linking buyers to markets | 8 | 10.5 | 11.3 |
| Total | 76 | 100 | 107 |

## 6.5 Awareness of the Actors in the Existing Camel Milk Value Chain Regulatory Frameworks

The producers are most disadvantaged, indicating a high level of lack of awareness in regulatory frameworks, existing policies, and legislation influencing the camel milk value chain in the county (Table 4). Specifically, there is low awareness of national livestock and dairy policies influencing the chain. The findings also showed the micro-actors lack awareness of the regulatory bodies and legislation that influence the system. The level of lack of awareness by producers of the consumers was found to be 84%, transporters 69%, bulking centers 67%, and producers 62% (Table 14).

**Table 13. Respondents' Awareness of Various Legislations, Policies and Regulatory Frameworks influencing the camel milk value chain**

| Awareness | Value chain player | | | | | |
|---|---|---|---|---|---|---|
| | Input supplier % | Producer % | Bulking center % | Processor % | Transporters % | Consumers % |
| **Existing regulatory frameworks** | | | | | | |
| Kenya Dairy Board (KDB) | 21 (68) | 42 (38) | 6 (33) | 79 (76) | 12 (31) | 8 (16) |
| Kenya Bureau of Standards (KEBS) | 9 (29) | 65 (59) | 15 (83) | 50 (48) | 27 (69) | 19 (38) |
| National Environmental Management Authority (NEMA) | 5 (16) | 32 (29) | 8 (44) | 24 (23) | 29 (74) | 18 (36) |
| Public Health | 26 (84) | 52 (47) | 18 (100) | 84 (81) | 32 (82) | 22 (44) |
| Existing policies | | | | | | |
| National livestock policy (NLP) | 7 ( (23) | 28 (26) | 15 (83) | 80 (77) | 29 (74) | 8 (16) |
| National dairy policy (NDP) | 9 (29) | 2 ( (2) | 3 (17) | 31 (30) | 9 (23) | 11 (22) |
| Sustainable Development Goals (SDGs) | 7 (23) | 15 (14) | 2 (11) | 22 (21) | 10 (26) | 18 (36) |
| Existing legislations / laws | | | | | | |
| The Constitution of Kenya, 2010 | 15 (48) | 38 (35) | 12 (67) | 85 (82) | 32 (82) | 32 (64) |
| The Dairy Industry Act | 11 (36) | 40 (36) | 15 (83) | 76 (73) | 14 (36) | 13 (26) |
| Public Health Act | 28 (90) | 40 (36) | 15 ( (83) | 76 (73) | 14 (36) | 13 (26) |
| Standards Act | 6 (19) | 42 (38) | 16 (89) | 90 ( (87) | 30 (77) | 41 (82) |
| Food and drug abuse | 23 (74) | 18 (16) | 11 (61) | 83 (80) | 28 (72) | 14 (28) |
| Animal diseases act | 18 (58) | 36 (33) | 16 (89) | 80 (77) | 31 (79) | 21 (42) |
| Environmental Management Coordination Act (EMCA) | 10 (31) | 79 ( 72) | 18 (100) | 92 (89) | 39 (100) | 37 (74) |
| Isiolo County Livestock Sales Yard Act, 2016 | 8 (26) | 20 (18) | 7 (39) | 14 (14) | 14 (36) | 6 (12) |
| Isiolo County Climate Change and Adaptation Act, 2017 | 6 (19) | 10 (9) | 10 (9) | 28 (27) | 18 (46) | 11 (22) |

The nominal values represent those who responded yes, while figures in parentheses show the frequency in the levels of awareness (%).

These requirements are well specified for the requirements for live animals and meat export trade. The requirements are therefore short of providing standards for quality and safety measures for dairy products such as camel milk. This study therefore concurs with the recommendations of Kumar (2010) for the need to develop innovative policies and regulatory frameworks that would enhance control of quality and standards for livestock-based products for sustainable commercialization of priority value chains in Isiolo County. It is imperative to understand that the

sustainability indicators for sustainable value chains is coined at the center of the dynamics of existing markets, meeting the requirements for these markets through control of trade sensitive diseases and the management of the natural resources through establishment of effective regulatory mechanisms which directly or indirectly affect the production and market system.

## 6.6 Evaluation of the existing National livestock food system regulatory and legislative frameworks

### 6.6.1 Agricultural sector reforms on national food policies and development strategies

The livestock sub-sector has undergone immense reforms and policy adjustments over the last four decades. Some of these reforms have not been favorable to the development of livestock sub-sector especially the Structural Adjustment Programme (SAP) of 1980's which led to removal of price controls and unregulated liberalization that triggered unfavorable market requirements for livestock-based products. This initially disfranchised the livestock and livestock-based products market systems and raised the levels of vulnerability in the system especially rural areas where the impact of informal and low market prices has most been felt. Some of the livestock sub-sector plan reforms aimed to boost livestock development in Kenya included: (i) The Sessional Paper No. 4 of 1981 (National Food Policy), (ii) Sessional Paper No.1 of 1986 (Economic Management for Renewed Growth), (iii) Sessional Paper No.1 of 1992 (Development and Employment in Kenya) and (iv) various National Development Plans. The main focus of these policy reforms and strategic plans was to improve economic management, accelerate national development, reduce poverty and food insecurity through commercialization and technological innovations in livestock value chains.

Specifically, a major problem in livestock food system was realized during the Sessional Paper No.1 of 1986 (Economic Management for Renewed Growth). The major setbacks were price and market liberalization, beneficiary participation and cost-sharing, parastatal reforms and restructuring and reorientation of policies to make the economy export driven in response to changes in the international economy. This was also followed by the National policy reform paper on public enterprise reform and privatization (1992) which focused on improving the productivity of state enterprises by privatization of commercial enterprises as strategic and non-strategic, streamlined to be under the public ownership (GOK, 2006). These negative impacts made the Government of Kenya re-think and re-engineer it's policies and programmes hence the initiation of ERS (2003-2007) and SRA (2004) initiated during the inception of NARC Government under

President Mwai Kibaki's regime. Although some of these strategies considered private sector led growth, there still exist no effective or harmonized coordination framework to achieve the overall objective.

However, currently the National frameworks related to the livestock sub-sector are still anchored on the National Livestock Policy (2008) document which is now overdue for review. The primary responsibility for coordination and implementation of livestock and livestock products development is under the state departments of livestock development and veterinary services. The apex organizations for livestock food system include the Kenya Dairy Board (KDB, Kenya Meat Commission (KMC) and the Kenya Livestock Marketing Council (KLMC) which is the advocacy organ for livestock marketing in ASAL areas. The other critical frameworks that influence the sustenance of livestock food system include Kenya Bureau of standards (KEBS) for product quality control and standardization, National Environment and Management Authority (NEMA) responsible for waste management and environmental integrity and the County Public Health department in charge of food safety and certification. Following are also critical in the sustenance of livestock food system:

(i) The Animal Diseases Act, CAP 364, 1965 was revised in 2012: This is an act of parliament that provides for the control of animal diseases and parasites and for measures to promote animal health. It is concerned with the control of animal diseases and quarantine of animals when at risk of spreading diseases. It is also concerned with the rules on vaccinations as well permits for animal movements. It also anticipates the reporting of notifiable diseases to the director of veterinary services (DVS), both at national and county levels.

(ii) Veterinary Surgeons and Veterinary Para-professionals Act, 2011: This is an Act of Parliament that provides for the training, registration and licensing of veterinary surgeons and veterinary para-professionals; it also provides a legal framework for matters relating to animal health services and welfare, and for connected purposes.

(iii) Investments Promotions Act of 2004: An Act of Parliament to promote and facilitate investment by assisting investors in obtaining licenses that are necessary for investing and by providing other assistance and incentives and for related purposes.

The concern is that these regulatory frameworks have failed to provide overall coordination, continuous assessments and review of livestock policies and strategic plans in order to ensure continued relevance and profitability. The current National Livestock Policy (2008) has already become outdated and requires review. The policy is not also consistent with the current Constitution of Kenya (2010) and the County Governments Act, 2012. Since the functions of livestock development is devolved to counties under Schedule Four of the Constitution of Kenya (2010), there is, therefore, the need to develop county specific policy and regulatory mechanisms for livestock food systems aligned with the new legislations. Further, building of capacities in the counties need to be undertaken to impart competencies in leadership and technical skills so as to meet the sustainability of the overall livestock food system.

Apparently, the Kenya blue print development agenda (Vision 2030) with the aim to commercialization and development of livestock markets infrastructure for the arid and semi-arid regions is a justification for the need to develop the livestock value chains. The target is to improve and establish livestock products processing facilities (milk factories, abattoirs) for milk, meat, and other livestock byproducts in order to increase the revenue base. Other national flagship projects that support facilitation for the development of camel milk value chain in the county include; the Lamu port Southern Sudan Ethiopia transport (LAPSSET) Corridor, Isiolo regional international AirPort, and the Resort City development plans. These projects are anticipated to have impact on the sustainability, not only on the camel production but entire livestock food system, due to anticipated increases in population growth and urbanization that triggers high demand for transformations of animal products to sustain the growing population in Isiolo County. These, therefore, will influence a paradigm shift in the sustainable development of livestock value chains that put a lot of pressure on the scarce natural resources. Hence, the need for transformation from one tier traditional food system to agri-industrial food system to cope with Kenya's vision agenda for transition to middle income country.

## 6.7 Results of household survey on awareness of National livestock food system regulatory frameworks

### 6.7.1 Awareness of National Livestock Food System Regulatory Frameworks

About 50.4% of the respondents confidently said there are no food system policies in place while 47% are either not aware or they are undecided on whether there exist any policies governing food

system. However, only 2.6% of the respondents have indicated the existence of food policies. The few respondents (2.6%) who are aware of the existing food system policies associate the food system regulatory framework with the existence of livestock policy (2008) in relation to veterinary inspections and current Isiolo County livestock sale yards Act, 2016. Its also important to note that these are mainly departmental and relevant private institutions related to livestock marketing systems. Observations have indicated that the producers who are mainly pastoral livestock keepers are not aware of the prevailing livestock policy and related legislations such as those governing dairy and dairy products, Meat Control Act and Animal Welfare Act, 2016 respectively. Hence there is knowledge gap in understanding how they may benefit more from livestock and livestock products and transformation strategies for sustainable trade in value chains as envisaged by the policy and legislation.

However, there is lack of synergy among these pieces of legislations envisaged to boost the livestock industry. The county sector development plans are supposed to match the National policies which cover a period of ten years and thereafter subject for review. One can draw assumptions from the fact that policies and legislations are made without the concept of the pastoral communities who are supposed to be the policy consumers for effective implementation. Thus there is lack of participatory planning which is an indicator of weak sustainability mechanisms in policy implementation. In Holland/Dutch, for example, the socio-cultural planning agencies have taken central role in ensuring participatory planning during policy development. This is contrary to the case in Kenya where majority of livestock keepers are neither aware nor understand the intensions of the existing policies and legislations.

The current Intergovernmental Relations Act (2012) also provides the framework on how the national and county governments relate in performing their duties to ensure that sustainable land and natural resources management are achieved. At the national level, the institutions supposedly to collaborate, carry out continuous consultations, and coordination of related activities include the frameworks such as; the departments of livestock at all levels, National Environment Management Authority (NEMA), the National Land Commission (NLC) stipulated in Chapter five, Article 60 of the Constitution of Kenya, 2010, trade department, and KEBS. In particular the enactment of the National Land Commission (NLC) and the Director of Physical Planning (Physical Planning Act, 1996) together with the devolvement of the state department of livestock development to county

government are all working independently and without effective consultative and coordination mechanism. These cause conflicts in decision making for the sustainability of the livestock food system not only in Isiolo County but all other counties with similar environments and practicing camel milk value chain. It is, therefore, imperative to have a reliable regulatory framework for productive livestock food system and sustainable natural resources utilization and conservation for sustainable commercialization.

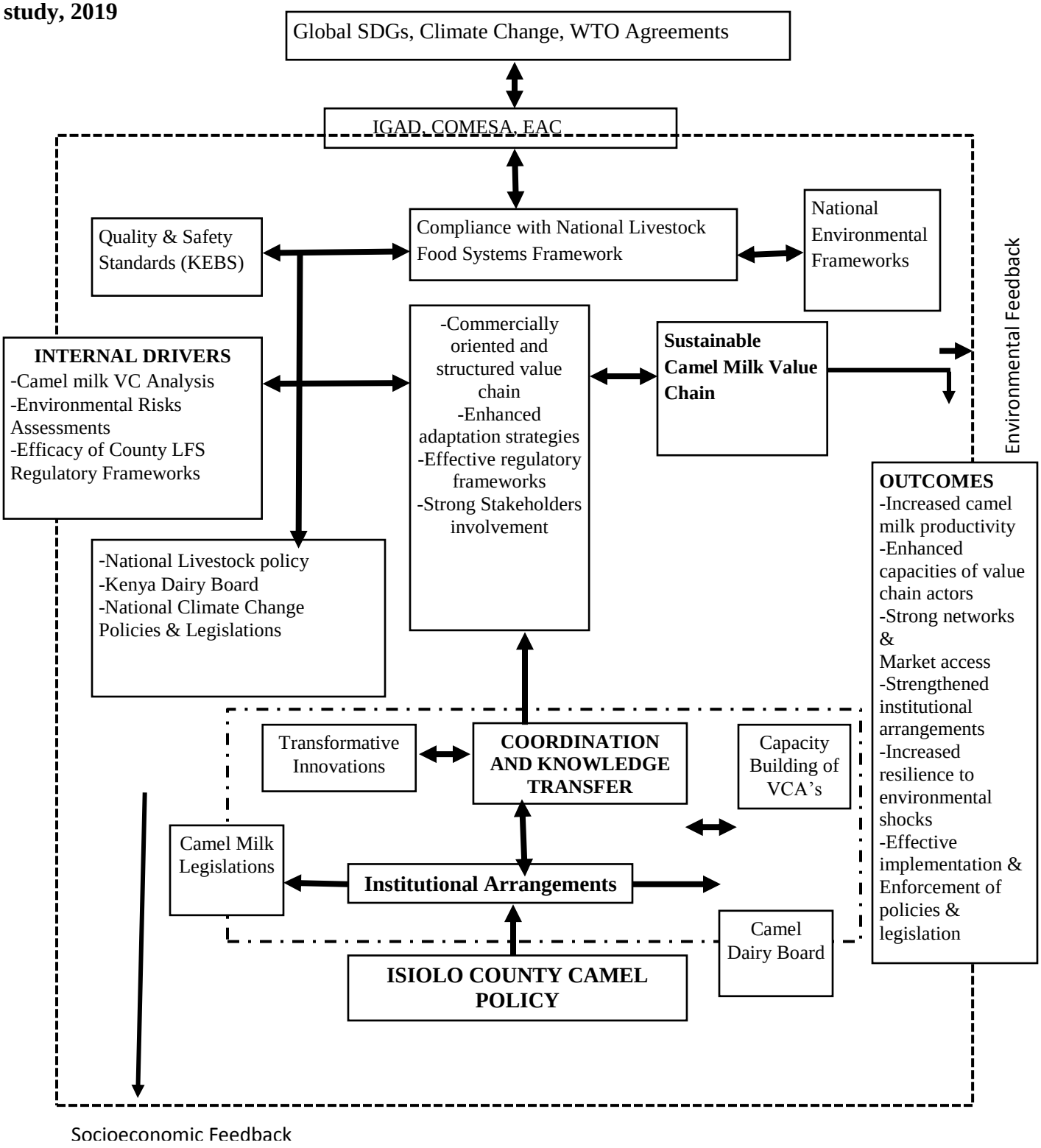
# CHAPTER SEVEN
# MODEL FOR SUSTAINABLE CAMEL MILK VALUE CHAIN IN ISIOLO COUNTY

This model was developed based on the findings from the study objectives with a focus to finding possible solutions towards factors influencing the sustainability of camel milk value chain in Isiolo County (Figure 12). Currently, the production of camel milk is dependent on the immediate environmental conditions and availability of forage materials. The major factors that influence the sustenance of the system include the high demand for camel milk products and increasing human population factors, land use system determining the productivity of the systems, environmental stressors (climatic variability and droughts), and governance systems pertaining to camel milk value chain in the County. The variables identified that affects the productivity of the system include; variations in milk supplied, milk sales and accruing benefits, low quality and safety of the milk and milk products, unreliable production systems and poor resilience to environmental shocks. The model, therefore, suggests the need for a modernized camel milk value chain system with a structured marketing system and well-connected value chain actors (e.g. producers, transporters, processors and marketers). This will reverse the present trend to a more formalized and aggregated groups with better bargaining powers for milk prices control that seem to be a major threat. At the end there will be a sustained system through increased capacities and coordination among the chain actors.

The model further shows the intervention measures to mitigate the present status of the camel milk value chain which is evidenced with low productivity, poor quality and safety products, weak resilience to environmental risks and poor institutional arrangements and coordination structures in the County. The model identifies the following as the primary intervention indicators for the sustainability of the system: (i) structured value chain with well aggregated actors (input suppliers, producers, processors, transporters, distributors and consumers), (ii) Enhanced environmental resilience and adaptation strategies through strengthening traditional land use and control structures (iii) set up of appropriate institutional arrangements and coordination structures with defined roles and responsibilities and (iv) establishment of camel policy and camel dairy board legislations that administer the camel food system. In this aspect, it's prudent to transfer knowledge and capacity building of the impoverished camel milk value chain actors and other stakeholders involved in the system.

At the global levels, the policies will be anchored on the global food system frameworks such as the WTO and the SENDAI framework (2015-2030) on drought risk reduction (DRR) and climate change strategies. At regional level, the model recommends linkages to the IGAD-IDDRSI and EDE (2015-2020) frameworks to counteract drought anomalies. These frameworks will help imparting pastoral knowledge developments towards communal rangelands or land uses, set up local institutional frameworks such as ward adaptation committees in order to build communities' resilience in environmental risks and often recurring drought episodes. Set up of these structures will also help the County benefit from the Global and regional climate change funds to reverse the current trends of low productivity and poor land use systems. At the County level, the model recommends anchorage or alignment of camel milk value chain to national policies such as National livestock policy (2008), National land policy (2012) and Climate change policy (2016). These will be harmonized with the existing County policies and legislations such as Isiolo climate change and adaptation policy (2018) and the Isiolo County livestock sales yards Act (2016) to enhance sustenance of the system.

**Figure 13: Model for Sustainable Camel Milk Value Chain In Isiolo County. Source: Field study, 2019**




**Key** ↔ Direct Linkages - - - Feedbacks ——→ Influence — · — County Intervention Strategy

In order to put control mechanisms in place, the county should put in place technical milk inspectors and laboratory technicians for bacterial load analysis and surveillance of other sensitive zoonotic diseases such as brucellosis among others. There is need also for adequate extension services providers for capacity building of camel milk micro actors on the food quality and safety regulations and requirements for both domestic and external trade. This will help put in place also the residue monitoring plan that is compliant with the national and global standards.

Hence the study recommends the establishment of Isiolo County camel policy and county camel dairy board (CCDB) that is charged with the responsibility for standards control in camel milk value chain and also oversight the sustenance of the system. The functions of the board will be to regulate in collaboration of the national government the compliance for quality and safety products. These institutional arrangements will also help the County take advantage of the Global climate fund.

# CHAPTER EIGHT
# SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 8.1 Summary of key findings

These findings are anchored on the results achieved from the research objectives. These include findings on the characteristic of livestock food system in the County, the environmental risks and the regulatory frameworks influencing the sustainability of livestock food system in Isiolo County.

### 8.1.1 Characterizing the camel milk value chain

The camel milk value chain shows a similar trend revealed in other studies, however, in Isiolo County, the system is operating in an informal marketing structure with loosely connected actors. The majority of micro actors (65%) driving the camel milk value chain were female, who despite largely lacking formal education (58%), were instrumental in bulking and processing of the milk products. Most (85%) of the milk is sold in unprocessed form and marketed without adequate adherence to stringent requirements for quality and safety measures. The capacity of milk processing is low (5%) due to lack of capacity in value addition and packaging. The local producers and most of the bulking centres use traditional production methods of fumigated milk and transporting vessels such as guards leading to high losses (20%).

### 8.1.2 Environmental risks related to sustainable camel milk value chain

Results from analysis of drought trends (2002-2017) indicated that the drought episode is exacerbated by highly irregular rainfall patterns coupled with poor distribution regime. This is evidenced by inter-annual rainfall variability with $\pm$2728.6 of milk sold between wet and dry seasons. The coefficient of variation for milk sold between 2014 – 2017 show variability of $\pm$3967.3 at $P_{(0.05)} < 0.001$. The analysis of variance (ANOVA) conducted on quantity of milk supplied during wet and dry seasons also indicated high significance difference at $P_{(0.05)} < 0.025$. This is attributed to threats of climatic variability and climate change effects. The impact has been associated with reduced milk quantities within and between seasons, low quality products and inconsistent accessibility of required camel milk volumes.

### 8.1.3 Aspects of regulatory and support services influencing the camel milk value chain

The regulatory frameworks in this study included the policies, legislation, and the institutional arrangements governing the camel milk value chain in Isiolo County. Although there are many institutions providing regulatory and support services to the camel milk value chain in the county, the low milk production and processing methods means the value chain, as currently constituted, do not offer a viable business environment. Poor institutional coordination exacerbates weak control mechanisms characterized by low awareness in regulatory aspects along the value chain. The analysis show that a structured and well-regulated system offers opportunities for increased revenue earnings from current production, by 68%.

Over 90% of the respondents have indicated lack of awareness and little knowledge on the existing regulations and legislation required for production of quality and safe products. The most unknown institutions to mainly the producers are the Kenya Dairy Board (KDB) and the Kenya Bureau of Standards (KEBS) and yet these are the main regulatory bodies for sustainable food system in the County. I also observed that there are conflicting roles among the government institutions, such as KDB, KEBS, Public Health, and County Government Authority, in the execution of their duties. It is also imperative to note that although the marketing of camel milk at the national level is a lucrative business, the quality of milk supplied is of poor quality and safety standards. Hence, the system is currently not sustainable. The major constraints that pose threats to the sustenance of the system includes: the land use system, lack of coherent policies and legislation, inadequate skills and capacities of the value chain micro-actors in handling ang processing of milk. Also, the weak networks among the actors and poor partnerships among the institutions that provide services to the system are a clear indication of weak institutional arrangements and coordination.

## 8.2 Conclusion

The major constraints to the sustenance of the camel milk value chain are attributed to low productivity, weak connectivity of the value chain actors within and between nodes exacerbating informal market channels, unusual drought episodes mainly due to weak institutional arrangements and coordination structures to implement and enforce the existing policies and legislations respectively. These conditions affect the supply chain from production, transportation, processing and distribution to final consumption of the products. The sustainability of the system is highly challenged by lack of adequate livestock food system policies and legislations and more

specifically the camel policy. This is mainly predisposed by weak regulatory mechanisms and poor institutional coordination and consultation arrangements to implement and also enforce the existing policies and legislations in livestock food system. There are also extensive gaps in capacities and knowledge sharing for technological innovations among the various levels of value chain actors, weak policy advocacy and poor networking across the institutions interested in the development of livestock sub-sector in the County. However, there is great potential for camel milk value chain in the County for domestic, national and international trade.

## 8.3 Recommendations

### 8.3.1 Improve productivity of camel milk value chain

1. Develop a coherent and aggregated camel milk micro actors with strong networks for increased commercialization and incomes generations. This will necessitate a formal and organized marketing system and will enhance an increased milk production against the current informal and low levels of milk production in Isiolo County.
2. Capacity building of the value chain actors especially at production, bulking, processing, and marketing levels on quality and safety measures during handling milk.
3. Value addition and manufacturing of fresh milk into "mala" and yoghurt in order to achieve increased gains and revenue, and also to reduce the high milk losses through spoilage that is currently experienced.
4. The camel milk value chain should be well-regulated and not left to free and open trade as this affects the quality and safety of products, hence sustainability. The micro actors should adhere to the Kenya Public Health and Kenya Dairy Board regulations in order to comply with KEBS certification for external markets.
5. The county government should put more emphasis on the provision of efficient and effective extension services that streamline and capacity build the value chain actors. The target departments should include; public health on supervision of services such as cleanliness of operational premises and milk safety, the veterinary extension services on diseases surveillance and treatment to reduce incidences of trade sensitive diseases, and the livestock production extension services to oversee the primary handling and requisite standard equipment's for clean milk production.

### 8.3.2 Improve the existing regulatory frameworks through:

6. There is need to develop a county camel policy and establish a camel dairy board regulatory Authority. The policy should be aligned to the national livestock policy and the national dairy industry policy and legislations. This regulatory board will oversee the sustainability of camel milk value chain and provide mechanisms for control and coordination among the camel milk value chain actors.
7. Establish Isiolo County Land Use Policy (ICLUP) with strong institutional frameworks for implementation and enforcement of land use plans for adequate utilization of grazing resources (pasture and water) and reduce resource use conflicts. The policy should focus also on the formulation of peace and conflict resolution mechanisms which is paramount for sustenance of the camel milk value chain system. This is in line with the requirements of the current community land Act, 2016, the National community land management and land registration legislative frameworks (2012) guided by the National land policy, 2012. The outcome is anticipated to reverse the source of land use conflicts as stipulated in National community land management and registration (2012).
8. The county should also put in place an effective county drought risk management policy (DRMP) to mitigate the current drought anomalies. The policy should be aligned with the National climate change policy (2017). The creation of an internal drought management authority will guarantee sustenance of the system and enable the county benefit from the Global and National climate change and adaptation funds.

## 8.4 Recommendations for further research

Camel milk value chain is an important livelihood base that cushions the pastoral community's requirements for food and other social amenities. Therefore, there is the need for further research to:

(i) Interrogate the dynamics of the camel milk value chain and explore opportunities to modernize the system sustainability.

(ii) Address the emerging camel diseases that are also becoming more prevalent and affecting the production, which ultimately translates to low gains to meet the socio-economic needs of the chain dependents.

(iii) Understand and align the better management of communal lands in a manner that strengthen ownership and production systems.

**(iv)** Develop frameworks for the regional coordination and integration mechanisms for effective implementation and enforcement of the global standards for quality and safety control measures in a camel milk value chain.

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## APPENDICES

### Appendix I: Questionnaire

**UNIVERSITY OF NAIROBI**

CENTRE FOR ADVANCED STUDIES IN ENVIRONMENTAL LAW AND POLICY

(CASELAP)

**Declaration:** ***The information obtained from the respondent as part of this Questionnaire will be confidential and will only be used for academic purposes.***

Survey Area/Sub-County……..

Ward …….....

GPS reading; Northings……..Easting…….

Interviewer…….Date……

### Part I: Background on Household Characteristics

1. Name of respondent……..

Please fill the table below:

| Household Members | Sex | Age | Relationship to HH head | Level of Education (primary, secondary, tertiary, university) | Occupation\ Employment | Monthly Income (Employ) (salaried, casual, contract, pastoral or livestock based, farm or crop based, others(specify) | Remarks |
|---|---|---|---|---|---|---|---|
| 1. | | | | | | | |
| 2. | | | | | | | |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |
| 6. | | | | | | | |
| 7. | | | | | | | |

Please tick appropriate for the following:

***Age brackets***: [ ] 01-17years [ ] 18-35years [ ] 36-43years

[ ] 44-61years [ ] 62-79years [ ]Over 80years

***Relationship to HH***: [ ] Husband [ ] Spouse [ ] Son [ ] Daughter [ ] Relative [ ] Others (Specify)

2. When did you settle in the present area of residence? Please tick appropriate

[ ] Before 1970 [ ] 1971-1980 [ ] 1981-1990 [ ] 1991-2000 [ ] 2001-2010

[ ] 2011 up to date

3. Why did you choose to settle in the area? Tick appropriate

[ ] Ancestral home [ ] Livestock rearing [ ] Crop production

[ ] Commercial or trade purposes [ ] Settled by Government

[ ] Security [ ] others e.g. Acquire relief food services

**Part II: To characterize livestock food system**

**4. Indices of livestock category sold in the last one year**

| Category of animal sold | Area/location of production | Destination market | Distance from point of origin | Reason for preference market | Price offered | Remarks |
|---|---|---|---|---|---|---|
| Cattle | | | | | | |
| Sheep | | | | | | |
| Goat | | | | | | |
| Camel | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Other products (specify) | | | | | | |

5. When do you sell animals mostly?

[ ]Wet season [ ]Dry season [ ]All year round [ ]Do not sale

6. Purpose for sale

[ ]When need arises e.g. household demand [ ]School fees [ ]Business/trade [ ]Restocking [ ]Others (specify)

7. What problems do you experience when marketing your animals?

……
……
……
……

8. What is your suggestion for overcoming the problems you highlighted?

……
……
……
……

**Part III: Camel milk value chain and challenges**

9. Which category of camel milk value chain node are you involved?

| Category of value chain node | Area/location of production | Destination market | Distance from point of origin | Reason for preference market | Price offered | Remarks |
|---|---|---|---|---|---|---|
| Input | | | | | | |
| Production | | | | | | |
| Transportation | | | | | | |
| Bulking | | | | | | |
| Processing | | | | | | |
| Marketing | | | | | | |
| Others (specify) | | | | | | |

……

……

10. Specify type of product you are involved (Fresh milk, Yoghurt, Mala)

……

11. How do you benefit from the product

……

……

……

12. Which camel milk value chain-based organizations (e.g. cooperative societies) exist in the area? Please list and their functions:

**.....**

……

……

……

13. What challenges do these groups experience in enhancing sustainable camel milk value chain in your area?

……..

……
……

14. What are the possible options to mitigate the challenges?

……

……

……

15. Please prioritize the support services that enhance camel milk value chain in your area: [ ] County Government [ ]International development agencies [ ]Local NGO's [ ] CBO's [ ]Community [ ] Others (specify)

16. Do camel milk value chain regulatory frameworks (policies, legislations, institutional arrangements) exist in your area? YES/NO

If YES please name them

……
……
……

17. What challenges do you experience with these frameworks you have mentioned?

18. What do you suggest to improve the situation?

.....
.....
.....

19. Do you have market-based information/communication networks? YES/NO

20. What is the mode of transmission? [ ] Mobile phone [ ] e-mail [ ]Letter [ ]Verbal or traditional

21. What kind of information is most important for you to know?

**……..……**
**……...**

**……...**

**Part IV: Quality control and safety measures**

22. Are you aware of any dairy products control systems? YES/NO

If YES please name them?

**……..……**
**……...**

**……..**

23. What is the mode of transportation of milk to destination market: Please tick appropriately:

[ ] Truck or lorry [ ] Donkey [ ] Motorbike [ ] Others (specify)

24. What is the role of the County Government in supporting camel milk value chain?

……
……
……

25. What is the role of the community in enhancing the system?

……
……

26. Which Development Agencies (local and international) are involved in supporting livestock food system in the County?

…….....
.....

27. Please state their activities

.....
.....
.....

28.What problems do you face in marketing your animals for quality and safety purposes?

……
……
……

29. How do you think the perceived problems can be solved?

……
……
……

**Part V: Environmental risks challenging the attainment of the sustainability of livestock food system**

**30**. Land tenure and livestock production patterns

Please fill in the table below;

| **Type of tenure** | Size of land | Uses of land | Season of Use | Remarks |
|---|---|---|---|---|
| Public/Government land | | | | |
| Communal land ownership/Free grazing | | | | |
| Community conservancies | | | | |
| Group Ranch | | | | |
| Free hold/Title deed | | | | |
| Private Ranch | | | | |

31. What problems do you face regarding land tenure?

……

……

……

32. Suggest ways in which these problems may be solved?

……

……

……

33. Which livestock production system do you use today?

[ ] Traditional/Communal free grazing [ ] Community conservancies [ ] Group ranches

[ ] Freehold [ ] Private ranching [ ] Others (please specify)

34. Please give reasons for the choice above?

……..

……..

……..

……..

35. Do you see changes in grazing patterns from the previous years? YES/NO

36. What changes do you observe?

…….

……

**.....**

……..

**PART VI: CHECK LIST FOR FGDs and KIIs**

**Focus group discussions in the identified markets (FDG's)**

- Name, registration, membership, duration and organizational structure of the group
- Activities involved and categories of traded value chains in the market
- Reliability of products supply (consistency in volumes and quality) in the existing markets by category
- Prices stability and/or fluctuations
- Reasons for the changes and/or challenges
- Possible options for sustainability
- Challenges experienced by producers, bulking centres, transporters, processors, marketers, and consumers
- Options for mitigation of the existing challenges

**Drought incidences evaluation**

Did you lose livestock in the recent droughts? YES/NO

Please list the drought episodes you encountered in hierarchy?

What were the reasons for livestock loss?

[ ] Inadequate Pastures for livestock [ ] Lack of adequate water sources

[ ] Raids from other tribes (specify) [ ] No livestock buyers though wished to sale

[ ] Weak livestock marketing structures

Please suggest possible ways to minimize the risks in future?

……
……
……

Are there changes in drought cycles? YES/NO

Give support answer for the choice above?

……
……
……

How have these changes affected the camel production? If any

……
……
……
……

In your opinion what are the drivers of the emerging changes in terms of pasture and water availability?

……
……
……
……

……
……

How do you cope with drought disasters and/or environmental related risks?

……
……
……
……

CHECK LIST FOR POLICY MAKERS AND STAKEHOLDERS

Part VII: Conformity with regulatory obligations (for County Govt, State departments and NGO's)

**County Government, State departments & NGO's:**

- Production and market dynamics of the existing livestock value chains i.e. volume of trade
- Which are the existing livestock food system regulatory frameworks in the county?
- Are there existing livestock-based policies and marketing strategies in the county?
- Are these policies and strategies operational and effective for enhancing sustainable food system?
- Do you think these policies and strategies guarantee sustainability? Support your answer
- Are there standards for marketing and pricing livestock and livestock-based products? YES/NO
- If YES, identify target market and standards required?
- Are these standards in conformity with the regional and international health certification standards for export trade?
- Which are the operational animal welfare legislations and Acts in Isiolo County?
- What are the gaps or current problems the county is facing in meeting sustainability of the overall livestock food system for domestic, national, regional and international trade?

**Food safety for export trade (Vet. Dept and Public health)**

- What control mechanisms are in place for camel milk trade?
- What challenges do you experience?
- Suggest possible options for remedy?
- Pre-requisite requirements and/or standards for regional and international trade

**Climate change, climate variability and seasonality impacts on livestock food system (NDMA, NEMA, KMS)**

- .Qualitative data on climate change impacts in the county
- Existing literature on climate variability and seasonality
- Drought episodes
- Adaptation strategies
- Experiences and departmental coordination frameworks and strategies for implementation of climate change related policies and legislations

Do you have anything to comment or ask concerning the questionnaire?

Thanks and God Bless You.

**Appendix II: Camel milk sold in litres (2014-2017): source Field Survey, 2018**

| Month/Year | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|
| | **Quantity of milk supplied** | | | |
| **January** | 60,100 | 43,817 | 55,857 | 75,000 |
| **February** | 51,890 | 50,400 | 59,120 | 80,870 |
| **March** | 59,200 | 49,735 | 63,402 | 94,120 |
| **April** | 65,400 | 79,720 | 63,402 | 88,400 |
| **May** | 64,735 | 78,130 | 97,885 | 85,300 |
| **June** | 64,720 | 62,170 | 88,904 | 82,850 |
| **July** | 63,130 | 55,780 | 64,735 | 73,905 |
| **August** | 62,770 | 59,430 | 64,720 | 79,404 |
| **September** | 55,857 | 48,540 | 63,130 | 79,720 |
| **October** | 59,120 | 54,600 | 63,713 | 78,130 |
| **November** | 63,402 | 59,400 | 160,920 | 88,130 |
| **December** | 67,533 | 65,300 | 160,920 | 90,540 |
| TOTAL | **737,857** | **707,022** | **1,006,708** | **996,369** |

**Appendix III: ANOVA table for Inter-annual variations in quantities of milk supplied between 2014-2017**

| Source of variation | d.f. | s.s. | m.s. | F | P |
|---|---|---|---|---|---|
| Year | 3 | 4217000000 | 1406000000 | 15.73 | <.001*** |
| Residual | 44 | 3931000000 | 89350000 | | |
| Total | 47 | 8149000000 | | | |

Results on quantity of milk sold over the years showed a significant ($p < 0.05$) difference. Means were separated using Fisher's LSD test at 5% level.

**Appendix III: Quantity of milk sold by years**

| Year | Quantity sold ± 2728.6 | |
|---|---|---|
| **2017** | 84689 | A |
| **2016** | 70790 | B |
| **2014** | 63130 | bc |
| **2015** | 60618 | C |

$LSD_{(0.05)} = 7777.1$

$p < 0.001$

CV(%) = 13.5

The separation of means using the Fisher's LSD test at 5% level indicate that the year 2017 had significant different compared to the others. The explanation is that there were more quantities of milk sold during this year. While the year 2016 was slightly different in terms of quantity of milk sold but there was much more similarity between 2016 and 2014. However, low milk trade was realized during the year 2015 among the others. This scenario concur with other studies conducted which reveals that inter-annual variability and respective seasonal variations suggest a shift in the bi-modal rainfall pattern which has several implications for rain fed agriculture ( Christensen, 2007; Boko et al, 2007; Kunstmann, 2005). However, although this phenomenon may not be likely the same for other value chains considered most vulnerable to climate variability (e.g. cattle, sheep and goats) the findings of the study indicate some level of resilience and reliability in production and trade of camel milk in the County.

**Appendix IV: Variations in quantities of milk sold between dry and wet seasons (2014-2017)**

| Season | Quantity sold (litres) ± 2570.8 |
|---|---|
| Dry | 65592 |
| Wet | 74021 |

$LSD_{(0.05)} = 7318.1$
$P_{(0.05)} = 0.025$
CV(%) = 18.0

**Appendix V: Determining Variation in Quantity of milk sold (litres) during wet season (2014-2017)**

| Season/Year | 2014 | 2015 | 2016 | 2017 | Totals |
|---|---|---|---|---|---|
| **MAM (Long rains)** | 189,335 | 207585 | 224689 | 267820 | **889,429** |
| **OND (Short rains)** | 190,055 | 179300 | 385553 | 256800 | **1,011,708** |
| TOTAL Quantities of milk sold (litres) | **379,390** | **386885** | **610242** | **524620** | |

*Source: Field survey, 2018*

**Appendix VI: ANOVA table for quantity of milk sold (litres)**

| ***Source of variation*** | **d.f.** | **s.s.** | **m.s.** | **F** | **P** |
|---|---|---|---|---|---|
| *Year* | 3 | 2228000000 | 742700000 | 7.86 | 0.001 |
| *Error* | 20 | 1889000000 | 94430000 | | |
| *Total* | 23 | 4117000000 | | | |

There was more milk sold during the short rains than the long rains season. This concludes that the short rains season (OND) is becoming more reliable than the long rains.

**Appendix VII: Coefficient of variation for quantities of milk supplied (2014-2017)**

| Year | Quantity of milk (litres) ±3967.3 | |
|---|---|---|
| **2017** | 89620 | A |
| **2016** | 74369 | B |
| **2015** | 66664 | B |
| **2014** | 65432 | B |

$LSD_{(0.05)}$ = 11703.4

$p_{)}$ = 0.001

CV(%) = 13.1

Note:

The quantities of milk sold over the 4 years were also compared to determine the coefficient of variation and LSD. The values not sharing the same letter (a, b) are significantly different at p< 0.05. There was no significance difference in the years2014, 2015 and 2016 in long and short seasons. The result also indicate that LSD(0.05) = 11703.4 and the **coefficient of variation as 13.1 % giving precision and validity of the study**. However, there was more quantities of milk sold in 2017 (higher than the other 3) indicating significance difference. There was more milk sold during the short rains than the long rains season. This concludes that the short rains season (OND) is becoming more reliable than the long rains.

**Appendix VIII: Regression Analysis**

**Coefficients[a]**

| Prices_Category | Coeff. | Range | Sig. |
|---|---|---|---|
| Farm gate prices per liter | 863747.625 | 676561.809 | .271 |
| | -.019 | .390 | .963 |
| Processed Fresh Milk Price per liter | -303185.108 | 713308.593 | .693 |
| | 1.008 | .485 | .106 |
| Processed Yoghurt Price per liter | -11452.282 | 13692.772 | .450 |
| | 1.516 | .177 | .001 |

**NB: The Independent variable is the predicted amount of milk produced.**
The dependent variable are the price categories at farmgate, processed fresh milk and yoghurt.

**At farmgate:**
The coefficient is negative and not significant. The interpretation is that for every unit increase in milk production, the price decreases.

**Processed fresh milk:**
The coefficient is positive and not significant, the interpretation is that for every unit of processed fresh milk, the total amount increases by coefficient value

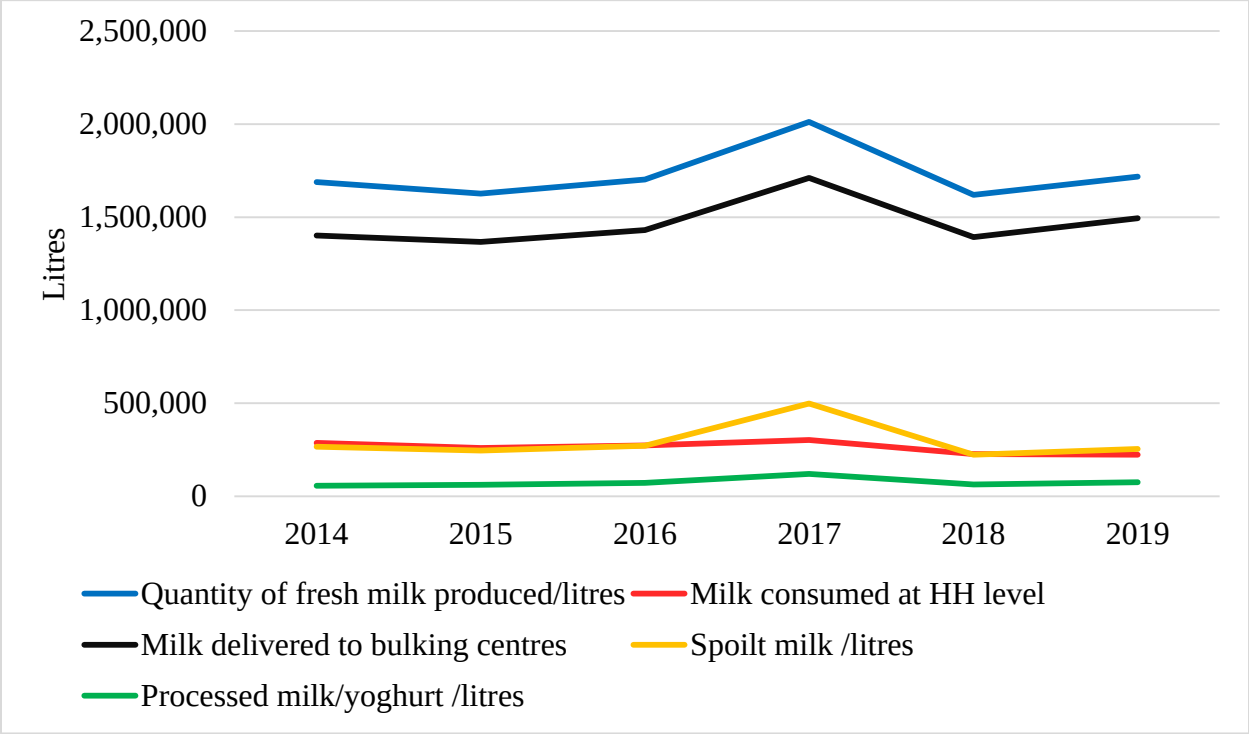
**Processes yoghurt**
The coefficient is positive and not significant, the interpretation is that for every unit of processed yoghurt, the total amount increases by coefficient value

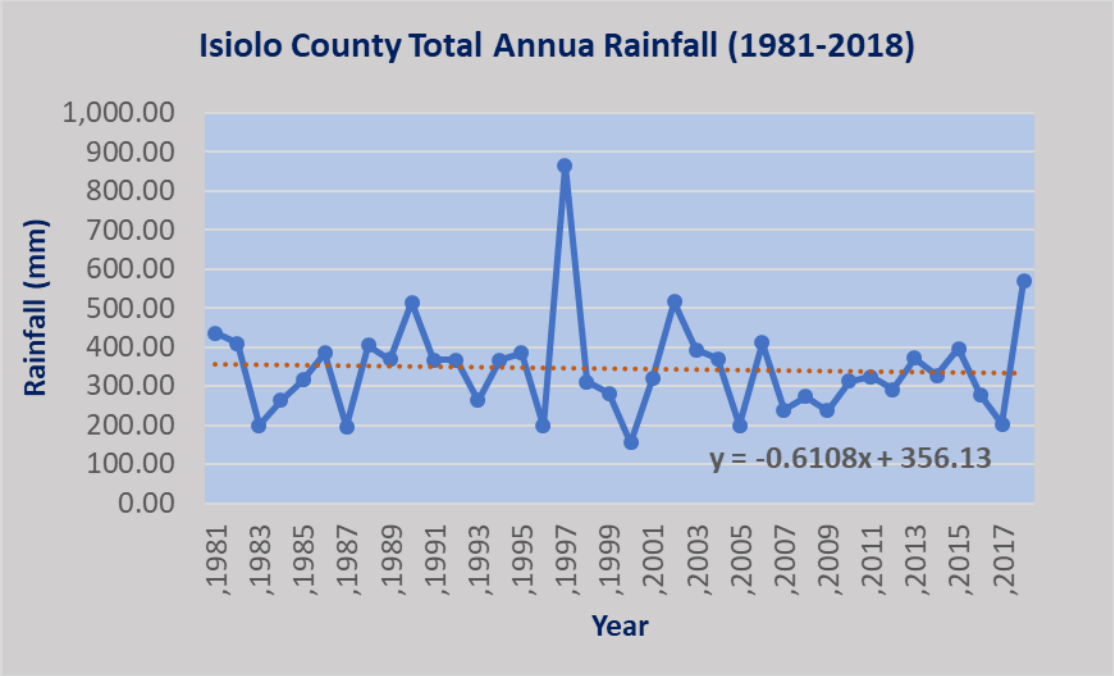
**ANOVA**

Prices

| | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 2.308 | 2 | 1.154 | 105.969 | .000 |
| Within Groups | .163 | 15 | .011 | | |
| Total | 2.471 | 17 | | | |

**Appendix IX: Graphical presentation of quantities of camel milk supplied between 2014-2019**






The rainfall analysis (fig. ) indicate that both the short rains and long rains are erratic and unreliable. There is variability in precipitation between and within seasons. The rainfall trends indicate increase in rainfall trends in the short rains (fig. ) and subsequent decrease in long rains (fig. ) from 1981-2018.

**Appendix X: Minimum and Maximum temperatures (1981-2012)**

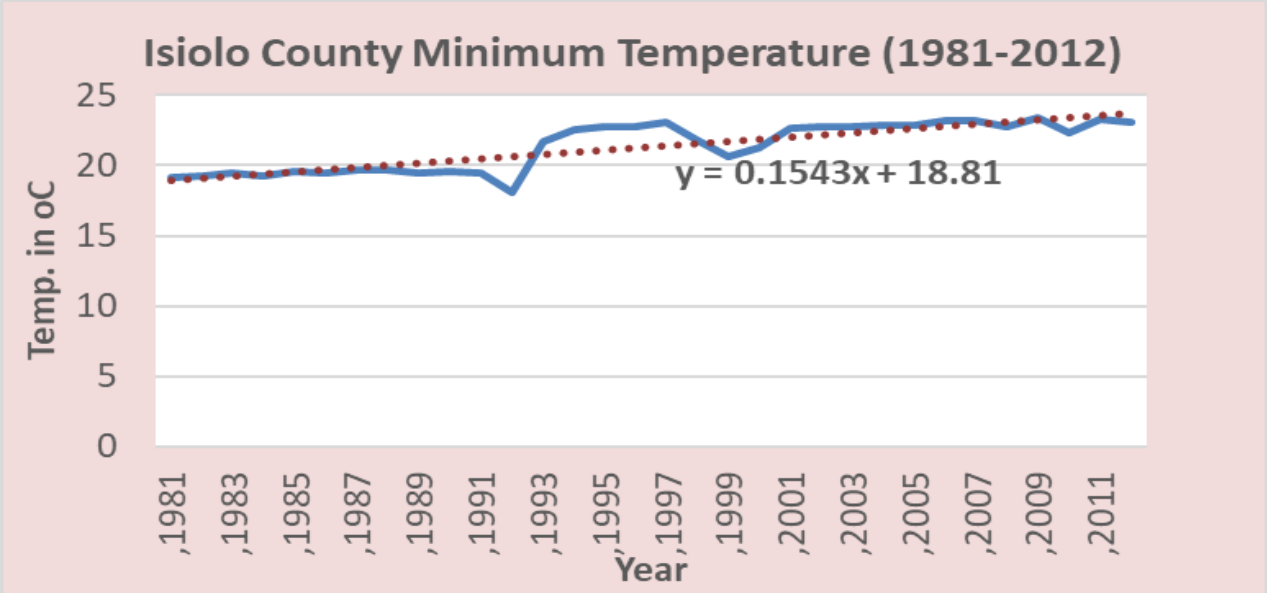



*Figure 2: Isiolo County Minimum Temperature (1981-2012):(Source: FEWSNET/GeoCLIM/RCMRD)*

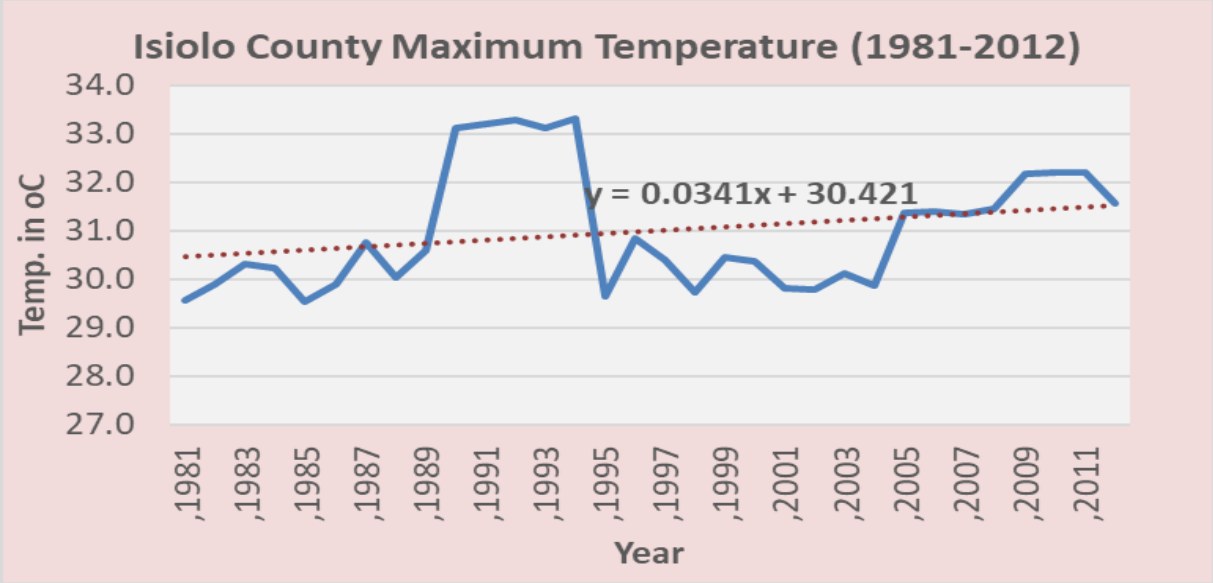



*Figure 3: Isiolo county Maximum Temperature (1981-2012): Source: FEWSNET/GeoCLIM/RCMRD*

The analysis indicates that the County has recorded average high temperatures of 29 degree centigrade. This could be influenced by variations in altitudes in different places (RCMD, 2018). The variations is described by a linear model Y=0.1543x + 18.81 for minimum temperatures (fig.

) and Y=0.0341x + 30.421 for the Maximum temperatures respectively. The analysis also indicate slight increase in temperature for the last three decades. This increase is an evidence of global climate change due to greenhouse gases (GHG's) emissions such as methane, carbon dioxide and nitrous oxide among others. Livestock through mass production of urine into the atmosphere is also believed to contribute to these GHG's due to methane highly present in urine. Other factors are mainly anthropogenic or human related activities with detrimental effect to ozone layer depletion. Locally, these effects are due to loss of biodiversity exacerbated by climatic variability, overgrazing, poor land use systems and irrational migratory patterns predisposing environmental degradation and deforestation caused by human settlements in previously livestock wet and dry seasons grazing zones.

## Appendix XI: Gantt Chart

### WORK PLAN

| Year/Months | Jan-Dec 2016 | Jan-Dec 2017 | Jan-Dec 2018 | Jan-Dec 2019 | Jan-Dec 2020 | Jan-June 2021 | July-Sept 2021 | Oct-Dec 2021 | Jan-March 2022 | April-June 2022 | July-Sept 2022 | Oct-Dec 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposal development and defense | | | | | | | | | | | | |
| Proposal refining | | | | | | | | | | | | |
| Preparation of data collection instruments | | | | | | | | | | | | |
| Training of research assistants | | | | | | | | | | | | |
| Data collection | | | | | | | | | | | | |
| Data coding and entry | | | | | | | | | | | | |
| Data analysis | | | | | | | | | | | | |
| Initial drafting of chapters | | | | | | | | | | | | |
| Final drafting of Thesis | | | | | | | | | | | | |
| Journal Article 1 | | | | | | | | | | | | |
| Journal Article 2 | | | | | | | | | | | | |
| Defense of the Thesis | | | | | | | | | | | | |
| Thesis refining and submission | | | | | | | | | | | | |
| Graduation | | | | | | | | | | | | |